FACTORS AFFECTING ADOPTION OF 15 % NaCl SOLUTION TECHNIQUE FOR SEPARATING RICE SEEDS: A STUDY OF NDUNGU RICE PROJECT IN SAME DISTRICT, TANZANIA

BY

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT FOR THE DEGREE OF MASTER OF ARTS IN RURAL DEVELOPMENT OF SOKOINE UNIVERSITY OF AGRICULTURE

2001

ABSTRACT

A study to identify factors affecting adoption of 15% sodium chloride (NaCl) solution, a seed separating technique was conducted at Ndungu rice project, Same District. A cross sectional research design, which allows collection of information at a single point in time, was adopted. Structured questionnaire was administered to a sample of 75 respondents of which 45 had adopted the salt solution technique while 30 had not. The data were analysed using the statistical package for social sciences (SPSS) computer software. The study described the importance of seed health and methods used by the farmers to separate infected seeds. In the process it was examined how informed the farmers were, their attitudes towards innovation's benefits, and the associated reasons for adopting and not-adopting the technology. The results of the present study revealed that, attitudes and practices towards method of seed selection, source of information, and level of education were significantly ($P<0.001$) associated with adoption. Some of the major factors, which limited adoption of 15 % NaCl solution technique, were insufficient water for irrigation and lack of awareness. Other limiting factors were lack of motivation and inadequate extension services, which resulted in poor participation in seminars. Although Chi-square test did not show a significant ($P>0.05$) association between extent of adoption and gender, participation of women was discouraged by their limited access to ownership of resources, information and household decisions. It is recommended that research should be geared towards conserving more water; promotion and dissemination of farming techniques which are relevant to local conditions and that

are environmentally friendly, and creation of voluntary farmers' groups whose farms will be used as demonstration plots.

DECLARATION

I, ANGELINA JULIUS MATTIJO do hereby declare to the senate of Sokoine University of Agriculture that this dissertation is my own original work and has not been nor is it being concurrently submitted for a similar degree award in any other university.

Signature..... A.J. Mattijo .....

Date..... 25. 10. 2001

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ACKNOWLEDGEMENTS

My studies at Sokoine University of Agriculture were financed by my parents Julius and Lucy Mattijo and their beloved friends Henry and Charlotte Rosenberger, for which I owe a debt of gratitude. I am also grateful to SUA-FRPB in collaboration with DGISP for facilitating my field work through provision of research funds and a lap top computer, which was very useful in data processing, and write-up of the dissertation. Professor R.B. Mabagala is particularly acknowledged.

I am deeply indebted to my supervisors, Doctor I.H. Kawa of Development Studies Institute and Professor R.B. Mabagala, of the Department of Crop Science and Production, respectively, for their invaluable guidance, close supervision and constructive criticisms without which, this work would have been very difficult to accomplish.

Appreciation is also extended to various individuals, particularly staff and students of Development Studies Institute, Professor S.O.W.M Reuben, Head, Department of Crop Science and Production, Mr. Bazugba, I. and Mr. Makauki, A. In addition, the assistance provided by the Ndungu ADP co-operative officer, Mr. Okada and other staff during data collection is highly acknowledged. Last but not least, my heartfelt gratitude and appreciation go to my family and my aunt Theopista for their encouragement, help and moral support during the entire period of my study.

DEDICATION

This work is dedicated to my parents, Julius and Lucy Mattijo who laid the foundation of my education.

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ABBREVIATIONS AND SYMBOLS

%	Percent
ADP	Agricultural Development Project
DGISP	Danish Government Institute of Seed Pathology
et al	And others
etc.	And so on (*et cetera*)
FAO	Food and Agriculture Organisation of the United Nations
FRPB	Field Research Project in Seed Bacteriology
ha	Hectare
JICA	Japan International Co-operation Agency
KADP	Kilimanjaro Agricultural Development Project
MAC	Ministry of Agriculture and Co-operative
MALD	Ministry of Agriculture and Livestock Development
Na	Not applicable
NADP	Ndungu Agricultural Development Project
NS	Not significant
P	Probability
SNAL	Sokoine National Agricultural Library
SUA	Sokoine University of Agriculture
TAS	Tanzanian Shilling
USD	United States Dollar
vs	Against

LIST OF ACRONYMS

Genge	A small local retail shop
i.e.	That is
Mama lishe	Women selling food in the streets
Samadi	Cow dung
Swahili	Tanzanian national language
Vibarua	Casual labour

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Rice (*Oryza sativa* L) is an important staple food crop of approximately two-thirds of the world and about 1000 million people rely on it for food (FAO, 1984). Rice production has drawn the attention of national and international agricultural policy makers, as a strategic component of food security and crucial element in the food economies of several African countries. Demand for rice in Sub-Saharan Africa is becoming more acute as a result of general dietary shift from traditional foods, and this demand is likely to continue increasing (Kaung zan *et al.*, 1985).

According to MAC (1998), rice is Tanzania's second among four most important staple crops in value and it is the fourth largest in volume. It is a major source of energy, 96.5 % of the whole grain (Grist, 1975). The other three cereals are maize, wheat, and sorghum.

Because of population increase and the improvement in per capita, the demand for world-wide rice consumption is expected to grow by 2.6 % annually (Horibata *et al.*, 1998). In order to meet this increased demand, many countries have formulated national integrated and comprehensive rice production programs. These programs aim at accelerating rice production through area expansion and /or increased productivity per unit area. Land development requires considerable capital

investment in *inter alia*, land clearance, infrastructure development and irrigation establishment. Unfortunately, most small scale-farmers in countries such as Tanzania have inadequate knowledge about the best methods of growing rice. The yield is therefore, below the world's average and many countries have not yet reached half of the present yield potential of around 10-11 t/ ha (Horibata *et al.*, 1998).

Tanzania's national rice production in 1998 was 811 500 tons and average yield was about 5.4 tons / ha (MAC, 1998). The main rice growing regions in Tanzania are Kilimanjaro, Mwanza, Shinyanga, Morogoro, Mbeya, Coast / DSM, Iringa, Dodoma and Arusha (FRPB, 1998; MAC, 1998). Rice production in Kilimanjaro region, has been reported to be 23 300 tons, with an average yield of 10.6 tons / ha; the national yield potential has been reported to be 4-5 tons / ha.

According to TPC (1997), agriculture constitutes the largest sector of Tanzania's economy, accounting for about 60 % of the Gross Domestic Product (GDP) compared to about 3 % in developed countries. It provides 90 % of rural employment and contributes more than 84 % of the recorded export earnings. Despite the government's intentions of increasing productivity as stipulated in the Agricultural National Policy of Tanzania, the sector is yet to sustain itself in terms of producing enough food for the population

The performance of the food industry has been precarious. Intermittent food shortages in the past years has been a common phenomenon. As a result, the meagre foreign exchange reserve is used to import food instead of the badly needed

intermediate and capital goods for development. To achieve self sufficiency and avert the serious economic drain of the foreign exchange reserves in most countries, including Tanzania, production and distribution of quality seed is now emphasised as one of the main strategies for increased crop productivity. Seed health is considered an attribute of quality and is of great concern both to the seed industry and growers. It is an integral part of seed quality control system in many countries (Tylokowska, 1997).

Cereal seed health has been found to have several advantages. It: ensures long-term security of production against the deleterious effect of seed-borne diseases on yield and grain quality; minimises input costs by enabling plant establishment ranging from approximately 100 to 400 plants/ m^2 (Tottman, 1987); maximises any additional benefits of seed treatment against seed borne or foliar diseases; ensures adequate returns to agrochemical companies and plant breeders; stimulates the development of better seed treatments and varieties and minimises pollution risks to operators, consumers and the environment (Paveley *et al.*, 1996).

In order to address seed quality issues, the Field Research Project in Seed Bacteriology (FRPB) based at Sokoine University of Agriculture (SUA) in collaboration with Danish Government Institute of Seed Pathology for Developing Countries (DGISP), introduced a salt solution technique at Ndungu rice project where 15 % sodium chloride (NaCl) solution is used to separate poor quality and infected rice seeds from good quality seeds. Results from field surveys conducted at Ndungu rice project revealed the existence of various diseases of rice. Such diseases

included rice yellow mottle virus, sheath rot, narrow leaf spot, and brown spots (FRPB, 1998). Other suggested control measures were cultural practices such as burning of ratoons and breeding for resistant varieties.

Ndungu rice project is in Same district. Kilimanjaro region. Rice is cultivated by groups of farmers working in co-operative unit known as CHAWAMPYO. Studies have shown that participation of farmers in co-operatives is positively correlated with adoption of modern crop varieties (Rogers, 1995; Herdit and Capule, 1983; Hamid, 1996). It is for this reason, that the SUA-FRPB opted to introduce the 15% NaCl solution technique for separating good from bad quality rice seeds.

However, in any farming system, adoption of an innovation has different outcomes for different classes and categories of farmers. Some of the outcomes may make the innovation either adoptable or not. Similarly, sources of innovation information and incentives for innovation adoption are multiple and may have positive impact on the rate of adoption (Biggs, 1990).

1.2 Problem statement

It is generally agreed that, the agricultural sector has under-performed due to the failure of farmers to use modern agricultural techniques, such as high yielding varieties and fertilisers. However, since the inception of 15 % NaCl solution technique, Ndungu project has been strongly commended for enabling farmers to increase rice yields as compared to the traditional or conventional methods of cleaning seed and controlling rice diseases (NADP, 2000).

Although the 15 % NaCl solution technique has been promoted for two years, the technique, has not been widely adopted by the majority of farmers at Ndungu rice project. Various factors may influence adoption of this technique. According to Benad (1988); Mvena and Mattee (1988) and Machumu (1995), socio-economic, cultural, technical, climatic, political and service related factors might influence the adoption of the 15% NaCl solution technique for separation of good from bad quality seed. Therefore, there is a need to identify factors for the technique not having been widely adopted and intervention strategies to the problem.

1.3 Justification

While there has been increasing recognition in agricultural policies on the importance of seed separating techniques to obtain good quality seeds in agriculture, developing intervention strategies that are effective and feasible for implementation on a large scale represents a difficult challenge (FAO, 1984). More research efforts are directed towards the biological and physical or technical aspects of agricultural innovations than towards their acceptability to rural people (Rogers, 1995). Thus, there is paucity of information on the adoption and likely impact of sodium chloride solution technique on the socio-economic situation of Tanzanian rural farmers. Adoption assessment has not been done since the technique was introduced at Ndungu, Same. Therefore, a study is necessary to find out factors affecting adoption of this technique. Carrying out such a study will assist in making recommendations that will facilitate improvement of the technique, and its dissemination elsewhere in the country for improvement of rice production, especially by small-holder farmers.

Moreover, considering the role of agriculture in the economy of Tanzania, it is evident that findings of the present study will be useful to rural people in the study area and other related agro-ecological zones as well as change agencies. The study will add significantly to the information data bank, which can be utilised by policy makers in their efforts to find solutions to rice production problems.

1.4 Objectives of the study

The broader objective of the present study was to identify factors affecting adoption of sodium chloride solution technique in Same district in order to recommend strategies for improvement and sustainability of rice production in Tanzania. Specific objectives were:

a) To identify the extent of adoption by gender and continued use of the technology promoted by SUA-FRPB project in the study area.
b) To assess farmers' opinions on the effectiveness of 15% sodium chloride solution technique in separating good from bad quality seeds.
c) To identify socio-economic, cultural, technical, political and institutional factors motivating adoption of the sodium chloride solution technique.
d) To identify factors limiting adoption of sodium chloride solution technique.
e) To make recommendations that will improve adoption of the 15% NaCl solution technique.

1.5 Hypotheses

Null hypothesis (Ho): Adoption of sodium chloride solution technique is independent of socio-economic, cultural, technical, service related and political factors.

Alternative hypothesis (Ha): Adoption of sodium chloride solution technique is dependent on socio-economic, cultural, technical, service related and political factors.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature on adoption of innovations and factors affecting adoption of agricultural innovations. The type of innovations available for agricultural development, and sources of innovations by small scale farmers in Low Income Countries (LICs) where agriculture constitutes the backbone of the economy. The role of 15% NaCl solution technique in rice seed health and gender differences in the impact of agricultural modernisation are also covered. The chapter concludes by examining the history of adoption in Tanzania.

2.2 Adoption of innovations

2.2.1 General overview

An innovation is an idea, practice, or object perceived by an individual (Rogers and Shoemaker, 1971). Van den Ban and Hawkins (1988), defined adoption of innovation as (i) decisions to apply an innovation and continue to use it and (ii) adoption process as changes that take place within an individual with regard to an innovation from the moment he/ she first becomes aware of the innovation to the final decision to use or not to use it. The authors identified five stages that resemble the normative decision making model which is used to analyse the diffusion process as: 1) awareness (first hear about innovation), 2) interest (seek further information about it); 3) evaluation (weighing up the advantages and disadvantages of using it);

4) trial (test the innovation on small scale for yourself) and 5) adoption (apply the innovation on a large scale in preference to old methods).

