THE INDEPENDENT AND INTERVENING VARIABLES THAT INFLUENCE THE ADOPTION OF RECOMMENDED FERTILIZER PACKAGE IN NAMTUMBO DISTRICT OF RUVUMA REGION, TANZANIA

BY

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ABSTRACT

The continuous fall of maize production and non or low adoption of recommended maize production practices like fertilizer application in the Namtumbo District of Ruvuma Region have enhanced to conduct this study. The study investigated the adoption level and factors that influence the adoption of recommended fertilizer package (Phosphate, Nitrogen fertilizers and time of Nitrogen application) in the study area. The primary data were collected by the use of structured questionnaire from135 respondents selected at random. Data were analysed by using statistical package for social science (SPSS) computer program where descriptive statistics such as frequency and percentage were used to determine distribution of the study variables. Correlation was used to determine relationship between independent and dependent variables while Chi – square tested the significance difference between variables. Findings reveal that the level of adoption of recommended fertilizer package in the study area is low. Majority 128 (94.8%) of farmers who applied fertilizers, applied at different levels below recommendations. About 86 (63.7%) fall under low adoption level, 42 (31.1%) fall under medium adoption and about 7 (5.2%) of farmers did not apply at all. Not a single farmer adopted in full the recommended package that is 50 kg/ac of DAP/TSP mixed with 25 kg of Nitrogen fertilizer at planting and 75 kg of Nitrogen during topdressing. Several factors seemed to have influence on the level of adoption. These are the independent factors like sex of the respondent and the intervening factors (variables) namely the Efficiency misperception (EM), Need tension (NT) (Need aspects), prominence (perception), and awareness (knowledge). n general, the adoption of recommended fertilizer package in the study area is strongly influenced by the intervening

variables. Therefore the intervening variables which need to be focused in enhancing the adoption of recommended fertilizer package in the study area are need, perception and knowledge. From this point of view, extension deliverance should be emphasized based on the intervening variables.

DECLARATION

I, Michael Henrick Mlyuka do hereby declare to the Senate of Sokoine University of Agriculture that, this dissertation is my own original work and that it has not been submitted nor being concurrently submitted for degree award in any other institutions.

…………………………………………..   …………………………

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The above declaration is confirmed by

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SUPERVISOR

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DEDICATION

I dedicate this work to my late father Henrick Stefano Mlyuka and to my beloved wife Leonila Simon Kahwili.

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LIST OF ABREVIATIONS

ARI   -   Agricultural Research Institute

°C   -   degree Celsius

CAN   -   Calcium Ammonium Nitrate

CIMMYT   -   Centro Internacional de mejoramiento de maizy trigo

                        (International Maize and wheat improvement centre)

DALDO   –   District Agriculture Livestock Development Officer

DAP   –   Diammonium Phosphate

DED   –   District Executive Director

EM   –   Efficiency misperception

Ton/ha   -   Tone per hectare

ILO   –   International Labor Organization

Kg/ac   -   Kilogram per acre

m   –   Meter

MAC   –   Ministry of Agriculture and Cooperative

Mm   -   Millimeter

N   -   Nitrogen

NT   -   Need tension

P   -   Phosphate

SNAL   -   Sokoine National Agricultural Library

SPSS   -   Statistical Package for Social Science

SUA   -   Sokoine University of Agriculture

TSP   -   Triple Super phosphate

URT   –   United Republic of Tanzania

CHAPTER ONE

1.0   BACKGROUND INFORMATION

In Tanzania, maize crop is regarded as major cereal food crop and a shift towards food self – sufficiency in the country depends largely on the improvement of maize production. Maize crop is grown almost all over the country. The major maize producing regions are Iringa, Ruvuma, Mbeya, Kigoma, Morogoro, Dodoma, Rukwa, Tabora, Mwanza, Kilimanjaro and Arusha (URT, 2006; Amani, 2004). On the overall, the Southern Highland agro ecological zone (Iringa, Mbeya, Rukwa and Ruvuma Regions) is the major maize producer.

In order to promote maize production, Tanzania government has undertaken several measures to increase maize production per unit area as strategy to improve food security in the country. Among measures undertaken, from 1940s during the colonial era, research started which mainly concentrated on the production of maize varieties, manufacture of fertilizer and other agricultural inputs like insecticides, herbicides and farm implements (Lyimo and Temu, 1992). In early 1970s to 1980s, the Government of Tanzania supplied subsidized inputs (fertilizers and seeds) with an overall goal to enhance the use and increase agricultural production (World Bank, 1994).

Other effort made by the Government, is the 1990s trade liberalization policy, which allowed foreign private companies like Intabex, Balton (T) Limited, Mohammed Enterprises, Premium, Minjingu Rock Phosphate Company, Export Trading Company Limited   and Colman (T) Limited to import and sell agricultural inputs.

The inputs are sold to farmers through their agent located throughout the country (URT, 2006 and URT, 1997 cited by Mtenga, 1999). Despite of all these attempts, maize production in the country including the Southern highland agro ecological zone of Tanzania which is earmarked as a potential area for maize production has not been convincing (Amani, 2004).