Unlike diffusion which is the spread of new technology across a given population over time, adoption is measured at one time. Diffusion assumes that cumulative proportion of adoption follows an S-shape curve in which there is a slow initial growth in the use of new technology, followed by a more rapid increase and then a slowing down as the cumulative proportion of adoption approaches its maximum (CIMMYT, 1993).

Lionberger and Gwin (1991) asserted that, the curve has three parts, meaning that adoption starts slowly by the majority of people wanting to see the innovation tried locally by someone else first. This is followed by an increased adoption as a result of interpersonal communications on an innovation and finally the adoption rate declines at the third part (Rogers, 1995). Depending on the type of innovation, some stages may be skipped and the trial stage, is the most frequently skipped due to difficulties in trying a little first and later (Lionberger and Gwin, 1991).

The aforementioned stages rely mostly on estimates, which in many cases have some problems. CIMMYT (1993) observed that these estimates assume cumulative adoption, that is, once a farmer begins to use the technology he/she will continue using it. However, in some cases this is not true as many farmers may have one or more years of technology and subsequently abandon it. In addition, several times, a significant proportion of farmers may have experience with the technology but very

few of them could be using it. In such situation, it is worth trying to get information on why farmers stop using the technology. Often, the time from first knowledge to first adoption is considerable (Lionberger and Gwin, 1991; CIMMYT, 1993). For example, the average time for the adoption of hybrid corn seeds in Iowa (USA) was five years for the individual farmer and 12-24 years before all farmers had adopted the hybrid corn seed (Van den Ban and Hawkins, 1988). It was later found that hybrid sorghum was adopted much faster in Iowa because farmers were familiar with success of hybrid corn manifested by the difference in production due to hybrid vigour.

In any social system, it is not possible for all individuals to adopt an innovation at the same time. Thus, Rogers (1995) categorised adopters based on the degree to which an individual or other unit of adoption is relatively earlier in adopting an innovation (innovativeness) as innovators (2.5 %), early adopters (13.5 %), early majority (34 %), late majority (34 %) and 16 % laggards. In a study of adoption, spread and production impact of modern rice varieties in Asia, Herdit and Capule (1983) categorised adoption into low, medium and high based on the use by farmers of a number of improved practices, measured by an adoption score (number of improved practices used) or by an adoption quotient (number of improved practices used over total number of recommended practices). Considering Rogers' (1995) categorisation, two years of introducing 15 % NaCl solution technique may be enough for innovators and early adopters to have gone through the stages of adoption process but not necessarily the rest of the community.

Evidence shows that, adoption of many innovations may take years (Rogers and Shoemaker, 1971), but it took only 3-5 years for most farmers to adopt modern varieties of rice in Philippines (Herdit and Capule, 1983). It should however, be noted that Rogers' (1995) categorisation does not objectively consider farmers' preferences, which are based on their livelihood strategies. It assumes that farmers of a certain system will adopt a certain innovation from a change agent in the same way, as others would do in other social communities after doing the necessary innovation decisions.

In reality, adoption of an innovation can be influenced by a variety of factors other than time of exposure. For instance, an additional fixed cost associated with a new technology may cause the old technology to be more attractive irrespective of the time of exposure. This aspect could likely alter Rogers' adopter categories when considered. Therefore, the adopter categorisation can not be generalised.

Since farmers are rational in decision-making, they balance between a wish to innovate and the expected worth of the innovation (Blum, 1989). It is important to understand that agricultural technology development and utilisation continuum is basically composed of three sub-systems, namely, knowledge: generation; dissemination and utilisation (Rutatora and Rutachokozibwa, 1993). Therefore, the objectives of extension communication should be, to provide knowledge on which action can be based; to persuade the farmer to make decision to try the new technology; to provide the information necessary for actual implementation and to provide farmers with the information to assess and confirm the results of the decision

made. This implies that the most desired innovations will likely be adopted by a greater proportion of members in the first instance than the Rogers proportion (2.5 %) and vice versa. All in all, adoption decisions by a farmer are products of several factors operating through time rather than something happening instantaneously (Lionberger and Gwin, 1991).

All farmers in Ndungu rice project were introduced to 15 % NaCl solution technique and hence, they viewed it as a new innovation in their area. The adoption or rejection of the technique has therefore, a bearing on the failure or success of the pre-existing methods in the area (i.e. winnowing, and soaking in water).

2.2.2 Adopter categories based on innovativeness

2.2.2.1 Innovators: Venturesome

Observers have noted that venturesomeness is almost an obsession with innovators. According to Rogers (1995), innovators are eager to try new ideas. This interest leads them out of a local circle of peers and into more cosmopolite social relationships. Communication pattern and friendship among a clique of innovators are common, even though the geographical distance between the innovators may be great. The prerequisites for innovators include control of substantial financial resources to absorb the possible losses due to unprofitable innovation and the ability to understand and apply complex technical knowledge.

The salient value of innovators is venturesomeness. Innovators desire the hazardous, the rash, the daring, and the risky. Innovators are willing to accept occasional setback

when new ideas adopted prove unsuccessful. According to Lionberger and Gwin (1991) they represent the first 2-3 % of individuals in the social system.

2.2.2.2 Early adopters: Respectable

Members of this category are more integrated part of the social system than the innovators. Whereas innovators are cosmopolites, early adopters are localites (Rogers, 1995). This adopter category has the greatest degree of opinion leadership in most social systems. Potential adopters look to early adopters for advice and information about the innovation. This category is sought by change agents to be a local missionary for speeding up the diffusion process. They serve as a role model for many other members of a social system.

According to Rogers (1995), this category decreases the uncertainty about a new idea by adopting it, and then conveying a subjective evaluation of the innovation to near peers by means of interpersonal networks. They represent 10-15 % of the members of a social system (Lionberger and Gwin, 1991).

2.2.2.3 Early majority: Deliberate

This category adopts new ideas just before the average members of a social system. The early majority interacts frequently with their peers, but they rarely hold leadership positions. This category links the very early and the relatively late to adopt in the diffusion process. They may deliberate for sometime before completely adopting the new idea.

The innovation-decision is relatively longer than that of the innovators and early adopter. "Be not the last to lay the old aside, nor the first by which the new is tried", might be the *motto* of the early majority (Rogers, 1995)

2.2.2.4 Late majority : Skeptical

Members of this category adopt new ideas after majority of people in the social system have adopted. Adoption may be both an economic necessity and the answer to increasing social pressures. Innovations are approached with a skeptical and cautious air, and the majority do not adopt until most others in their social system have done so (Rogers, 1995).

2.2.2.5 Laggards : Traditional

Laggards are the last in the social system to adopt an innovation. They possess no opinion leadership. Of all the adopter categories, they are the most localite in their outlook; many are near isolates. The point of reference for the laggards is the past. Decisions are made in terms of what has been done in previous generations. When laggards finally adopt an innovation it may already have been supersede by another more recent ideas that the innovators are already using. They tend to be frankly suspicious of innovation, innovators, and change agents. In this case, adoption may lag behind knowledge of the idea (Rogers, 1995).

2.2.3 Factors affecting adoption of innovations

The available literature is deficient in the factors affecting the adoption of 15 % NaCl solution technique for separating good from bad quality rice seed. Similarly, with other agricultural innovations, several factors may be associated to adoption since research efforts are reported to be directed towards biological, physical or technical aspects of innovations more than their acceptability to users (Rogers, 1995). The major commonly influencing factors reported in literature have been found to be awareness of the expected benefits from the innovation and the access to resources (Nypan, 1991).

There are other factors that may influence farmers' decision to adopt or reject a particular innovation. They are generally associated with economic forces affecting their production decision, performance of technology under local conditions and characteristics of farmers, innovation, institution, environment and infrastructure (Benad, 1988). Farmers characteristics includes education, gender, ethnicity, resources and land tenure which make additional factors for farmers to be receptive to adopt new technologies (CIMMYT, 1993).

An innovation may be adopted at the decision stage in the process and be used continuously or rejected at a later date (discontinuance) or adopted at the later date due to changes in how the individual perceives the innovation. A discontinuance may be due to innovation's replacement by an improved idea or to disenchantment with the innovation or insufficient level of "how to"-knowledge which causes the change agent's long- run task to remain very difficult. For example, a change agent in India

advocated the adoption of new crop varieties to villagers. But because the basic principle on how to evaluate this seed innovation was never developed, the change agent had to conduct repeated diffusion campaigns each time a new crop variety became available (Lionberger and Gwin, 1991).

Education can make a farmer more receptive to advice from an extension worker or more able to deal with technical recommendations that require a certain level of numeracy or literacy. The more complex the technology, the more likely it is that education will play a facilitative role in technology adoption (CIMMYT, 1993). However, a high level of education was not required for adoption of modern rice variety in Philippines (Liao, 1968). Bhati (1975) confirmed that technical knowledge is a positive influence on adoption. A large farm size is a common variable for adoption and a good proxy for wealth (Rogers, 1995).

Innovation characteristics which affect adoption are relative advantage, compatibility, complexity, triability, and observability (Rogers, 1995). Relative advantage is the degree at which an innovation is perceived as being better than the idea it supersedes and is always expressed in economic profitability. Compatibility is the degree at which an innovation is perceived as being consistent with existing values, past experiences and needs of potential adopters (Rogers, 1995). Often the name given to a new product can affect its compatibility and hence, its rate of adoption. This is because words are thought to be symbols that structure our perceptions (Rogers and Shoemaker, 1971). Complexity is the degree to which an innovation is perceived relatively difficult to understand and use. It is negatively

related to adoption as perceived by members of a social system. Triability is the degree to which an innovation may be experimented on a limited basis. New ideas can be tried on the instalment plan and will generally be adopted more rapidly than innovations which are not divisible. Observability is the degree to which the results of an innovation are visible to others (i.e. easily observed and communicated to others).

Environmental factors such as climate, edaphic or soil factors and prevailing pests and diseases can influence acceptance of a new technology as well as agricultural institution such as research, credits and marketing (Kauzeni, 1988). The author further urged that, slow rate of adoption is frequently an indictment of project methodology rather than unwillingness of farmers to adopt the technology. Small farmers are able to produce enough for their subsistence and a small surplus for sale. Therefore, the low income realised by small farmers is not a result of inefficient use of resources, but due to the lack of technology and resources they need to realise higher productivity.

Reports from India by Hiremathu and Raju (1999), indicate that some farmers sought modern agricultural technologies, on their own, without any assistance from extension network and there were the majority who, despite all extension efforts, refuse to change from their traditional way of farming. This suggests that the problem may either be the inappropriateness of technologies or the failure of extension networks.

It was further suggested that farmers are not only fairly well aware of the available technologies but also they do not have serious reservation for adopting them. In addition, lack of good infrastructure, such as access to water, land, roads and attractive prices of farm products had influence on the adoption of technology (Benad. 1988).

In 1998, conflicts between farmers, co-operative unions, private traders and marketing board concerning the fixing of producer prices for cotton and tobacco were reported in the media. After the Shinyanga Regional Co-operative Union (SHIRECU) had fixed the price at Tshs 200 for a kilo of cotton, the General Meeting of Nyanza Co-operative Union (NCU) adopted the same price against the protest by private buyers and management. It was then reported that, while private buyers had threatened to boycott buying the crops, the General Manager of NCU had threatened to resign if the price of Tshs 170 per kg which was accepted by both private traders and management was not approved by the union (*Nipashe, May 27, 1998*, cited by Kapinga, 1998).

Attitude towards the innovation is of concern because it consists essentially of favourable or unfavourable belief in the usefulness of the new idea for the individual (Mvena and Mattee, 1988). A negative experience from an innovation that is perceived as a failure leads to resistance to future ideas. If change agents are to begin their activities in a particular client system with an innovation that possesses a high degree of relative advantage, that is compatible with existing beliefs, and that has a

very high likelihood of success, it will create a general positive set towards change and grease the ways for future ideas that may be introduced (Rogers and Shoemaker, 1971).

Studies on knowledge attitude and practice (KAP) provide an understanding of the existing situation in relation to specific aspects. Before launching any programme aimed at improving knowledge, bringing about change in attitude and improving practices, it is imperative to assess the existing situation. This is also true in the light of the available evidence where higher levels of knowledge have not brought about much change in attitude (Yogananda, 1994).