The Southern Highland agro ecological zone of Tanzania produces about 46% of the National maize production and constitutes for nearly 90% of maize purchased for the National food security granary (Bisanda *et al.,* 1998 and Amani, 2004). Although this is the case, the production of maize in the Southern Highland zone has been decreasing yearly. For example in Ruvuma Region, maize yield decreased from 340 485 tones in the year 2000 / 2001 to 225 855 tones in the year 2007 / 2008 (Ruvuma Regional Commission Office (RRCO), 2009). This was exacerbated by low maize yield of 1.3 ton/ha, instead of 7.2 ton/ha expected under good management conditions (ARI Uyole, 2006; Bisanda *et al.,* 1998).

 One of the main factors for low maize yield in the region has been related to poor adoption of recommended fertilizer package that is the recommended type, rate and time of fertilizer application (Skarsten, 2005). It is from this background, this study was set out to examine factors that influence adoption of recommended fertilizer package in Ruvuma Region.

1.1   Problem Statement

Although efforts have been taken since independence to improve maize production in Tanzania, maize yield has not shown good improvement. According to Amani

(2004) the national maize yield growth rate is 2.4% per annum that is 0.3% less than population growth rate. The average national production is approximately 0.75 ton/ha instead of 7.2 ton/ha expected under good management practices (ARI Uyole, 2006 and Bisanda *et al*., 1998). This is partly attributed by the fact that the recommended maize production practices like fertilizer application have not significantly been adopted by farmers.

For example, in southern highlands fertilizer application decreased from 142 000 tones in 1992/1993 to 65 000 tones in1996/1997 (Amani, 2004). This is partly attributed by the fact that the recommended fertilization practices have not significantly been adopted by farmers who either not apply fertilizers or apply fertilizer against the recommendations. According to Skarsten (2005) in the Southern Highlands only one third of farmers regularly use fertilizers - and not in all plots. Farmers spread small quantities over a larger area instead of recommended quantities in a smaller area, in order to minimize risks in case of crop failures.

In Namtumbo District where this study was conducted the recommended rate of phosphate is 50 kg/ac and Nitrogen 100 kg/ac that is 25 kg/ac of nitrogen at planting and 75 kg/ac as topdressing. Despite of these, the adoption level of these practices has been low and some do not apply fertilizer at all. As a result of this the average maize production in the District is as low as 1.3 ton/ha as stated earlier. In order to improve maize production in the District, there is a need to study factors that influence the adoption of recommended fertilizer practices.

Several factors have been associated with the adoption behavior. These are the independent factors like personal, institution, environmental, socio - economic (Matata *et al.*, 2001; Mtenga, 1999 and Nanai, 1993), and intervening factors like needs, perception and knowledge (Msuya, 2007; Duvel, 1991; Koch, 1987; Duvel and Botha, 1999). According to Duvel (1991) the intervening variables are the key determinants of the adoption behavior. However, very few studies have been conducted in the area of intervening variables to determine their influence on the adoption behavior. Considering poor adoption of the recommended fertilizer package in Ruvuma Region, this study intends to determine the intervening and independent factors that influence the adoption of recommended fertilizer package in Ruvuma Region.

1.2   Justification

This study assessed the level of farmers' adoption of recommended fertilizer package and determined factors that influence their adoption in Namtumbo District of Ruvuma Region. The result of this study will provide in- depth information to all stakeholders, namely farmers, researchers, extensionist and policy makers on the level of adoption of recommended fertilizer package and the factors that influence the adoption. These will form the basis for recommending measures to be taken in order to facilitate farmers' adoption of recommended fertilizer package and ultimately increased maize production, improved food security and income in Namtumbo District of Ruvuma Region.

1.3   Objective of the Study

1.3.1   General objective

The main objective of this study is to asses the independent and intervening factors influencing the adoption of recommended fertilizer package among maize growers in Namtumbo District of Ruvuma Region.

1.3.2   Specific objective

(i)   To assess the level of adoption of recommended fertilizer package in Namtumbo District of Ruvuma Region.

(ii)   To determine the independent factors that influence the adoption of recommended fertilizer package in Namtumbo District of Ruvuma Region.

(iii)   To determine the intervening factors that influence the adoption of recommended fertilizer package in Namtumbo District of Ruvuma Region.

(iv)   To recommend measures that will enhance adoption of recommended fertilizer package in Namtumbo District of Ruvuma Region.

1.4   Conceptual Framework

The conceptual framework of the study (Fig.1) is adapted from Duvel (1991) model of adoption behaviour analysis and change. According to Duvel, adoption of any innovation or recommended practice can be influenced by the independent and intervening factors. Duvel (1975) defines the independent factors as all factors initiating causes of the individual action. The intervening factors are postulated

exploratory entities conceived to be connected by one set of casual functions to the independent factors on the one side and by another set of functions to the dependent factors of behavior on the other hand. The dependent factors are defined as the interventions that mainly focus on the adoption behaviour with respect to the recommended practice (Duvel, 1991).

The independent and dependent factors are regarded as observable while the intervening factors are not accessible to observation. Duvel (1991) contends that the intervening factors are the immediate precursors of the adoption behaviors and the influence of the independent factors become manifested in behaviour via intervening factors. The author adds that the intervening factors indicated in the conceptual framework (needs, perception and knowledge) are only those determinants which have been found to be important in the analysis, understanding, and prediction of behaviour based on extensive research done by Duvel (1991) and Koch (1987). The independent factors resort mainly under the broad category of personal, institutional and environmental factors.

Independent factors		**Dependent factors**
Independent	Intervening	Behaviour
Personal → Institutional Environmental	Needs Perception → Knowledge	Adoption

Figure 1: The conceptual framework adapted from Duvel (1991) model.

CHAPTER TWO

2.0   LITERATURE REVIEW

This chapter reviews the concept of adoption and factors affecting adoption that is, the independent and the intervening factors.

2.1   The Concept of Adoption

The studies of innovation adoption originated in the United States of America, where the University of Iowa State started studying the pattern of diffusion and adoption of hybrid maize, and opened the door for further research (Ryan and Cross, 1943). Rodgers (1995) defines innovation as an idea, practice, or object that is perceived as new by an individual or other unit of adoption. This wide definition captures any idea or process that is perceived to have utility.

In agriculture context, adoption is a decision made by an individual to start using new agricultural innovations with the aim to increase productivity. This might be a new crop variety or management practices adopted by an individual, family or corporation. Lionberger (1968) and Van den Ban and Hawkins (1996) contend that, adoption is a process, which the decision to adopt usually takes time. People do not adopt new practice or idea as soon as they hear about it; they may wait several years before trying it. Van den Ban and Hawkins (1996) sighted the example of American farmers who took four years for the majority to adopt hybrid maize seeds.

Therefore, the adoption and diffusion of innovation process has been characterized as the acceptance overtime of some specific items by individuals (or adoption unit) linked to specific channels of communication. In this study the term innovation

refers to recommended fertilizer package. The term innovation, recommended fertilizers practices and recommended fertilizer package will be therefore used interchangeably in this study.

2.2 Factors that Affects Adoption

This section explores factors that influence farmers' adoption behaviour. These are the independent and the intervening variables, which according to Duvel's model of behaviour analysis and changes (Duvel, 1991) are regarded as the important determinants of the adoption behaviour.

2.2.1 The Independent Factors

Studies have shown that, there are a number of independent factors that affect adoption of recommended practices. These are broadly categorized into personal, institutional, environmental, and socio - economic factors (Matata *et al.,* 2001; Mtenga, 1999; Nanai, 1993). The following section reviews some of these factors.

2.2.1.1 Personal (Farmers characteristics)

2.2.1.1.1 Sex

According to International Labour Organisation ILO, (2007) and URT (1997) women agricultural workers are responsible for half of the worlds' food production. They are the main producer of staple crops such as rice, maize and wheat that accounts for 60% to 80% of the food produced in most developing countries (ILO, 2007). Women are the key players of day-to-day agricultural tasks', the investigator of activities that generates agricultural income and non- agricultural income.

In most cultures, women are responsible for planting, weeding, watering, harvesting, transporting and storage of crops. Although the contribution of women farmers in agricultural production is highly recognized, in practice they are less represented in most agricultural oriented development plans. This is attributed by several challenges that face them as explained below.

The challenges of women in agriculture are; lack of education, decision-making power and their rights and they lack access to equipment required for food production on large scale. Women often have more difficult than men in getting good land, credit, training and access to markets. In addition, they are also affected by social and traditional factors. Due to this, they become a disadvantaged group especially when it comes to the introduction of innovation in their areas (ILO, 2007; Ibrahim and Evans-Klock, 2002).

2.2.1.1.2 Age

Farmer's age is another characteristic or variable used to determine innovation adoption (Rogers, 1983). Age may influence adoption in one of the several ways. Older farmers may have more experience, resources, or authority that can allow them more possibilities for trying an innovation (CIMMYT, 1993). Other studies contend that there are no relationship between age and the use of new farming practices (Mussei *et al.,* 2001). Still other studies show that younger farmers are more likely to adopt farm practices (Van den Ban and Hawkins, 1996).

2.2.1.1.3 Educational Level

Education has been valued as a means of increasing knowledge about innovation. Lionberger (1968) asserts that education facilitates learning, which in turn is presumed to instill a favorable attitude towards the use of improved farm practices. According to Machumu (1995) education broadens the horizon of an individual and encourages the involvement of the individual in development activities. An individual with education becomes more critically aware of the need and scope for social change. More years of education are associated with high level of comprehension of new technologies, for example the use of high yielding variety, fertilizers, insecticides and pesticides (Machumu, 1995 cited by Elala, 1999). Therefore many adoption studies show some relationship between technology adoption and educational level of the farmer (CIMMYT, 1993). The more complex the innovation, the more likely it is that education will play a role (Machumu, 1995).

2.2.1.1.4 The number of people in a household

The number of people in a household is another factor that can influence the adoption of recommended fertilizer package. Fivawo (1976) noted that the bigger the size of a family in a household the higher the chance of adopting recommended innovation. Also Mussei *et al.* (2001) contended that large household sizes are able to provide the necessary labour required to adopt the recommended practice.