In Tanzania, various factors have been shown to influence adoption of innovations. The factors differ widely depending on the type of innovation. For example, risky conditions of weather such as floods, drought and water logging have been reported to give challenges to smallholder farmers who rarely afford to adopt new technologies (Mvena and Mattee, 1988; Machumu, 1995)

From 1969/70 to 1973/74, the prices of major strategic crops in Tanzania, both export crops and staple grains, increased a little in yield and then fell dramatically in real terms. Of ten crops (cashew, coffee, cotton, pyrethrum, tobacco, maize, paddy, wheat, groundnuts, sunflower) six experienced real price decline in excess of 30 % and other four experienced price decline of between 19 and 30 % in the short space of 5 years (MALD, 1989). This limited adoption of improved agricultural technologies by farmers and resulted in the stagnation of the total marketed output

over an entire decade. In addition, large decreases in output for a number of strategically important crops occured.

Despite a number of improved structures and pesticides developed, Mvena and Mattee (1988) observed continuous use of traditional system of grain storage in Tanzania. The authors reported lack of credits, limited access to information, knowledge and inadequate incentives associated with farm tenure arrangements to be major factors that limited adoption of improved grain storage structure. In another study, Ashimogo (1994) identified lack of cash and insufficient grain to store as factors that caused poor adoption of storage pesticides in Sumbawanga.

2.3 The role of 15 % NaCl solution technique in cereal seed health

Regular drought and increased poverty necessitate the importation of vast quantities of grains, for instance, through food aid and seed trade. During transportation, spillage which happens and use of infected grains as seed can be a source of new seed borne diseases in areas where such diseases do not occur (Baruchura and David, 1995; Pospieszny *et al.*, 1996). To avoid that, cereal seed health is thus a key requirement in the modernisation of agriculture.

The principle of 15 % NaCl solution is based on specific gravity whereby, it separates light seeds by allowing them to float. The poor quality seeds (floating) are then discarded, while the seeds that sink are used for sowing (JICA, 1996). This technique has also been used in Kilimanjaro Agricultural Development Project (Horibata *et al.*, 1998). Laboratory results indicate that, the mean germination

capacity of rice seeds which sunk in 15 % sodium chloride solution was higher (94.6 %) than that of the floated seed (39.4 %) (FRPB, 1998). Seedling vigour was increased for seedlings raised from sinking seeds.

The technique has been reported to be successful in rice and wheat (JICA, 1996; FRPB, 1998) and some vegetable seeds such as cabbage (*Brassica* spp). The technique also reduces the incidence of diseases. For example, among the four varieties of *Brassica* tested in 15-20 % Sodium Chloride solution at SUA-FRPB laboratory, 35-37 % of all 'Copenhagen market' seedlings from light (floated) seeds were infected with blackrot compared to only 6-8 % of heavy seeds (Kaitira, 2000). This technique is cost effective in terms of labour (i.e. skilled labour is not required), time, improved seeds (treated seeds) and reduces application of fungicides to growing crops which is expensive and sometimes harmful to the environment (Mabagala, R.B. personal communication, 2000). For example, chemical treatment with antibiotics such as streptomycin ensures bacterial free seeds (Agrios, 1988), however, antibiotics have been reported to be phytotoxic (Harman *et al.*, 1987). Adoption of 15 % NaCl solution technique holds potential for decelerating the spread of seed borne pathogens of rice, since farmers are advised to use their own seeds for planting in order to compliment the shortage of certified seed (FRPB, 1998).

Improvement of the health status of rice seeds has been shown to improve crop perfomance. For example a survey done in Kuala Lumpur indicated that farmers could easily obtain a 10-20 % increase in yields (Merca and Mew, 1992), by winnowing, flotation and physical appearance (by sorting to remove discoloured seed

mixtures, shrunk seeds, insect attacked and weed seeds). However, this improvement is lower than that achieved through the use of 15 % sodium chloride solution (94.6 %) (FRPB, 1998). There are other effective laboratory techniques, but these are relatively expensive as they require trained personnel and significant investment to provide sufficient capacity (Reeves, 1995). This means therefore that, adoption of 15 % sodium chloride solution can be the best alternative in reversing the problem of low productivity by improving seed quality.

2.4 Gender differences and agricultural modernisation

2.4.1 General overview

Within any social economic system, classes may be expected to stem primarily from initial differences between women and men in (i) the extent and nature of their involvement in agricultural fields work; (ii) the extent and nature of their involvement in non-field work, including cattle rearing, fetching fuel, water and fodder, domestic work and childcare, (iii) the extent of their control over the pattern of distribution of household earnings and consumption items and (iv) the extent of their direct access to productive resources, especially land.

According to Agarwal (1988), these initial differences would themselves stem from historical, social and cultural factors which, in addition to the economy, govern the norms *vis a` vis* the sexual division of labour, both within the home and the outside in any community. These norms are manifested within the home in women being primarily, and often solely, responsible for childcare, and outside the home in their being confined to certain agricultural tasks and physical spaces and socially barred

from others. Agarwal further contended that, technological changes impinging on such initial differences in labour are likely to lead to different implications for women and men in their access to employment in agricultural and non-agricultural work and in their overall work burden. Given the inequalities in the control over and distribution of household earnings and expenditure between women and men, any impact of agricultural modernisation to income or consumption may be expected to vary by gender.

2.4.2 Gender roles and adoption of Agricultural innovations

2.4.2.1 Decision making

Defective economic policies and absence of adequate educational facilities lead to poverty multiplication. Finding no way to be rescued from such a suffocating situation, rural people resuscitate their age-old beliefs and traditional value patterns. As a result, the issue of man-woman relationship is settled in favour of the old beliefs. Man at the pinnacle, is the final decision-maker both in the family and society; the role of women is marginal and they are pushed to the bottom of the social pyramid (FAO, 1994). However, few joint decisions have been reported with respect to the use of new innovations (Nypan,1991; Reddy and Kusuma, 1994). For example, the decision to adopt agroforestry innovations in Turiani division, Morogoro (Rural) district was reached more jointly than by men alone (Makauki, 2000)

The denial of decision making opportunity to women, is a threat to the adoption of an innovation, because, self decision on one's obligation is more worthwhile than when

decision is made by a party that is not responsible for its implementation. Besides, women constitute half of the society and virtually, monopolise agriculture with the minor exception of clearing land, which is seen as a man's job.

They play a key role in most agricultural systems such as handling 60 % of the marketing and 50 % of tasks involved in storing food (Bwana, 1996). Therefore, if they can not take an equal stride with the other half, the expected advancement of the society can never be achieved.

2.4.2.2 Access to resources

The disparity between women and men in ownership and access to different resources, and services such as land tenure and policy, has great influence on the adoption of a technology. In different areas, research has reported women protesting and revolting against excessive demands for their labour or loss of control over resources (Mascarenhas and Mbilinyi, 1983; Agarwal, 1988 and Boserup 1989). Even the way in which development programmes are conceived and executed has worked against women in several countries (Rogers, 1980 cited by Nypan, 1991).

In Tanzania, the reform of villagisation has been reported to have increased oppression of women (Mascarenhas and Mbilinyi, 1983). Women have also been denied access to financial services such as credit. For example, women were only 15 % of the total membership of the formal rural savings and credits associations in Tanzania in 1992. This small number was due to, lack of land as collateral, illiteracy, predominance of the subsistence sector and small size of agricultural enterprises

among women (FAO, 1994). Bonnard and Scherr (1994) asserted that access to resources, user rights and control over the benefits of the resources are important factors to consider in planning interventions.

2.4.2.3 Division of labour

In many African countries, nearly all the tasks connected with food production such as sowing or planting, weeding and transporting the crops home are left to women while activities like tree felling or bush clearance are always done by men (Overholt *et al.*, 1985).

According to Bonnard and Scherr (1994) the roles played by different ages based on gender classes are important in designing agricultural interventions and assessing programme impacts. This is because, the roles played by women and children have in most cases been disregarded by some projects which are gender biased (i.e. may require heads of households who are men in most cases). In such situations, transfer of information to other members of the households may not reach them by a large proportion and hence affect adoption of the intended innovation.

Studies done in different communities in Tanzania showed that participation of women in Income Generating Activities (IGAs) has risen from 7 % in 1971 to 65 % in the 1990s while their contribution to household economy has increased by more than 100 % (Tripp, 1994). In Zanzibar unlike other areas, both men and women participate fairly equally in such activities as site clearance, land preparation, sowing and planting while women carry out most of the weeding, harvesting, transportation,

threshing, processing and storage activities (FAO, 1994). Nypan, (1991) reported similar observations.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The Chapter details description of the study area, sampling, research design employed and data collection procedures and instrumentation. Procedures used in statistical analysis of the data are also described.

3.2 Description of the Study Area

Tanzania mainland is divided into twenty administrative regions. Kilimanjaro is one of the regions and it borders Kenya to the north, Tanga region to the Southeast and Arusha region to the west. The region covers an area of 13 210 km^2.

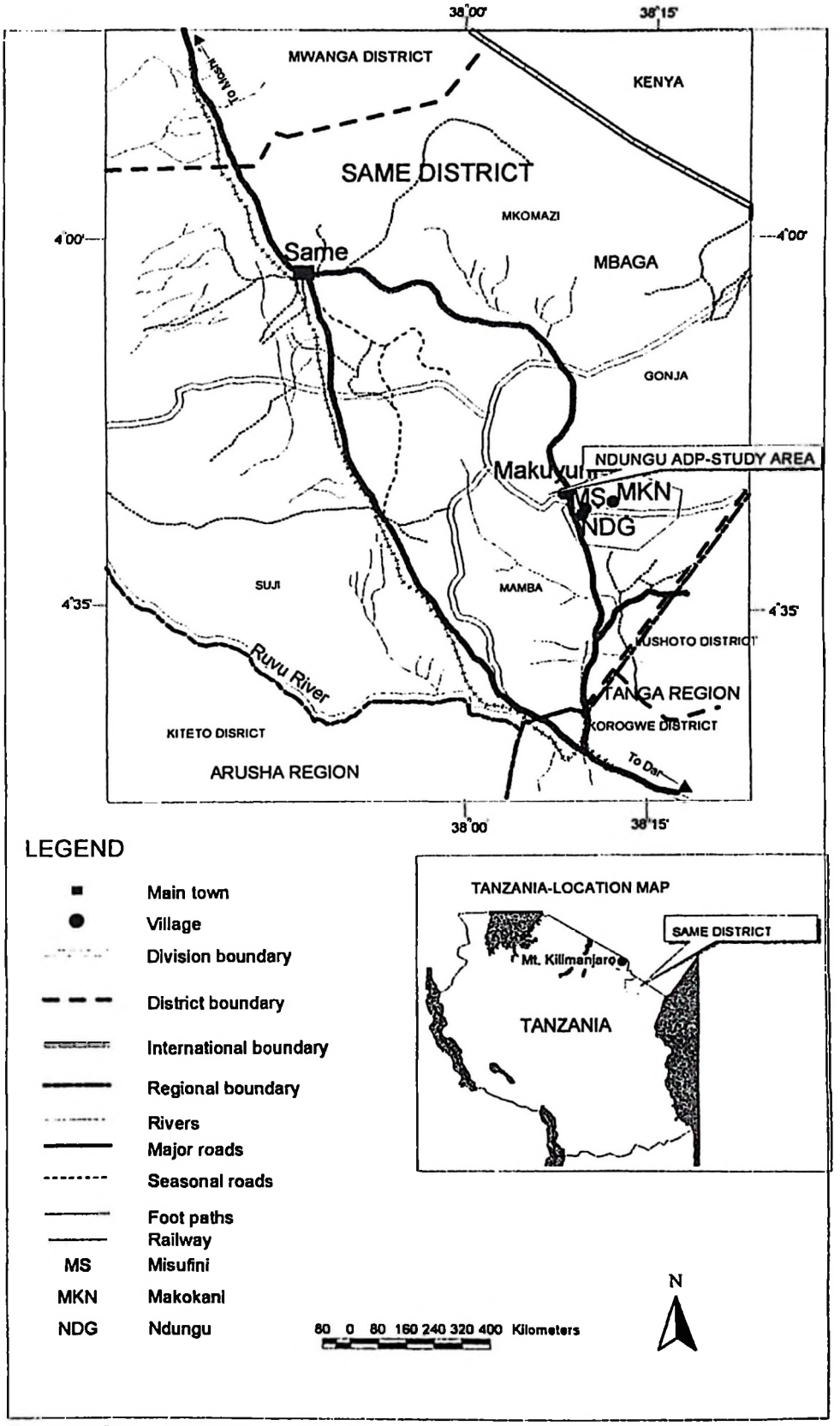
Administratively, Kilimanjaro is divided into six districts, namely Moshi Urban and Rural, Hai, Rombo, Mwanga, and Same. The region can be divided into two distinctive areas, the highland and lowland areas based on natural conditions such as climate and topography and the extent of sociological and economical development.