2.2.1.1.5 Marital status

Overholt *et al.* (1984) observed that married women are rarely consulted when new farming technologies are introduced. Whatever agricultural information that exists in a village is passed over to husbands and neither to wives nor to single women who

are busy working on the fields. On the other hand Van den Ban and Hawkins (1996) contend that married couples tend to share experience of technologies.

2.2.1.1.6 Farm size

According to CIMMYT (1993) farm size is a common variable in determining the adoption of an innovation. It has been recognized that, small and large farm operators differ in the speed of adoption of innovations (Polson and Spencer, 1991). Rogers (1983) averts that those farmers who own large farms enjoy a high socio economic status. They also have ample mass communication opportunities, and are more innovative in adopting new agricultural technologies (Okwell *et al.,* 1991).

2.2.1.2 The institutional factors

The institutional factors, which may influence farmers adoption or rejection of innovations includes the Extension services. Extension services are part of a large organization, normally a Ministry or department of Agriculture. The organizational setting has considerable influence on the way in which the extension service operates. The Ministry of agriculture use agricultural extension as one of the instrument to promote agricultural development (Van den Ban and Hawkins, 1988).

The role of extension service is to change farmer's adoption behavior through conscious use of communication of information to help farmers form sound opinion and make sound decisions. World Bank (1990) adds that, extension is a complex process that involves changing human behavior through communication and its major task is information transfer to improve agriculture. Due to its complexity, it requires competent institution and mechanism both for disseminating and for receiving information.

Although this is the case, extension system has been blamed for poor performance. Mattee (1989) points out several factors that lead to low or Poor performance of agricultural extension systems. These include; inefficient and bureaucratic management of staff, ineffective extension methodologies and unaffordable innovation by farmers, project approach to extension that is decline in extension performance after expiration of the project, and poor staffing in terms of quality and quantity.

Other factors pointed by Karegero (1987) are financial constraints, which lead to poor transport facilities, poor infrastructure, low salaries and incentive for extension workers. Wambura (1992) and Nanai (1993) contend that, the failure of extension systems to influence farmers to adopt improved technologies has been pointed out as a major cause of poor performance of agricultural sector. Nyerere (1975) remarked that, due to the failure of agricultural extension system, the agricultural results have been very disappointing, modern practices have not been spread widely; the majority of traditional crops are still being grown by the same methods as the ancestors (forefathers) used.

2.2.1.3   The environmental factors

These include the natural factors like; rainfall pattern, topography of the land, land quality, drought, soil fertility. These factors have influence in determining farmers' adoption behavior. Matata *et al.* (2001) comments that, the natural factors influencing farmers adoption as the rainfall, both total rainfall distribution and variation that are equally important in determining the production system.

The distribution patterns often provide management challenges to the farmers. Possible effect of rainfall on the system can be agronomic or socio- economic. The agronomic effect of rainfall include the length of growing season, diseases outbreak, crops / livestock combinations raised in the system, amount of time spent on farm operation and preparation, planting, weeding, harvesting, transportation and storage. Socio-economic effects include variation in rainfall that introduces risk (drought) and it affects input availability and marketing of products.

The nature of land topography has an influence for farmers adoption of new innovations; for example, on hilly and dissected land limits the use of farm machinery in the process of production. On the other hand Land quality has also an impact on adoption; for example unfertile or waterlogged land, farmers may not adopt innovations that require fertile or well aerated soil. Thus, according to CIMMYT (1993) environmental factors in one area may set limit on the acceptability of an innovation.

2.3   The Intervening Variables / Factors

The intervening variables discussed in this study are based on Duvel (1991) Model of behavior analysis and change (Fig. 1). These are the needs related factors, perception and knowledge.

2.3.1   Needs related factors

The concept of needs, aspirations, drives, motives, incentive, desires, goals have been associated with forces that incite the individual to action or that sustains or gives direction to motion.

They refer to the forces that energise behavior and give it direction. Research results show existance of relationship between need related aspects like efficiency misperception, need tension and adoption behaviour (Duvel, 1991).

2.3.1.1. Efficiency misperception

The efficiency misperception is one of the results of insufficient or absent aspiration. The insufficient aspiration is a function of overrating own efficiency. Therefore efficiency misperception refers to the degree to which individuals incorrectly (usually overrate) their efficiency (Duvel, 2004). Duvel (1991) noted that, there is a tendency of individuals to overrating (or underrating) their own production and/or practice adoption efficiency. This has been argued by the author to have a tremendously effect on adoption behaviour due to the fact that the more the current efficiency is overrated, the smaller the problem scope or need tension becomes and thus the smaller the incentive to adopt recommended innovations.

2.3.1.2 Need tension

Need Tension is defined as a perceived discrepancy between the present situation and the desired situation or level of aspiration (Fig. 2). This variable has been shown by different research studies to have a direct and positive relationship with the adoption behaviour (Koch, 1987; Duvel and Botha, 1999; Duvel and Scholtz, 1986; Msuya, 2007). Distorted problem perceptions around the factual situation could lead to irrational decision-making that may include non-adoption, under adoption or even over adoption (Duvel, 1995).

Figure 2: Diagrammatic illustration of problem magnitude or need tension as influenced by perception

2.3.2 Perception

Although perception and needs are related and interwoven, the necessity to identify all possible direct behaviour determinants as specifically as possible, justifies a separate focus on perception. Where needs usually relate to all positive or driving forces that in total constitute the attractiveness, perceptions are here understood to be of more specific nature and are analysed based on attribute of innovation (Duvel, 1991). Rogers (1983) classification of innovation attributes does not suit the purpose, mainly because of the broad and unspecific categories. In order to make provision for a wider spectrum of specific forces, these attributes have been redefined (Duvel, 1991). One of attributes that can be directly associated with field forces is prominence.

2.3.2.1 Prominence

According to Duvel (1975), prominence is synonymous with Rodger's (1983) concept of relative advantage, which he defines as the degree to which an innovation is perceived as being better than the idea it supersedes. The already mentioned necessity to specify the causes as specifically as possible led to an alteration of the concept 'relative advantage' to relative advantages in order to make provision for the more specific advantages and disadvantages such as economical, social, managerial and the like.

Prominence on the other hand, was introduced to replace the global concept of relative advantage and is a measure of how prominent or how much more or less advantageous or attractive the innovation as a whole is, relative to the other alternative. The necessity for this global comparison lies in the phenomenon that innovation are frequently perceived very positively but nevertheless not implemented, simply because another alternative is preferred, that is perceived to be more prominent (Duvel, 1991).

2.3.3 Knowledge

The aspect of knowledge looked at in this study is the knowledge in respect of the application of recommended innovation or practices. It refers to an awareness of recommended solutions or the optimum that is achievable in terms of efficiency. This aspect has been found to be important in determining the adoption behaviour by other researchers like Duvel, 1991 and Msuya, 2007.

CHAPTER THREE

3.0   METHODOLOGY

3.1   Introduction

This chapter describes the study area, Research design, population, and sampling procedure, instrumentation, pre testing of the research instrument, data collection, variables and their measurement and data analysis.

3.2   Description of the Study Area

This study was done in Namtumbo District council of Ruvuma region which is lying in the Southern part of Tanzania. Namtumbo District has moderate mild temperature between 20ºC to 25ºC during daytime and 15ºC to 17ºC during night from May to mid August. High temperature 25ºC to 30ºC is predominant in September to November. The District normally experiences a mono modal rainfall which begins in November and end in mid May. The average annual rainfall is between 800mm and 1000mm. However the rainfall pattern is erratic and unreliable.

The topography of Namtumbo District is hilly to steeply dissected land with rock outcrop, rolling to hilly land and flat to hilly land. The altitudes range between 400m to 1000m above sea level. The major economic activity is agriculture whereas maize is the main staple food grown. Others are cassava and rice used both as food and cash crops while the major cash crops grown are tobacco and cashew nuts. The population of the Namtumbo District council is about 185 051 people of which 85 651 are male and 89 190 are female. The average population growth is 3.2% and the average Household size number is 6 (URT, 2002).

The predominant ethnic groups in Namtumbo District are Ndendeule, Ngoni, Yao and Nindi. The Ndendeule cover about 80% of the District area.

3.3 Research Design

Due to limited resources like manpower, finance and time, the research used a cross sectional survey design. This design allows data to be collected at once in time from a sample that is selected to describe the larger population (Babie, 1990).

3.4 The Population and Sampling Procedure

The population for this study is composed of the small holder maize growers in selected villages of Msindo Ward in Namtumbo District council of Ruvuma Region. Msindo Ward was purposeful selected since it is among leading maize producer. Msindo Ward consists of seven villages namely Hanga, Mawa Mtakanini, Msindo, Mlilayoyo, Lumecha and Maguezi. Three villages were randomly selected for this study which is Lumecha, Mawa and Mageuzi. Simple random sampling procedure was used to select 135 respondents from the sampling unit. Matata *et al.,* (2001) describes that, 120 respondents is optimum for the study of an innovation. The sample size of maize growers in the selected villages was increased in order to increase the preciousness of the findings of this study.

3.5 Instrumentation

An interview schedule was used in primary data collection. The schedule was used to solicit quantitative data from farmers that used to measure the level of adoption of recommended fertilizer package and to determine the independent and intervening factors that influenced the adoption of recommended fertilizer package in Namtumbo District of Ruvuma Region.

3.6   Pre-testing

An interview schedule was tested before commencing the research. The pre testing was done in Suluti village, which is outside of the study area where 13 small scale maize farmers were interviewed. The pre testing of the interview schedule helped to determine the validity, reliability and practicality of the instrument prepared (Kothari, 2004). After pre-testing, the instrument was revised to accommodate identified changes.

3.7   Data Collection

3.7.1   Primary Data

 Primary data were collected from the respondents by the researcher assisted by four enumerators. The enumerators were trained before and during pre testing of the research instrument. Data were collected from each selected maize household respondent and each response was carefully recorded in an interview schedule.

3.7.2   Secondary Data

The primary data were complimented by secondary data pertinent to this study.

These were obtained from Namtumbo District Agricultural Office, Regional Agricultural Office, Suluti Research Sub station, Uyole Research Centre, Ministry of Agriculture and Food Security and Sokoine National Agricultural Library (SNAL).

3.8   Variables and their Measurement

3.8.1   The independent variables

The independent variables considered in this study are personal characteristics like sex, age, marital status, Number of people in a household, education level and farm size.