The highlands are located around the slopes of Mt. Kilimanjaro and the Pare mountains in the belts from 800 to 1 000 m above sea level. This area has moderate temperatures and abundant rainfall. In contrast, the lowland, which includes the Ndungu area is located below 800 m above sea level, and is characterised by low rainfall and high temperatures. The area extends over the basins of the Ruvu river,

the Mkomazi river and the elevation of the alluvial plains which ranges from 507 – 520 m.

The present study was carried out at Ndungu Rice Project in Ndungu, Same district (Fig. 1). Three villages namely Misufini, Makokane, and Ndungu were involved in the study. Ndungu rice project is situated between Latitude 4^0 and $4^0 35'$ S and Longitude 38^0 and 38^0 15′ E. According to Ndungu ADP (1987), the area is affected by the north-east monsoon which provides most of the rainfall in the area. Based on rainfall distribution, there are two seasons per year. The rain season last from November to May and dry season from June to October. The average holding size is calculated at 0.77 ha per farm household based on the estimated arable land of 1,010 ha and the related farming households of 1,500 farms to the project area. Generally, these farmlands consist of small plots ranging from 200 to 800 m^2 in size, scattered in a few places or in several locations. Fragmentation of land holding has proceeded recently due to population growth.

The major occupation in the villages is farming. Farmers mainly cultivate paddy, maize and beans. Most of them still prefer traditional farming techniques, though irrigated farming has been introduced to a certain extent. Paddy cultivation is mainly practised in the low-lying area where the land has been developed as irrigatable land and irrigation water is substantially available for paddy growing.



Source: Same district map (1989).

Fig 1: A map of Same District showing location of Ndungu Agricultural Development Project

Livestock production is also practised extensively in this area using natural pasture in the savannah land, especially at Makokane village. The major livestock types found in the area includes cattle, goats, sheep and chicken. Livestock were kept mainly for sale and domestic consumption.

The ethnic composition in the study area consists mainly of *Wapare* and *Wasambaa* who are mostly descendants of those who worked in sisal plantations in Tanga and Kilimanjaro regions, and later migrated to this area. Other immigrants to these villages are *Wachagga*, *Wangoni* and *Wazigua*.

3.2.1 Selection of the Study Area

Selection of the study area was done by the researcher with the help of SUA-FRPB which is promoting the use of the 15 % sodium chloride solution technique. The selection of the area was based on the following reasons: First, no such study had been conducted in that area since the technique was introduced; Second, Ndungu rice project had been affected by seed born pathogens of rice for a long time because of the continuous rice cropping under irrigation; Third, Ndungu rice project is ranked as second to the Lower Moshi among the five (5) priority schemes which were selected through feasibility study (F/S) on the Mkomazi Valley Area Irrigation Development Project executed by the JICA in 1982/83; Fourth, it was favourable logistically to the researcher's resource constraints and Fifth, it was the only area where the impact of using 15 % NaCl solution technique on rice production could be assessed.

3.3 Research design

Cross sectional research design outlined by Casley and Kumar (1988) was adopted in the present study. The study was basically a one time look at the phenomena, that is. data were collected at a single point in time. The design was chosen because of the limited time (one year) and funds.

3.4 Sampling procedures

The target population for the study was 1500 rice growing household farmers from three villages with access to Ndungu rice project. The unit of measurement was the household. According to Casley and Kumar (1987) if the group and behaviour being studied are narrowly defined and relatively homogeneous, diagnosis can be based on a small sample. In this case, a minimum of 5 % of the total households in the village was sampled as suggested by Boyd *et al.* (1981).

3.5 Sampling design

The project covered three villages, namely, Ndungu, Misufini, and Makokane. These villages were selected to cover surveys of the whole project area. The Project Manager and an agronomist were selected purposely for technical data. Village executive officers were purposely selected in order to help in providing general information such as number of farmers, total acreage of crops, crops grown other than rice, etc. They also participated in locating the sampled households in the respective villages for interviews.

A multi-stage sampling technique was used to select households to interview. The design was chosen because of its convenience for studying large and diverse populations (Fowler, 1993). In addition, it reduces the amount of travelling for interview and hence the corresponding costs (Casley and Kumar, 1988). In stage one, using purposive sampling, one ward (Ndungu ward) was selected because it was the one involved in the project. In stage two, three villages with access to the project were selected and 25 households were randomly selected from each village. In stage three, female-headed households were purposely selected and included in the sample to reduce the degree of gender imbalance of the respondents. The key informants were 2 project staff members, 3 extension workers, and 6 village leaders. The whole procedure made a sample of 86 respondents available for the study.

3.6 Data Collection

3.6.1 Instrumentation

A preliminary survey was done for familiarisation with the research areas. During that period appointments were also made for actual survey which was between August and December 2000. Individual in-depth approach was adopted whereby formal and informal interviews with extension officers and other key informants were conducted so as to get the insight of the research problem which facilitated generation of relevant questionnaire items for the first draft. Two sets of questionnaires were formulated and administered to project farmers and key informants, respectively. The questionnaire for key informants verified and supplemented the survey information, which was given by the farmers.

To establish validity and reliability, the first draft of the questionnaire was pre-tested at Misufini village, so as to allow for necessary additions, omission, and modification of some questions. Six farmers and one extension worker were involved in this procedure.

3.7 Data collection procedures

3.7.1 Primary data

The interview schedule was written in English. But it was administered to the respondents in '*Swahili*', the national language and therefore understandable to the respondents. Formal interviews and discussions were also done in Swahili. The problem of inconsistency and non-response was minimised because data collection was done by the researcher, assisted by an enumerator who was trained by the researcher as suggested by Vaus (1993). The exercise was done by, visiting and interviewing household heads in their homesteads. It was believed that, the respondents would feel freer to respond to interviews conducted within their homesteads.

Both close and open ended questions focusing on socio-economic, political, cultural, gender role and service related aspects were included in the structured questionnaires, which were the main instruments used for data collection. Such aspects as education, inputs and credit availability, sources of income and extension services variables (Appendix 1) were thus explored.

Visual observation on the project irrigation facilities, the crop fields, extension services and the on-going operations in the crop fields were employed in individual farms to verify and supplement some of the information given by the respondents and to understand more the concepts of the project.

3.7.2 Secondary data

Secondary data were obtained through review of documents related to the study from Ndungu ADP, SUA-FRPB office and Sokoine National Agricultural Library (SNAL) in Morogoro for supplementing the survey information. The data included information on location, rainfall, temperature, water use charges and other costs paid by farmers as well as the problems faced by the project.

3.8 Data analysis

In order to draw conclusions, the collected survey data were coded and analysed using the Statistical Package for Social Sciences (SPSS) computer programme. Descriptive statistics such as frequencies, percentages, means and standard deviations were computed. Where desired, cross tabulation sub-programme involving Chi-square test was used to test association between adoption of 15 % sodium chloride solution technique and other qualitative variables, such as level of education and service related factors. Cross tabulation is both a powerful way of communicating information and the commonest form of data presentation (Casley and Kumar, 1988).

To compare means of some individual pairs of quantitative variables between adopters and non-adopters of the innovation, T-test was employed. In both Chi-square and T-test, the level of significance used was 5 % and where significant, the comparison was done at lower levels (1 % and 0.1 %) as well. Various gender roles in farming activities and their influence on the adoption of the technique were evaluated through simple Gender Analysis Framework (GAF) which involved benefit, resource and activity analysis.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Farmers background characteristics

4.1.1 General

The background characteristics of the respondents interviewed in this study are shown in Table 1. The parameters included sex, age, marital status, education level and family size for both the adopters and non-adopters of 15 % NaCl solution technique.

4.1.2 Sex

The selected sample for the present study constituted 45 and 30 adopter and non-adopter respondents. Of the 45 adopters of salt solution technique interviewed, 80 % and 20 % were male and female respondents, respectively. For non-adopters, 60 % and 40 % were male and female respondents, respectively (Table 1). Chi-square test indicated that, there were no statistically significant ($P>0.05$) association between sex and adoption of 15 % sodium chloride solution technique. The imbalance in sex distribution was a result of interviewing the household heads.

4.1.3 Age

Age is among farmers' characteristics, which is often examined in adoption studies as it may influence adoption in many ways. Since all farmers had equal chances of participation in this project therefore, no age group had special treatment. Higher

proportions of the adopter respondents (57.7 %) and non-adopter respondents (63.3 %) aged between 18 and 45 years (Table 1). The mean age of the respondents was 45 years for both adopters and non-adopters.

According to the Chi-square test, the distribution of respondents was not significantly ($P>0.05$) associated with adoption of the technique. This means that, the studied respondents were in the economically active group and were involved in different farming and non-farming activities. The economically productive class in Tanzania ranges from the age of 15 to 64 years (Mandara, 1998 cited by Makauki, 2000).

The availability of active labour force has a positive influence on the food availability in the household through productive activities. Within this group respondents aged less than 30 years were only 6.7 %. This small number is not a surprise because the traditional customs and values prevailing in the study area do not give chance to youths to have land. Additionally, very few youths were interested in farming, and therefore preferred to work in non-farm occupations or to migrate out of the village to urban areas.

Table 1 : Distribution of respondents by their background characteristics

Characteristics	Adopter (n=45)		Non-adopter (n=30)		Probability
	Number	%	Number	%	
Sex					
Male	36	80.0	18	60	
Female	9	20.0	12	40	0.059
Age					
18-30	3	6.7	0	0	
31-40	13	28.9	7	23.3	
41-50	22	48.9	10	33.3	
More than 50	7	15.5	13	43.3	0.409
Marital Status					
Single	1	2.2	2	6.7	
Married	38	84.4	27	90.0	
Divorced	6	13.3	0	0	
Widowed	0	0	1	3.3	0.92
Education level					
No formal education	3	6.7	9	30	
Adult	3	6.7	2	6.7	
Primary	32	71.1	18	60	
Secondary	7	15.6	1	3.3	0.03
Family size (Persons)					
1-5	35	77.8	21	70.0	
6-9	8	17.8	6	20.0	
10 and above	2	4.4	3	10.0	0.624

Source: Survey data (2000)

The higher proportions of respondents aged more than 50 years was found for non-adopters (43.3 %) than adopters (15.5 %). According to Agarwal (1988) within an ageing population, older men and women withdraw from the labour force. The

concentration and intensity of labour required within a short period, especially with double cropping, do not allow for much breathing space for the older peasants who work from dawn to dusk. They prefer to work slowly, but surely, on their own plots of land, and if they can afford it, to hire in a labourer. CIMMYT (1993) reported that age had no influence on adoption of agricultural innovations because older farmers with more experience, resources and authority were able to try a technology. Similarly, young farmers did the same because of their education and exposure to new ideas through events like migrants labour movement. Such reports agree with findings reported in the current study.

4.1.4 Marital Status

In the present study, the majority of the respondents (84.4 % and 90.0 %) were married while 2.2 % and 6.7 % of the adopters and non-adopters, respectively, were single. The distribution of the phenomenon was not statistically ($P>0.05$) associated with adoption of the 15% NaCl solution technique. Results of the present study give a clear situation of most rural areas of Tanzania where the majority of adult people are married. This is probably because of the belief that, marriage can offer a solution to possible hardship in life especially for most women. For example, access to credits is often more difficult, if a woman has few or no resources and most importantly access to land for her own livelihood.

This argument agrees with what was reported by Nypan (1991) for Meru women and Jaya (1992), that joint decisions between man and woman are useful not only in farm activities but also in non-farm and domestic operations. In addition, men and women

are two wheels of the chariot of life and the success in life depends on the stamina and steadfastness of both men and women.

4.1.5 Level of education

The majority of respondents in this study had attained primary education. It was observed that 71.1 % and 60 % of adopters and non-adopters, respectively, had attained primary education, while 6.7 % and 30 % of adopters and non-adopters, respectively, had no formal education (Table 1). About 6.7 % of all respondents attended adult education, also known as literacy classes. The high literacy rate indicates that, most of the respondents knew how to read and write. However, the proportion of respondents who had attained at least primary education was higher for adopters than for non-adopters (i.e 86.7 % vs 63.3 %) (Table 1).

Similarly, the proportion of those who had primary and secondary education as their highest levels were higher for adopters than non-adopters (71.1 % vs 60 % and 15.6 % vs 3.3 %) showing a clear influence of education on adoption (Table 1). Education is necessary in facilitating the task of communicating agricultural innovations to rural people by change agents. Chi-square test indicated a statistically significant ($P<0.05$) association between level of education and adoption of 15 % NaCl solution technique therefore, confirming education as a factor influencing adoption. Similar results were reported by Bwana (1996) who identified education as a factor that influenced the adoption of improved storage technology.