3.8.1.1 Sex

Sex is the state of being male or female and therefore the respondents were grouped according to their status of being male or female.

3.8.1.2 Age

Respondent age was measured according to the total number of years that a person had lived since his / her birth to the time when this survey was done. Then, the respondent age was categorized into three age groups namely > 35 years as youth, 35 to 45 years as adults and above 45 years of age.

3.8.1.3 Formal education

Education was measured on basis of an individual education attained over period of time at school. Individual education was categorized into five groups as follows; No education, Primary education, Secondary education, Certificate and Diploma.

3.8.1.4 Marital status

This was achieved by asking a respondent to indicate his / her marital status which was then categorized as single, married, widow and divorced.

3.8.1.5 The number of people in a household

This refers to the number of people living in a household. Respondents were asked to indicate the number of people living in household and were categorized into three categories as 1 to 3, 4 to 6 and above 6 people.

3.8.1.6   Farm size

Farm size is whole piece of land for agriculture owned by the respondent. It was determined by requesting an individual respondent to indicate his / her farm size owned. Farm size in the study area ranges from 0.5 to 50 ac. Farm size were recategorised into three category namely ≤ 5 ac, 5 to 10 ac and above 10 ac.

3.8.2   Intervening variables

The intervening variables (factors) considered in this study include the need related factors (efficiency misperception and need tension), knowledge (the awareness) and the perception (prominence).

3.8.2.1   Efficiency misperception

  Closely associated with the perceived current efficiency is the efficiency misperception or the degree to which individuals incorrectly (usually overrates) their efficiency (Duvel, 2004 cited by Msuya, 2007). To capture this parameter, farmers were asked to estimate their own efficiency in a five point scale and the enumerator did similar rating based on the objective (researched) criteria. The five point scale was used to assist in calculating farmers' degree of misperceptions.

Degree of overrating / underrating = Farmer's scale point − enumerator's scale point

Percentage of overrating / underrating = $\{(A - B) - 1\} \div 4 \times 100$ (Duvel, 2004)… (i)

Where

A = Represent farmer's own assessment (scale point)

B = Enumerator's assessment (scale point) based on research findings

1 = the first figure in the five point scale and has to be subtracted in order to make the lowest point on the scale = 0

4 = the difference between the highest and lowest scale point (5 - 1).The percentages obtained were categorized into; underrating, slightly underrating, assess correctly, slightly overrating and overrating.

3.8.2.2 Need tension

Need tension or problem perception refer to the perceived discrepancy between the present situation and the desired situation or level of aspiration (Duvel, 2004; Botha, 1986 and Msuya, 2007). Based on the definition, farmers were asked to indicate their present and the aspired level of adoption of the practice. The higher the level of aspirations the higher the need tension. The difference between present situation and that of the aspired level was used as criteria to group farmers into three categories namely; low, medium and high need tension.

3.8.2.3 Awareness

This is the state of an individual being aware of recommended solution or the optimum that is achievable in terms of efficiency (Duvel, 2004). For this case, awareness refers as knowledge of recommended fertilizer package in the study area. Farmers' awareness therefore was measured by requesting them to indicate the recommended fertilizer package for maize production that they are aware of in their area. Farmers were then assessed using a scale of not aware and aware.

3.8.2.4 Perceived total attributes of innovation

The perceived total attributes of innovation are the driving forces which in totality constitute the attractiveness of innovation. Therefore, perceptions are understood to be of a more specific in nature and are analysed based on attributes of innovations (Duvel, 2004 cited by Msuya 2007).

The perception aspects looked at in this study was prominence. According to (Duvel, 1975) prominence is synonymous with Rogers (1983) concept of relative advantage which is defined as the degree to which an innovation is perceived as being better than the idea it supersedes. With regard to this definition, farmers were asked to indicate what was regarded to be the best practice in maize production in their area. Farmers were then categorized into three groups as low prominence, medium and high prominence.

3.8.3 Dependent variables

In this study the dependent variables was the adoption of recommended fertilizer package that is the use of Phosphates, Nitrogen fertilizers and time of Nitrogen application.

3.8.3.1 Phosphate fertilization

As indicated earlier the recommended phosphate fertilizer for Namtumbo District is 50 kg/ac of Phosphate. Farmers were therefore asked to indicate the type of Phosphate fertilizers and rate used in 2008 / 09 season. The responses were then categorized as follows;

0)   Nill

1) $\leq$ 10 kg / ac

2)   10   -   19 kg / ac

3)   20   -   29 kg / ac

4)   30   -   39 kg / ac

5)   40   -   49 kg /ac

6) $\geq$ 50 kg /ac

3.8.3.2   Nitrogen fertilization

The recommended Nitrogen fertilizer in Namtumbo District is 100 kg/ac of Urea. The Nitrogen fertilization was therefore measured based on the amount applied and time of application. The response of farmers applied Nitrogen fertilizers were categorized into adoption scale below;

0)   Nill

1) $\leq$ 20 kg / ac

2)   20   –   39 kg / ac

3)   40   -   59 kg / ac

4)   60   -   79 kg /ac

5)   80   -   99 kg / ac

6) $\geq$ 100 kg / ac

3.8.3.3   Time and rate of Nitrogen application

The recommended time and rate of Nitrogen application is 25 kg at the time of planting and 75 kg as topdressing. Farmers were therefore asked to indicate time and

amount of Nitrogen fertilizers applied. The responses were categorized into five groups as follows;

0) Nill or No Nitrogen applied at all

1) 1   -   25 kg as top dressing

2) 26   -   50 kg as top dressing

3) 51   -   75 kg as top dressing

4) 76   -   100 kg as topdressing

5) 25 kg at planting and 75 kg as top dressing

3.8.3.4   Total fertilization package

The total fertilization package, involves the use of recommended Phosphate, Nitrogen fertilizers and the time of Nitrogen application. As indicated earlier, for Phosphate the recommended rate is 50 kg/ac while for Nitrogen fertilizers is 25 kg at the time of planting and 75 kg as top dressing. The scale used to assess the adoption of total fertilization package was obtained by adding scale points for rates of Phosphate, Nitrogen fertilization and time of application indicated in parts 3.8.3.1, 3.8.3.2, and 3.8.3.3 above. Therefore the total fertilization package adoption score is 17 scale points.

This was categorized as

1) Nil = 0   -   No adoption

2) 1 – 8   -   Low adoption

3) 9 – 16   -   Medium adoption

4) ≥ 17 -   Full or high adoption

3.9   Data Analysis

The collected primary data were coded, entered, cleansed, and analysed using the stastical package for social science (SPSS) computer programme at Sokoine University of agriculture (SUA). Descriptive statistics such as frequency and percentage were calculated to determine distribution of the study variables. Correlation was used to determine relationship between the independent and dependent variables while the Chi-square was used to test the significance difference between variables under investigation. The significant level of 0.05 (95%) was selected as a criterion for determining significances.

CHAPTER FOUR

4.0   RESULT AND DISCUSSION

This chapter presents the findings on the level of adoption of recommended fertilizer package in Namtumbo District of Ruvuma Region. It also describes the independent and intervening factors and their influence on the adoption behaviour of recommended fertilizer package. The following section describes the level of adoption of the recommended fertilizers in the study area.

4.1   Level of Adoption of Recommended Fertilizers

Various researches recommend the use of fertilizer in maize production in order to attain optimum yield. Maize crop have relative high demand of nutrients especially Phosphorous and Nitrogen (Thompson, 1957; Uriyo *et al.,* 1983). As indicated earlier the recommended source of Phosphate fertilizers in the study area are TSP or DAP at a rate of 50 kg/ac and Minjingu Rock Phosphate which is new to majority of farmers in the District at a rate of 100 kg/ac (DALDO, 2010). As far as Nitrogen is concerned, the recommended Nitrogen fertilizers in the study area are Urea and CAN. Majority of farmers use Urea because of its availability and it is less expensive compared to other Nitrogen fertilizers. The recommended application rate for Urea is two bags (100 kg/ac), about 25 kg at the time of planting and 75 kg at the time of topdressing (DALDO, 2010).

In this study farmers were requested to indicate fertilizer type, the rate used and time of application in their maize fields. Table 4.1 summarizes the adoption level of Phosphate fertilizer in the study area.

Table 1:   Distribution of respondents according to their adoption of recommended Phosphates fertilization rate

Scale point	Phosphates fertilizer (kg/ac)	Frequency	Percent
0	Nil	118	87.4
1	< 10	2	1.5
2	11 – 19	3	2.2
3	20 – 29	3	2.2
4	30 – 39	4	3.0
5	40 - 49	0	0.0
6	≥ 50	5	3.7
	Total	**135**	**100.0**

Table 4.1 shows that the majority 118 (87.4%) of respondents did not apply Phosphate fertilizer at all. Only 5 (3.7%) adopted the recommended rate of Phosphates fertilizer while the rest 12 (8.9%) applied below the recommended rates (Table 4.1). As far as Nitrogen is concerned, the results in Table 4.2 show that majority of farmers in the study area used Nitrogen fertilizers, but below recommended application rate.

Table 2: Distribution of respondents according to adoption of Nitrogen fertilizer

Scale point	Nitrogen fertilizer (kg/ac)	Frequency	Percent
0	Nil	7	5.2
1	<20	8	5.9
2	21 – 39	19	14.1
3	40 – 59	38	28.1
4	60 – 79	25	18.5
5	80 – 99	2	1.5
6	≥100	36	26.7
	Total	**135**	**100.0**

According to Table 4.2 only 36 (26.7%) of respondents used the recommended Nitrogen fertilizer in the study area, majority 92 (68.1%) of respondents used Nitrogen fertilizers below the recommended rate of 100 kg/ac. Others, 7 (5.2%) did not use Nitrogen fertilizers at all. This implies that majority of farmers in the study area use Nitrogen fertilizers as compared to phosphates fertilizer.

As stated earlier, the recommended nitrogen fertilization rate is 25 kg/ac of Nitrogen mixed with 50 kg/ac of Phosphates fertilizer at the time of planting and then 75 kg / ac of Nitrogen fertilizers during topdressing making a total of 100 kg/ac of Nitrogen. This study therefore investigated the adoption of the recommended time and rate of Nitrogen application in the maize field. Table 4.3 summarizes the findings.