Similarly, CIMMYT (1993), observed that, education can make a farmer more receptive to advice from an extension worker or more able to deal with technical recommendations that require a certain level of numeracy or literacy. Thus, the more complex the technology, the more likely that education will play a facilitative role in technology adoption. Since the use of 15 % NaCl solution is a simple technique, it can be influenced by participation in various projects and attendance to training sessions such as workshops, seminars, meetings *etc*. Such opportunities can trigger their motivation therefore, facilitating the adoption process. This could be relevant when considering innovations that involved complicated instructions.

4.1.6 Family size

Family size was determined by considering all the members present in each household. These were the parents, children and dependants who made the respondents' family size. It was observed that 77.8 % and 70.0 % of the adopters and non-adopters, respectively, had between one and five persons in their families, while 17.8 % and 20 % of adopters and non-adopters, respectively, had families of six to nine persons (Table 1).

Families with more than 10 persons accounted for only 4.4 % and 10 % of adopters and non-adopters, respectively. The overall average family size for adopters was small 5.8 compared to 6.3 persons for non-adopters. This size is relatively larger than the national average household size which stands at 5.1 in rural areas (National Bureau of Statistics, 1997). Larger family size tends to strain the food budget especially in households with low income.

In the present study, family size had no significant (P>0.05) association with adoption of 15 % NaCl solution technique.

4.2 Socio-economic status of the respondents

Socio-economic status in this study is indicated by income per year and social status of the respondents.

4.2.1 Income

The major sources of respondents' income were farm and non-farm activities. The average annual income of each respondent was recorded. Distribution of the respondents by their source and level of income are shown in Table 2. The majority of respondents were involved in farming as their major source of income. However greater, proportion was observed for non-adopters than for adopters (66.7 % vs 35.6 %), suggesting that, those that depended on farming activities alone were not as receptive to new innovations as those who depended on both farming and non-farming activities. However, the relationship was not statistically significant (P>0.05).

These results can be explained by the fact that, greater proportions of adopters (64.4 %) than non-adopters (33.3 %) were involved in both farming and non-farming activities. Results suggest that, most of the adopters were engaged in other (non-farm) activities in order to supplement their farming activities. The main non-farm activities identified were employment, small-scale trading (e.g. *genge, mama lishe,* kiosk, retail shops, marketing of rice and animal products, tailoring, and casual

labour *'vibarua'* in other people's farms).

It was also observed that due to risks such as unpredictable weather conditions and the outbreak of diseases, farmers had a tendency of diversifying their income generating channels. Similarly, Machumu (1995) reported the involvement of farmers in more than one enterprise in order to spread risks.

Table 2 : Distribution of respondents by source and level of annual income

Parameter	Adopter (n=45)		Non- adopter (n=30)		Probability
	Number	%	Number	%	
Source of income					
Farming	16	35.6	20	66.7	
Farming & non-farming	29	64.4	10	33.3	0.296
Income level (TAS)					
Up to 250 000	18	40.0	15	50.0	
250 001-500 000	11	24.4	9	30.0	
More than 500 000	16	35.6	6	20.0	0.35

TAS =Tanzanian shillings (USD 1 = TAS 800).

Source: Survey data (2000)

Table 2 shows that the annual income of at most TAS 250 000/= was earned by 40 % and 50 % of adopters and non-adopters, respectively, while 24.4 % and 30 % of adopters and non-adopters, respectively, earned between TAS 250 001-500 000/=.

The higher income level exceeding 500 000/= was earned by 35.6 % and 20 % of adopters and non-adopters of 15 % NaCl solution technique. These results indicate that the proportion of the adopters who earned higher income exceeded that of non-adopters. Despite the above variations, income level and adoption of 15 % NaCl solution technique were not statistically ($P>0.05$) associated. This implies that source of income and income level do not influence the adoption of this innovation and hence, the technique can be adopted by members of any socio-economic status. These findings agree with Mabagala, R. (Personal communication, 2000) who contended that, the technique is cost effective in terms of the amount of salt to be used, labour, time, improved seed and that, it is environmentally friendly.

4.3 Social status

The social status of respondents can be indicated by the level of living, education level, family size, possession of wealth, occupational and self perceived identification with a social class. In the present study, social status was determined by assessing the position of an individual in the society; such as leadership (religious or political), employment, or ordinary small scale farmer. Each position of the respondents was given a score of one point for each level. These were recorded and ranked as low, medium and high status as summarised in Table 3.

Table 3 shows that 68.9 % and 63.3 % of adopters and non-adopters, respectively, were of low status; where as 24.4 % and 33.3 % were of medium status. Of the adopters and non-adopters, 6.7 % and 3.3 % respectively, were found to fall under the high status category. Earlier studies by Rogers and Shoemaker (1971) reported

that, early adopters have higher status than late adopters. Chi-square test in the present study indicated that there was no significant (P>0.05) association between social status and adoption of 15 % NaCl solution technique implying that, the innovation is acceptable to members of different categories of the social system.

Table 3 : Distribution of respondents by their social-economic status

Status	Adopters (n=45)		Non-adopters (n=30)		Probability
	Number	%	Number	%	
Social position					
Low	31	68.9	19	63.3	
Medium	11	24.4	10	33.3	
High	3	6.7	1	3.3	0.617
Possession of assets					
Poor	33	73.3	16	53.3	
Ordinary	9	20.0	9	30.0	
Rich	3	6.7	5	16.7	0.624

Source: Survey data (2000)

Rogers (1995) emphasised that, although wealth and innovativeness are highly related, economic factors do not offer a complete explanation of innovative behaviour (or approach of doing so). For example, agricultural innovators tend to be wealthy, but there are many rich farmers who have been reported not to be innovators. This argument is supported by the economic position of farmers at Ndungu. The ownership of properties and assets apart from farmsize were

considered. These included shops, milling machine, sewing machine, motor bike, bicycle, radio, television, butcher and house.Each asset was ranked according to its estimated value and given a score. The scores were then categorised as poor (at most 10 points); ordinary (11-20 points) and rich (above 20 points).

Findings of the present study (Table 3) showed that, 73.3 % and 53.3 % of adopters and non-adopters, were poor, while proportions for ordinary farmers were 20 % and 30 %, respectively. The proportion of adopters who were rich was less than that of non-adopters (i.e. 6.7 % vs 16.7 %). Following Chi-square test wealth was not significantly ($P>0.05$) associated with adoption implying that, the relationship of wealth and innovativeness might not be curvilinear because of the intervening variables of perceived risk.

4.4 Land Acquisition

The present study has revealed that farmers in Ndungu rice project have acquired land through different modes. A previous study conducted at the project area reported that, of the 43 farmers interviewed, 74.4 % were given land by village government, 16.3 % had rented or hired land while 9.3 % had both inherited and hired land. None of the respondents acquired the free holding land (NADP, 1999). It was further noted that, the average farm had become fragmented into several plots through land inheritance custom, which is a common practice in many areas of Tanzania. Ndungu rice project consolidated these percels of land in 1981 and redistributed them to the owners so that each farm was in one large plot. But farmers' attitude towards large fields had not been changed. Therefore, some farmers

immediately divided their newly consolidated farms into several plots. They claimed that their seeding and fertilisation rates were effected by the small plots. In this study it was observed that in some farms, rice production had stopped or productivity was very low due to the problems of salinity. Despite the fact that farmers were often advised to add cow-dung *'Samadi'* so as to supplement the low level of soil nutrients, they did not bother to do so. This is probably because some farmers were not confident of land ownership right. Lack of land ownership right may be considered as one of the factors that hindered adoption of agricultural innovations, since farmers are not always ready to invest on rented land which may not be available again in the following seasons.

Renting land is now a common practice at Ndungu because of unreliable rainfall and hence, inadequate irrigation water. This problem has resulted in water allocation system, which allows certain blocks of rice to get water in one season while others in the next season. The system has made farmers who are not able to cultivate rice, but have access to water to rent their farms to other farmers. Such a situation affects the adoption of agricultural innovations because some adopters may not grow rice due to water shortage.The present study is in agreement with Makauki (2000), who reported that the mode of land acquisition could affect the adoption, success and realisation of agroforestry innovations.

4.5 Farm size

The majority of the respondents were found to own small pieces of land with an average of 0.3 ha. Table 4 shows that 20 % and 6.7 % of the adopters and non-adopters, respectively, owned at most 0.09 ha per household, while the majority of the respondents (71.1 % of adopters and 83.3 % non-adopters) had 0.1-1.0 ha. The farms exceeding 1ha were owned by 8.9 % and 10 % of adopters and non-adopters, respectively.

Table 4 : Distribution of respondents by farm size for rice and maize crops

Farm size (ha)	Adopter (n=45)		Non-adopters (n=30)		Probabilty
	Number	%	Number	%	
Rice					
At most 0.09	9	20	2	6.7	
0.1-1.0	32	71.1	25	83.3	
Above 1.0	4	8.9	3	10	0.278
Maize					
0.1-1.0	8	88.9	5	62.5	
Above 1.0	1	11.1	3	37.5	0.20

Source: Survey data (2000)

Despite the argument given by Rogers (1995), that a large farm size is a common variable for adoption and a good proxy for wealth, Chi-square test in the present study did not indicate a significant ($P>0.05$) association between the two variables, implying that farmsize was not an important factor influencing adoption of 15 %

NaCl solution technique. This is because the innovation does not necessarily require more land as a pre-condition for adoption.

Similarly, the majority of adopters (88.9 %) and non-adopters (62.5 %) who were engaged in maize production had small farms (0.1-1.0 ha). This is supported by Machumu (1995) and Lyatuu (1994) who reported that traditional farming systems in Africa are characterised by small farm size.

4.6 Importance of seed health practised by farmers at Ndungu rice project

Seed health is an attribute of quality and is of great concern both to the seed industry and seed growers. It ensures long-term security of production against the deleterious effects of seed borne diseases on yield and grain quality. According to FAO (1984), there has been increasing recognition in agricultural policies on the importance of seed separating techniques to obtain good quality seeds in agriculture. In Tanzania, this is mainly because farmers are advised to use their own saved seeds for planting in order to complement the shortage of certified seeds (FRBP, 1998).

Results from the present study indicate that 46.7 % and 56.7 % of adopters and non-adopters, respectively, were using improved and their own saved seeds, while those who used their own saved seeds were only 20 % and 13.3 % of adopters and non-adopters, respectively (Table 5). About 30 % of both adopters and non-adopters were using improved seeds only.

The improved seeds referred to in this study are seeds bought or ordered by the project or co-operative union and were sold to farmers. The seeds could either be treated by chemicals or untreated. However, untreated seeds needed to be cleaned by using 15 % NaCl solution technique before sowing.

Table 5 : Distribution of respondents by source of seeds

Parameter	Adopter (n=45)		Non-adopter (n=30)		Probability
	Number	%	Number	%	
Source of Seeds					
Improved seeds*	15	33.3	9	30.0	
own saved seeds	9	20.0	4	13.3	
Improved & own saved seeds	21	46.7	17	56.7	0.644

*Seeds bought by the project but still needed to be cleaned.

Source: Survey data (2000)

The Chi-square test showed no statistically significant (P>0.05) association between source of seeds and adoption of 15 % NaCl solution technique. This implies that, the type of seeds used whether improved or own saved seeds was not an influencing factor in adoption of the technique. These findings agree with those reported by Hamid (1996) from a study conducted in Malaysia. The author reported that, between 20 and 70 % of farmers chose to use their own saved seeds and the remainder obtained seeds from other farmers, relatives or bought seeds from seed growers or seed agents.

In Kuala Lumpur, farmers could easily obtain a 10-20 % increase in yield by improving their own saved seeds. The improvement was achieved by winnowing, floatation, and sorting by hand (Merca and Mew, 1992). These traditional methods, which in the present study, were also used by 4.4 % of adopters and 100 % of the non-adopters (Table 6). It was further observed that greater proportion of the adopters (95.6 %) used 15 % NaCl solution technique only, while a smaller proportion (4.4 %) had used both 15 % NaCl solution and the traditional methods.

Table 6 : Distribution of respondents by methods used to select rice seeds

Selection method	Adopter (n=45)		Non-adopters (n=30)		Probability
	Number	%	Number	%	
Traditional methods	0	0	30	100	
15 % NaCl technique	43	95.6	0	0	
Both traditional & 15 % NaCl technique	2	4.4	0	0	***

***Highly significant (P<0.001)

Source: Survey data (2000)

The Chi-square test indicated that, the associations between method of selecting rice seeds and adoption of 15 % NaCl solution technique was highly significant (P<0.001). This distribution was mainly caused by the nature of study, which involved random selection of farmers.

However, the imbalance shown among the adopters themselves in the use of

selection methods indicates that there was a shift from the use of traditional methods to the 15 % NaCl solution technique. This is because the adopters were free to use both methods but only 4.4 % did so.

The 15 % NaCl solution seed separating technique has therefore, a high degree of acceptability to the Ndungu society. The innovation is thus, perceived as being consistent with existing values, past experiences and needs of potential adopters. It also implies that, the innovation is easily used and communicated to others. The probable reason for the observed relationship may be the way this technique has been effected by the promoting agencies, SUA-FRPB and Ndungu ADP. Promotion and communication of innovations by extended extension services through field visits, demonstration plots, seminars, and workshops as shown in Table 7, have been reported to be useful to farmers. For example, the VEO of Makokane village confirmed the provision of such services to his village. However, due to long distances from the village to the project office, farmers' oftenly did not attend seminars. Besides, training required extra money for transportation, meal allowances and incidentals. Despite the observed limitations, the majority of respondents had access to services (*i.e.* extension services, irrigation water and seeds).

However, all respondents admitted not to have credit or any source of known credit in their villages. Farmers' need for credit was rated very high. Credit is needed for ploughing, planting, weeding, seeds, fertilisers, and insecticides. Such findings were also reported by Lyatuu (1994), that credit is vital for continued technology adoption. Seminars conducted by Ndungu ADP at the beginning of every season have proved

to be a good source of information for 60 % of the adopters of 15 % NaCl solution technique (Table 7). About 31 % of the adopters were informed about the technique by project staff while both fellow farmers and village extension workers (VEW) informed only 4.4 % of the adopters. Although about 43 % of non-adopters were informed by their fellow farmers about the use of 15 % NaCl solution technique, they did not adopt.

Table 7 : Distribution of respondents by access to services and source of 15 % NaCl solution information

Parameter	Adopter (n=45)		Non-adopter (n=30)		Probability
	Number	%	Number	%	
Service related factors					
Access to seeds	45	100	29	96.7	0.218
Access to irrigation water	44	97.4	30	100.0	0.411
Access to Extension services					
• Once	14	31.1	11	36.7	
• 2-3 times	25	55.6	19	63.3	
• + three times	6	13.3	0	0	0.113
Adequate field visits	22	48.9	10	35.7	0.21
Sources of information about NaCl technique					
VEW	2	4.4	Na	Na	
Ndungu project staff	14	31.1	1	14.3	
Seminars	27	60.0	3	42	
Fellow farmers	2	4.4	3	42.9	0.015

Na= Not applicable.

Source: Survey data (2000)

A greater proportion of non-adopters (43 %) were informed of the technique by their fellow farmers. The source of information and adoption of 15 % NaCl solution technique were significantly ($P<0.05$) associated, identifying the source of information as a factor influencing adoption of this technique.

In previous studies, Lionberger and Gwin (1991) asserted that adoption starts slowly and eventually increases as a result of interpersonal communication on an innovation. In the present study, more than 50 % of respondents agreed to have heard about and seen 15 % NaCl solution technique tried locally by other farmers who adopted the technique. Some respondents claimed that although people were aware of the innovation, more time was still needed in order for non-adopters to improve their awareness through observing the benefits of the technology from adopters. Lack of enough time of exposure was claimed by 53.3 % of both adopters and non-adopters as a reason for poor participation in seed cleaning practices. However, time was not significantly ($P>0.05$) associated with adoption. This is probably because farmers were involved in other income generating activities (IGAs), since income gained from agriculture could not fulfil their obligations. However, more than 50 % of respondents including women, agreed to use such a technique if involved in attending seminars about the technique.

4.7 Factors motivating the adoption of 15 % NaCl solution technique

All (100 %) of the adopter-respondents claimed to have used 15 % NaCl solution technique because they were aware of the innovation's benefit. The respondents maintained that the innovation was cheap and simple. Specific reasons that motivated

farmers to engage in soaking seed in 15 % NaCl solution are presented in Table 8. Results indicate that 48.9 % of the adopters agreed that the technique increased seed germination, and reduced the incidence of seed borne diseases, while 8.8 % said that it increased yield (Table 8).

Table 8 : Distribution of respondents by reasons for adopting 15 % NaCl solution technique

Parameter	Adopter (n= 45)		Non-adopter (n=30)		Probability
	Number	%	Number	%	
Reasons for adopting					
Reduce diseases	5	11.1	Na	Na	
Increase germination	11	24.4	Na	Na	
Both diseases & germination	22	48.9			
Advised by extension officers	3	6.7	Na	Na	
NaCl increases production	4	8.8	Na	Na	NS
Better than traditional	43	97.7	Na	Na	***
Seminars on 'SS' attended*	41	91.1	Na	Na	***
Instructions were understood	45	100	Na	Na	***

NS = Not significant (P>0.05); *** Highly significant = (P<0.001); 'SS' = Seed separating technique; Na = Not applicable

Source: Survey data (2000)

The technique was reported to be better than the pre-existing (traditional) methods of seed selection by 97.7 % of the adopters. Instructions on how to use the 15 % NaCl solution technique were understood by all adopters, however a few could not remember the exact proportion of salt to water.

According to Rogers and Shoemaker (1971), this positive attitude is of concern because it will create a general positive set towards change and grease the ways for future ideas that may be introduced. Only 6.7 % admitted to have used it simply because they were advised by extension officers in seminars (Table 8).

4.8 Factors limiting adoption of 15 % NaCl solution technique at Ndungu Rice Project

In the present study, respondents were asked to give reasons for not adopting the technique despite the fact that, they attended seminars in which this technique was introduced. The reasons are presented in Table 9. Sixty percent of the non-adopters were not aware of the technique, 10 % did not see the importance for adopting the technique and 30 % said that, it consumes time. In addition, 70 % of non-adopters did not attend seminars on seed separating technique while 30 % attended but did not use the technique. However, 44.4 % of non-adopters who attended seminars, understood instructions, while 55.6 % did not understand procedures of the technique (Table 9).

The study was carried out at the time when there was insufficient water for irrigation. This inadequacy of water was used as an excuse for not adopting the technique since they could not cultivate rice.

Table 9 : Distribution of respondents by reasons for not adopting 15 % NaCl solution technique

Parameter	Adopter (n= 45)		Non-adopter (n= 30)		Probability
	Number	%	Number	%	
Reasons for not adopting					
NaCl not important	Na	Na	3	10.0	
NaCl consumes time	Na	Na	9	30.0	
Not aware of NaCl	Na	Na	18	60.0	***
Did not attend seminars on 'SS' [y]	Na	Na	21	70.0	***
Instructions were not Understood [z]			5	55.6	***
Yes	Na	Na	4	44.4	
No	Na	Na	5	55.6	***
Insufficient time for women	24	53.3	16	53.3	NS

NS = Not significant (P>0.05); *** Highly significant = (P<0.001); y = Seed separating technique; z = Non-adopters but attended seminars; Na=Not applicable

Source: Survey data (2000)

Such an allegation is in line with previous findings by Benad (1988), Kauzeni (1988) and CIMMYT (1993). Insufficient time for women was another factor that limited the adoption of 15 % NaCl solution technique. This was pointed out by 53.3 % of both adopters and non-adopters.

The respondents most of whom were Muslims, identified the tendency of female farmers not to mix with male farmers in the meetings due to their religious belief as a factor that hindered adoption of 15 % NaCl solution technique for separating good quality rice seed. The key informants also acknowledged this argument as a limiting factor to male extension officers. Guerin and Guerin (1994) enumerated farmers' beliefs, opinions and level of motivation to be adoption constraints in dissemination of agricultural technologies in Australia, results which agree with findings of the present study.

4.8.1 Political influence on adoption of the innovation

Opinion leaders in the study area were village and ward executive officers, councillors, CHAWAMPYO leaders, and religious leaders. There were also leaders with multiple roles, for instance, a councillor was also a CHAWAMPYO leader. Opinion leaders are able to informally influence other individuals' attitudes or overt behaviour in a desired way with relative frequency. They are always used by change agents as lieutenants in their campaigns of planned change.

However, few leaders make decisions, which are private rather than public affairs. This may result in lack of motivation towards new innovation just like what was

reported by farmers in the study area. In a meeting held by project and CHAWAMPYO leaders, it was agreed to cultivate 4 blocks instead of 7 blocks of rice due to insufficient water.

Unfortunately, this collective agreement was regarded as project leaders' decision, because, telling farmers not to cultivate would have caused some of the CHAWAMPYO leaders who contested for councillor's seat (*Udiwani)* in the 2000 general elections to lose votes.

Project leaders could not stop farmers to cultivate since they are perceived as social strangers temporarily alight in the system. These are change agents according to Rogers (1995), who have possibly high technical competence but of low general status and social power, and of relatively low credibility regarding decisions for members of the social system.

It is disheartening to note that, project leaders were blamed when most of the rice dried. Consequently, there was generally a poor attendance to seminars, field demonstrations and hence adoption of agricultural innovations including the 15 % NaCl solution technique. For example, in the present study, it was observed that, during demonstrations on the effect of late transplanting of rice seedlings, only four farmers attended. In addition, some farmers attended seminars on seed cleaning but they neither used it nor recognised its importance.

Regarding poor participation in seminars by farmers, the main reason put forward by the respondents was that, they were tired of attending seminars or field demonstrations on plots, which were well maintained and irrigated, unlike their fields that were not irrigated. Such findings agree with Rogers (1995) who asserted that pre-existing ideas might make an innovation rejected or adopted slowly.

4.9 Extent of adoption of 15 % NaCl solution technique by gender

The extent of adoption was measured based on the number of seasons during which the adopters used the technique during the four seasons they had gone through since the technology was introduced in the area. The respondents were asked to mention when they had started using the technique. It was found out that 85.3 % and 14.7 % of the adopter respondents, who started to use it one year before the year of the present study were male and female respectively, while the proportions were 54.6 % and 45.5 % for those who had used it for the past two years (Table 10).

The proportion of male adopters who had used the technique for one season was by far higher than that of female adopters. The study revealed that 84.3 % and 15.6 % of the adopters, who used it for one season were male and female, respectively, while 60 % and 40 % of the adopters who used it for two seasons were male and female, respectively. None of the adopter respondents were found to use it for three seasons. However, the technique was used in all four seasons by only three respondents out of whom 66.6 % and 33.3 % were male and female adopters respectively (Table 10). The low adoption of the technology may probably be due to insufficient water for irrigation which limited farmers to grow rice in two seasons per year. Those farmers

who managed to use the technique in four seasons had hired farms on the basis of water allocation at that particular season.

Following the quantitative analysis, the average number of seasons during which the respondents used 15 % NaCl solution technique was 1.3 out of 4 recommended seasons. This gives the adoption of 32.5 % indicating that more time and training were needed for the rest of the community to adopt the technique. The observed higher proportion of male (80 %) than female (20 %) adopters who used the technique was a result of interviewing the heads of households. Chi-square test showed that there was no statistically significant ($P>0.05$) association between gender and extent of adoption of the technique.

Table 10 : Distribution of respondents by extent of adoption and gender class

Parameter	Male		Female	
	Number	%	Number	%
When started using 15% NaCl				
one year ago (n= 34)	29	85.3	5	14.7
two years ago (n= 11)	6	54.5	5	45.5
Number of seasons				
one season (n= 32)	27	84.3	5	15.6
two seasons (n= 10)	6	60.0	4	40.0
all four seasons (n= 3)	2	66.7	1	33.3

Source: Survey data (2000)

Evidence from other studies support these results that adoption of many innovations may take several years. For example, it took three to five years for farmers to adopt an improved variety of rice in Phillipines (Herdit and Capule, 1983). Similarly, it took five years for hybrid corn in Iowa (USA) to be adopted (Van den Ban and Hawkins, 1988). In the present study, the period of two years for the technology to diffuse may therefore, not be enough. Rogers and Shoemaker (1971) pointed out that, due to a number of factors, time might be too short for the different groups of farmers to have gone through the adoption process, thus, more exposure time may be needed.

4.9.1 Gender roles in the farming systems

Gender participation was of interest in this study. Of all 75 respondents interviewed, 80 and 60 % were male adopters and non-adopters, whereas 20 % and 40 % were female adopters and non-adopters, respectively. Despite the higher proportion of male than female adopters and non-adopters, gender roles in the farming systems was not significantly ($P>0.05$) associated with adoption. This observation supports the assertion that women have a mediating role in the household welfare; and they share insight with breeders, pathologists and agronomists, by designing, managing, and monitoring their own trials (Agarwal, 1988; Jaya, 1992).

Women are constrained by several factors, such as barrier to access related services, child bearing, time, mobility, education and an array of socio-cultural characteristics (Rathgerber, 1990). They tend to have less secure tenure and that is more fragmented or simply smaller plot. Their labour productivity is reduced and their management

problems are magnified when their holdings are geographically dispersed. When land owned could not support the family, outside income is sought such as selling one's labour which reduces the time available to work on his/ her own farm (Ng and Mohamed, 1992). They are less likely to have secured title to land because in African countries, title is always in the name of the male head of the household.

This discourages them from participating in agricultural support services particularly extension and credits (Kelkar, 1988). It was further observed in the present study that, some women were not willing to be interviewed. This is probably due to the pre-existing perception that women are less able to understand most of extension messages due to their generally low level of education (Katrine and Weidemann, 1990). In many societies men are considered the spokesmen of all family matters. This tradition does not allow women to interact openly with outsiders in the absence of their husbands. Such an attitude may have contributed to the fear expressed by the women in the present study.

Gender roles are examined in two categories. These are resource analysis (access to different resources to male and female); activity analysis (division of labour); decision making among gender classes and benefit analysis.

4.9.2 Resource analysis

The following analysis, based on data from Ndungu represents an attempt to trace the effect on the gender division of labour, and women's control over resources of an expansion of agricultural production, in order to improve the living conditions. The

changes are part of a strategy of the households for particular ends. In this study men had great opportunity to own resources relative to women. Even in the joint ownership, men still remained with the title of official registration hence more authority (Table 11).

Women access to, or control over, rented land was even more limited. The majority of households with male heads rented paddy fields, while most female households did not do so. This is probably because they were not able to command adequate family labour for producing high yield necessary for paying the high land rents. Women access to knowledge on different agricultural innovations was also denied due to the fact that farmers with title of land were the only ones recognised by the project and hence attended seminars about 15 % NaCl solution technique.

According to Jaya (1992), male-female differential rights in agricultural productivity has been aggravated by the infrastructural support programmes that give pre-economics to men as heads of the household. Thus, it was the men who were provided with the training although some agricultural operations such as fertiliser application and seed soaking were performed exclusively by women in the area of the present study. As a result, female agricultural workers have much less access to information and training for improved farming methods.

Table 11 : Percentage Distribution of Respondents by Access to Resources

Resource	Adopters (n=45)			Non-adopters (n=30)		
	M	W	B	M	W	B
Land	82.2	2.2	15.6	86.7	6.7	6.7
Capital	82.2	0	17.8	83.3	6.7	10.0
Knowledge	84.4	0	15.6	80.0	10.0	10.0

Source: Survey data (2000)

To a great extent, the access could be limited by predominance in the subsistence sector, illiteracy, and women's limited access to land and time. However, there were few aged female landowners who inherited the land from their late husbands or parents. This suggested that their control over the land came later in their lives, when they were too old to work on the land, an observation which was also reported by Agarwal (1988) in India. Another interesting point to note is that these female land owners were heads of households. The difference in control exercised over the land by male and female land users suggests that using land does not necessarily imply social and economic power for women over the resource.

4.9.3 Activity analysis

4.9.3.1 Division of labour

Table 12 summarises the average percentage of each gender responsible for labour input for some of the important crops cultivated by the households. It needs to be stressed that there are considerable variations from one household to another. There were households in which the wife still takes care of almost all tasks, apart from land

preparation, planting, harvesting, hoeing and seed preparation, which remain exclusively male tasks. There were households in which all tasks in cultivation are equally shared. Where necessary some activities such as weeding, harvesting, transporting crops home and threshing were done by hired labour.

Table 12 : Percentage distribution of respondents by activity and gender

Activity	Adopters (n =45)				Non-adopters (n = 30)			
	M	F	B	H	M	F	B	H
Land preparation	64.4	4.4	24.4	6.7	56.7	13.3	30.0	0
Hoeing	60.0	4.4	28.9	6.7	36.7	13.3	50.0	0
Seed preparation & sowing	44.4	13.3	42.2	0	23.3	23.3	53.3	0
Transplanting rice seedlings	33.3	28.9	37.8	0	13.3	46.7	40.0	0
Manure/fertiliser application	73.3	11.1	15.6	0	50.0	16.7	33.3	0
Weeding	31.1	20.0	42.2	6.7	16.7	26.7	56.7	0
Harvesting	46.7	4.4	31.1	17.8	36.7	13.3	46.7	3.3
Transporting crops home	55.6	2.2	26.7	15.6	60.0	6.7	30.0	3.3
Threshing	48.9	11.1	31.1	8.9	45.3	13.3	36.0	5.3
Crop selling	40.0	15.6	44.4	0	76.7	10.0	13.3	0
Fetching/gathering firewood	11.1	77.8	11.1	0	0	100	0	0
Fetching water	2.2	93.3	4.4	0	0	100	0	0
Cooking	2.2	95.6	2.2	0	0	100	0	0
Laundry	2.2	93.3	4.4	0	3.3	96.7	0	0

M= Male F= Female B= both male and female H= Hired labour (male/ female)

Source: Survey data (2000)

Generally, nowadays men apparently participate in farm operations to a larger extent than in 1968 (Nypan, 1991). For example, in the present study 44.4 and 23.3 % of male adopters and non-adopters were involved in seed preparation and sowing while 55.6 % and 60 % were transporting crops from the field to their home. Despite the increased participation of men, women undoubtedly still carry the large burden of cultivation and animal feeding (Boserup, 1989).

Based on this argument, some activities were reported as women and children's tasks more than men by 90 % for both adopters and non adopters. These activities included fetching firewood, water, cooking, and laundry. These findings agree with previous studies by Agarwal (1988); Machumu (1995) and Bwana (1996) who reported that, women play a key role in most agricultural systems as well as in domestic tasks. This situation is likely to limit the participation of household female gender in agricultural innovations, although 53.3 % of all respondents maintained that women could participate fully in the exercise on condition that extension agents visit their villages. Findings in this study also agrees with findings reported by Makauki (2000). Thus, there is a need for modifying the socio-cultural gender relations, which oppress females in rural communities.

4.9.3.2 Decision making and benefits from agricultural crops

For certain products and activities, joint decision was reported by a number of women. Data on whether it was the wife or husband who made decisions regarding sales of the produces, type of crops to be grown, the use of 15 % NaCl solution technique and how to use the cash income, indicate some aspects of distribution of

control between spouses (Table 13). There is no doubt that, twenty years ago, women had no right to handle cash income and agricultural innovations were reserved for men. However, the control over produce and cash is becoming an issue of contention between husband and wife.

Findings of the present study agree with Nypan (1991) that, although men were the main decision makers than their wives, the greater proportion of farm operations were done by joint decision. For example, more than 50 % of adopters contended that decisions on the type of crops and when to plant were done by both husband and wife; but the proportion was smaller for non-adopters (36.7 %) than adopters (53.3 %).

Table 13 : Decision making and benefits from agricultural crops by gender as distributed among respondents

Operation	Adopter (n = 45)			Non-adopter (n = 30)		
	H	W	B	H	W	B
Type of crops to grow	33.3	13.3	53.3	56.7	6.7	36.7
When to plant	37.8	8.9	53.3	50.0	10.0	40.0
When to weed	40.0	11.1	48.9	46.7	10.0	43.3
When to harvest	44.4	8.9	46.7	53.3	6.7	40.0
When to sell	42.2	11.1	46.7	46.7	6.7	46.7
Whether to use NaCl	53.3	11.1	35.6	Na	Na	Na
Benefits of crops	42.2	8.9	48.9	43.3	10.0	46.7

H = husband; W = wife; B = both

Source: Survey data (2000)

Although most women did not attend seminars on the use of 15 % NaCl solution technique, 35.6 % of the adopters reported joint decisions with their husbands on whether to use the technique or not. This implies that some men do communicate with their counterparts about innovations. This is probably due to the fact that most of the farm operations and judgements are done jointly by the husband and wife.

The present study has revealed that decision making on the ownership of the benefits from agricultural crops was higher for men (42.2 % vs 43.3 %) for adopters and non-adopters than for women (8.9 % vs 10.0 %) for adopters and non-adopters, respectively (Table 13). However, there was a proportion of joint decisions on the ownership of the benefits for 48.9 % and 46.9 % of adopters and non-adopters of 15 % NaCl solution technique, respectively.

4.9.4 Limitation of the Study

The present study had the following limitations:

1. Most of the respondents were not keeping records of inputs, outputs and the instructions or advice given by the extension officers. Thus, some relevant information on their previous farming operations, purchases and sales depended on their memory.
2. The actual farming practices of the respondents may vary from season to season depending upon the weather conditions, cash holding within the household, availability of the necessary inputs and labour during that particular season. Thus, it is not possible to infer a true picture of the extent of farmers who have adhered to the recommended practices.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study examined several factors that were thought to influence adoption of the 15 % NaCl solution technique used to separate good from bad quality rice seed. According to the findings, essential conditions and opportunities were identified as follows:

1. Production and distribution of quality seeds is the main strategy for increasing cropping intensities, productivity and yield.

2. This can be achieved by considering seed health, which is an attribute of quality and an integral part of seed quality control system.

3. The present study has also revealed that most farmers were aware of the benefits of using 15 % NaCl solution. However, exposure time to the innovation was inadequate for the community to adopt it confidently. The technique was found to be cost effective in terms of labour, time and resources. It also reduces risks to operators, consumers and environmental pollution; increases germination capacity and seedling vigour-factors that contribute to high yield. Thus, its adoption can ensure long term security of production by reducing the deleterious effects of seed borne diseases on yields and seed quality.

4. All farmers had access to extension services, but there was lack of adequate and regular irrigation water. In addition, inadequate field visits and extension services as well as poor farmers' participation in the seminars or demonstration plots was significantly associated with poor adoption of 15 % NaCl solution technique.

5. The project recruited farmers irrespective of gender. However, the majority of farmers were male. The political leadership and mode of land acquisition were also important factors that influenced adoption of the technique.

6. Socio-economic status of adopters and non-adopters did not differ significantly. This implies that, 15 % NaCl solution technique can be adopted by any class of farmers irrespective of their socio-economic status.

5.2 Recommendations

1. Although combinations of different methods of technology transfer such as seminars, demonstrations and field visits were effective and successful in this study, only a few farmers were reached by extension agents and Ndungu ADP staff. Therefore, there is a need for regular field and home visits, and more frequent demonstrations, to reach the majority of farmers. Creation of voluntary farmers' groups whose farms will be used as demonstration plots for benefits arising from the use of 15 % NaCl solution is recommended.

2. Further studies are suggested on the diffusion and adoption of the 15 % NaCl solution technique in order to assess the benefit of the technology over time. The present study emphasised on farmers who participated in the project for two years only. A comparative study between farmers covered and those that are not covered by the project will determine the multiplier effect of the technology to other areas.

3. An open and readily available local and external markets for the produced rice should be sought. This may include diversification of rice utilisation, which will provide good prices and assure farmers of good incomes to buy necessary inputs. In addition, the introduction of credit schemes is also recommended for continued adoption and use of 15 % NaCl solution technique.

4. Dissemination of 15 % NaCl solution technique should also cover women who are mainly involved in seed preparation and planting. This can be achieved by increasing extension services by training more female extension agents to increase woman-to-woman interactions and hence side-step social taboos which limit male-female interactions. Efforts should also be made to ensure that female farmers are directly targeted as beneficiaries and encouraged to form groups to increase direct access to extension services.

5. More research on water harvesting and conservation is recommended to make it available throughout the cultivation season as well as promotion and dissemination of appropriate and environmentally friendly technologies relevant to local conditions.

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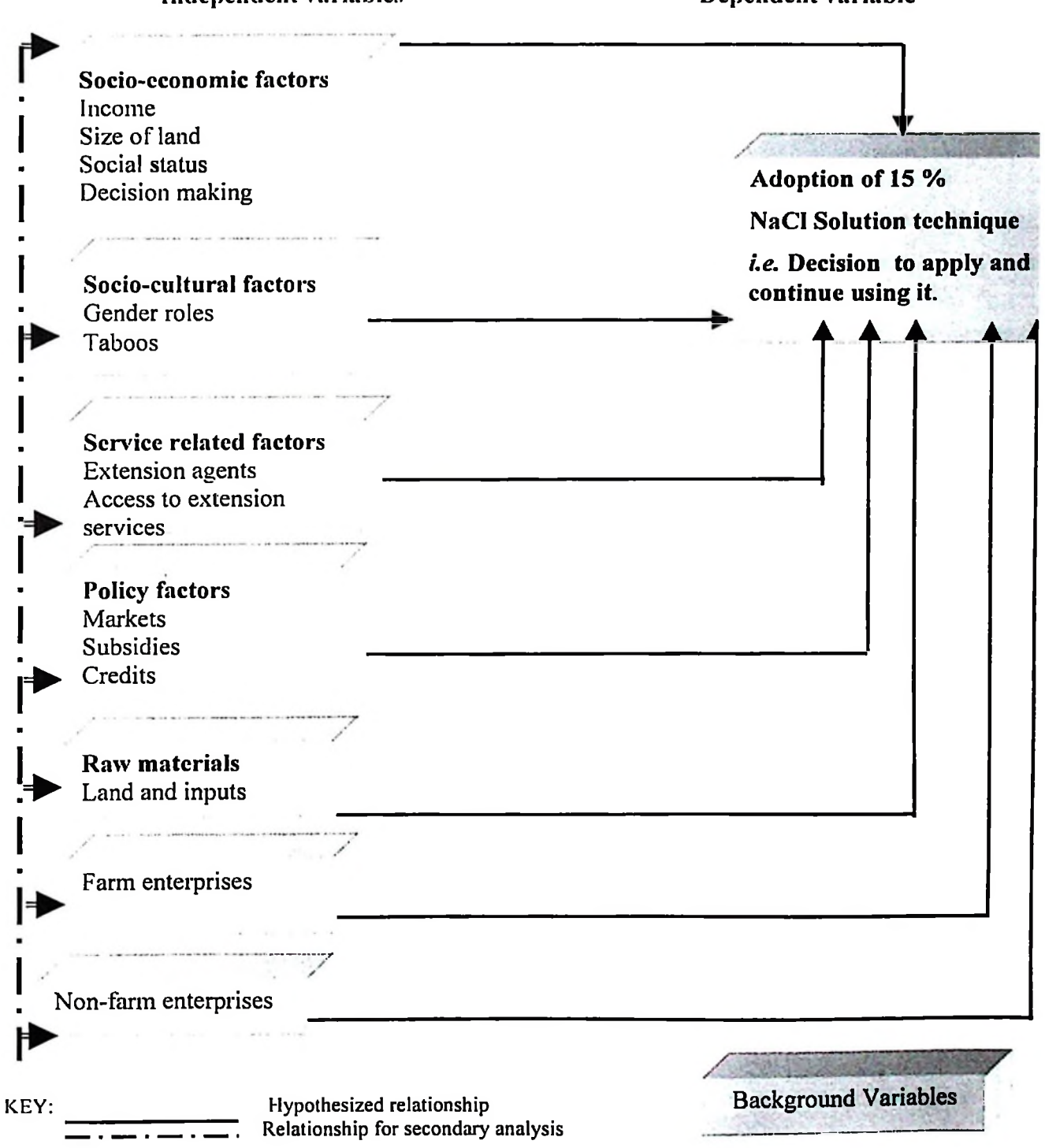
APPENDICES

Appendix 1: Conceptual framework of factors affecting adoption of 15 % sodium chloride solution technique



Appendix 2: Research variables, definitions, indicators, and measurement levels

Variables	Definitions	Indicators	Measurement level
2.1 Background variable a) Sex	Being male or female in the biological sense	1= male 2= female	Nominal
b)Age	Age of household heads in years	1= young (18-25) 2= medium (26-45) 3= Old (46 +)	Ratio
c) Education	Level of education	1= none 2= Primary 3= Secondary 4= Higher 5= Adult education	Ordinal
d) Marital status	State of being married; Not yet being married or having ever married	1= married 2= Not yet married 3= Divorced 4= Widowed	Nominal
e)Household size	Number of people living together	1= small (2-4) 2= medium (5-7) 3= large (8 +)	Ratio
2.2. Independent variables a) Non farm enterprises	Non primary economic activities including services, constructions, mining, manufacturing, of agroindustrial activities, processing and marketing of agricultural commodities, but excluding crop and livestock production, forestry, and fishing	• Carpentry • Pottery • local brewing • trade • tailoring • wage activities • construction • services • mining • agroindustrial • activities • processing of agricultural commodities etc	Nominal

b) Farm enterprises	Production activities including crop and livestock production, beekeeping, fisheries, hunting and forestry.	• crop production • livestock production • forestry activities	Nominal
c) Factors of Production	Factors in production economics		
i. land	.Area of land cultivated in 1999/2000	• hectares • acres	Ratio
ii. capital	. Value of initial land	• Tshs	Ratio
iii. Labour	. People who produce or help to produce	• household labour or hired labour	Nominal
d) Extension services	Knowledge and skills taught to villagers	e.g. Knowledge of roles of cleaning seeds for planting	Nominal
e) Costs	Value of inputs used and overhead e.g. fertilizers, NaCl, and seeds.	• Tshs	Ratio
i. Outputs	. Amount of products produced	• kg, bags	Ratio
ii. Prices	. Value of products sold	• Tshs	Ratio
f)Socio-cultural factors	Cultural practices or beliefs which affect adoption of NaCl technique. .Attitude towards an innovation	• Taboos • gender roles 1= strongly agree 2= agree 3= uncertain 4= disagree 5= strongly disagree	Nominal Ordinal
g)Policy factors	Policies which affect adoption of 15 %NaCl solution technique	Lack of : - markets - subsidies - credits	Nominal

h) Socio-economic factors			
i. Income	Amount of money earned monthly or annually, from farm or non-farm activities	• Tshs	Ratio
ii. Size of land	Land owned by a household	• Hectares • Acres	Ratio
iii. Socio Status	Position held by a respondent in the village	• Farmer • Village leader • Political leader • Project staff/Manager • Extension worker	Nominal
i) Decision making	Who decides on important / new ideas in the household e.g. whether to adopt or not.	1= Male 2= Female 3= Members of household.	Nominal

Appendix 3: Farmers' Structured Questionnaire

Number of respondent.....

Village: .....

Name of enumerator:.....

Note to enumerator:

Where applicable, circle the number bearing the correct answer.

For open- ended questions, you may use the reverse side if the space provided is not sufficient.

SECTION A: FARMER'S BACKGROUND.

1 (a) Sex

1. Female
2. Male

(b) Age (years):

1. Young (18-25)
2. Medium (26-45)
3. Old (46 +)

(c) Marital status:

1. Single
2. Married
3. Divorced
4. Widowed

(d) Household Composition:

Category	Number
Spouse(s)	
Children:	
Female	
Male	
Other dependants:	
Female	
Male	
Total	

SECTION B: FARMERS SOCIO- ECONOMIC STATUS

2. (a) What is your highest level of education?

1. No formal education
2. Adult education
3. Primary education
4. Secondary education
5. Other

(specify).....

(b) What is your social position?

1. Ordinary small scale farmer
2. Political leader
3. Traditional leader (specify).....
4. Religious leader (specify).....
5. Employee (specify).....

(c) What is your major source of income?

1. Farming activities
2. Non- farm activities
3. Both 1& 2
4. Other (specify.....

(d) What is your average harvest per year?.....

(e) What assets (properties) among the following, do you own and their number?

1. Radio
2. Bicycle
3. Motor bike
4. Sewing machine
5. Water source (e.g. tap, well, bore hole)
6. Milling machine
7. Farm size (acre/ ha)
8. Shop
9. Other (specify).....

SECTION C: LAND USE

3. Out of the farm area cultivated in 1999/2000, how many hectares were under

Crop	1 0.1-1.0 (ha)	2 above 1.0 (ha)
Rice		
Maize		
Other (specify)		

4. Apart from rice cultivation, which income generating activities are you involved in?

1. Shop owner
2. Brewing
3. Mansory / Carpentry
4. Tailoring
5. Brick making
6. Other (specify).....

SECTION D: SERVICE RELATED, POLICIES AND CULTURAL INFORMATION

5. Do you have access to the following services?

1. Crop seeds .....Yes/ No.
2. Irrigation water.....Yes/ No.
3. Credits.....Yes/ No.
4. Extension services.....Yes/ No. If Yes, What are the subject areas covered by extension agents.....

(If No, go to question No.9)

6. How frequent do you get advice from extension officers or project officers?

1. Once per season
2. Twice per season
3. Thrice per season
4. Several times

7. Do you think the visits are adequate?

1. Yes 2. No

8. Have you received credits in the last five years?

1. Yes 2. No

EXTENT OF ADOPTION

9. What is your source of seeds for planting among the following?

(1) Improved rice seeds from shops

(2) Own served seed from the previous seasons

(3) Both (1) and (2)

(For answer (1) above go to section E).

10. Which method among the following do you use to select seed for planting?

(1) Traditional methods (2) 15 % NaCl solution technique (3) Both

(1) Traditional methods

- Winnowing
- Soaking in water
- Seed selection by hand

For (1) above, give reasons why you prefer traditional methods to 15 % NaCl solution technique:

1. Less time consuming
2. Profitable vis `a vis NaCl technique
3. Seedlings adequately available
4. Other (specify).....

(If seed separation is by traditional methods, go to Section E)

(2) Introduced 15 % NaCl solution technique from SUA?

11. Why do you prefer using 15 % NaCl solution technique from traditional methods (i.e. Winnowing and Water)?.....

12. Since when did you start to use 15 % NaCl solution technique?

(a) 1 year (b) 2 years (c) 3 years ago.

***Use of technology*:**

Seasons	1 year	2 year
1		
2		

13. From whom did you get the information about 15 % NaCl solution technique?

1. Village extension workers
2. Village leaders
3. Ndungu project staffs
4. Seminars/ Workshops
5. Fellow farmers

14. After adopting it, do you think it has helped your seed separating knowledge?

1. Yes 2. No

15. Has 15 % NaCl solution technique increased your production since you started using it?

1. Yes 2. No

16. Are there any farmers who have adopted this technique after observing your increased yields?

1. Fully adopted
2. Partially
3. None.

SECTION E: GENDER ROLES

I. Resource analysis

17. Between man and woman who has access to the following resources:

(Use 'V' to mark in the appropriate columns)

Resource	Man	Woman
Land		
Capital		
Credits		
Knowledge		

II. Activity Analysis

(a) Division of Labour

18. (i) Among the members of the family who does the following activities? Use the following key to fill in the table below. (Use 'v' mark). M = Male, F = Female, MA = Male Adult, FA = Female Adult, MC = Male Child FC = Female Child

Activity	M		F	
	MC	MA	FC	FA
Land preparation				
Hoeing				
Seed sowing / preparation				
Transplanting rice seedlings				
Manuring and fertiliser application				
Weeding				
Harvesting of agricultural crops				
Transporting crops home				
Threshing				
Crop selling				
Fetching firewood				
Fetching water				
Cooking				
Laundry				

(ii) With the above division of labour do you think there is a chance for women to participate fully in seed separating activities?

1. Yes 2. No

(b) Decision making

19. Between the husband (H) and the wife (W) who decides to carry out the following activities.

Note: 'B'= Both husband and wife.

Activity	Decision maker		
	H	W	B
Types of crops to grow			
When to plant			
When to weed			
When to harvest			
When to sell			
Whether to use salt solution or not			

III. Benefit Analysis

20. Who owns the following benefits?

Benefits of farm crops	M	F
Rice		
Maize		
Money (from sales)		

SECTION F: FARMERS PERCEPTION

Farmers perception of the approach

21. Did you attend any meeting(s) where somebody discussed about seed separating solution?

1. Yes 2. No.

22. If Yes, How many times did you attend such meetings?

1. once 2. twice 3. Three times

23. Did you understand the instructions given on how to use this technique ?

1. Yes 2. No.

24. What amount of salt do you mix with water?.....

Appendix 4: Questionnaire for Key Informants

Village..... Ward.....

Occupation of the respondent.....

1. How frequent do extension workers visit villagers?

2. Do you think the visit are satisfactory

1. Yes 2. No.

If No, why?.....

3. Do extension workers/ project staff advises farmers to use seeds which are free from diseases?

1. Yes 2. No

4. Apart from SUA-FRPB, is there any other agency/ organisation which promote the use of clean seeds?

1. Yes 2. No

If Yes, mention the agency/ organisation and the technique used.....

5. What do you think are the factors which motivate farmers to use 15 % NaCl solution technique for separating seeds?.....

6. Are there any problems with the technique which discourage farmers from adopting it ? .....

7. Are rice seedlings easily available to farmers?

1. Yes 2. No

If Yes, What are the sources?.....

If No, What are the associated problems?...1. Lack of credits 2. Financial factors

8. Are there any policies among these, which affect adoption of this technology in the village?

1. Market
2. Price
3. Credits availability

9. What are your views about farmers' perception on this technology?

.....

10. Do you think this technique needs improvement?

1. Yes 2. No

11. What improvement/ modification(s) do you suggest to make this technique the most efficient?.....

THANK YOU FOR YOUR COOPERATION!