Table 3: Distribution of respondents according to the time and rate of Nitrogen fertilization

Scale point	Time and rate of Nitrogen (kg/ac)	Frequency	Percent
0	Nil	7	5.2
1	1 - 25 kg as top dressing	6	4.4
2	26 - 50 kg as top dressing	58	43.0
3	51 - 75 kg as top dressing	24	17.8
4	76 - 100kg as top dressing	40	29.6
5	25kg at planting &75kg as topdressing	0	0
	Total	**135**	**100.0**

The findings in Table 4.3 reveal that, of 128 (94.8%) respondents who used Nitrogen fertilizers non of them adhered to the recommended rate and time of Nitrogen fertilizer application.

All of them used for topdressing only at different rates as indicated in Table 4.3 above. This indicates that although most of farmers in the study area applied

Nitrogen fertilizers, they did not adhere to the recommended rate and time of application.

In order to understand the adoption level of recommended fertilization package (P, N, and Time of N application), scale points for individual fertilization practice discussed above were added to obtain the total fertilizer package applied in the maize fields. For example a respondent farmer who applied 50 kg/ac of DAP/TSP, 100 kg/ac of N fertilizers twice i.e. 25 kg/ac at planting and 75 kg/ac as topdressing his / her level adoption of the total fertilizer package was obtained by adding the following scale points 6 + 6 + 5 = 17 scale points (Refer Table 4.1, 4.2 and 4.3). Similar procedure was used to obtain different scale points that represent certain level of adoption. The scale points were then categorized as 0 for non adoption, 1 – 8 for low adoption, 9 – 16 medium adoption and ≥ 17 for high or full adoption of recommended fertilization package. Table 4.4 shows the level of adoption of fertilization package in the study area.

Table 4: Distribution of respondents according to their adoption of total fertilizer package

Fertilizer application	Frequency	Percent
Nil (0)	7	5.2
Low (1 to 8)	86	63.7
Medium (9 to 16)	42	31.1
High (≥17)	0	0
Total	**135**	**100.0**

According to Table 4.4 not a single respondent who applied the recommended fertilizer package which is 50 kg of Phosphate mixed with 25 kg of Nitrogen fertilizer at the time of planting followed by 75 kg of Nitrogen fertilizer during

topdressing represented by ≥ 17 scale point. Majority 128 (94.8%) of farmers applied fertilizers at different rates below the recommendations. About 86 (63.7%) fall under low adoption level represented by $1 - 8$ scale point, while 42 (31.1%) fall under medium adoption represented by the scale point of $9 - 16$. About 7 (5.2%) of the respondents did not apply fertilizer at all. The findings are in line with the study done by Elala (1999) who found low adoption of recommended fertilizers among maize growers in Ethiopia.

4.2   Factors that Influence the Adoption of Recommended Fertilizer Package

This study investigated further the independent and intervening factors influencing adoption of fertilization package in Namtumbo District council. The preceding section explores the independent factors that influence the adoption of recommended fertilization type and rate in the study area.

4.2.1 The independent factors that influence the adoption of recommended fertilizer package

Independent variables investigated in this study were sex, age, marital status, education level, household size and farm size. Each variable was assessed separately to determine its influence on the adoption behaviour.

4.2.1.1 Sex

In most African cultures women are responsible for planting, weeding, watering, harvesting, transporting and storage of crops (ILO, 2007). However, several challenges face them such as lack of education, decision making power as well as

their rights. As the outcomes of these challenges, women are backward in the adoption of new innovation (ILO, 2007). It is therefore assumed in this study that the adoption of recommended fertilizers package is higher in men than women farmers. The findings regarding the relationship between sex and adoption is summarized in Table 4.5

Table 5: Distribution of respondents according to their sex and adoption of fertilizer package

Fertilizer application categories	Sex					
	Male		Female		Total	
	n	%	n	%	N	%
Nil (None)	3	42.9	4	57.1	7	5.2
Low (1 to 8)	61	70.9	25	29.1	86	63.7
Medium (9 to 16)	37	88.1	5	11.9	42	31.1
High adoption (≥17)	0	0.0	0	0.0	0	0.0
Total	101	74.8	34	25.2	135	100

$\chi^2 = 8.414$; df = 2; p = 0.015;   r= -0.239;   p = 0.005

Table 4.5 shows that not a single farmer had adopted the recommended fertilization package in the maize field. Majority of men, 37 (88.1%) fall under the category of medium adoption represented by 9 to 16 scale point, while the category of women who fall under the same category is only 5 (11.9%). The correlation results show that there is a significant relationship (p < 0.05) between sex and the adoption of recommended fertilization package. The negative correlation depicts that the adoption is higher in male and low among women.

These results are inline with Bisanda and Mwangi (1996) who found high adoption of fertilizer among men than women farmers. The Chi square findings ($\chi^2 = 8.414$; df = 2; p = 0.015) further reveals that there is a significant difference between men

and women in the adoption of recommended fertilizer package. This implies that the adoption of recommended fertilization type and rate is determined by sex difference.

4.2.1.2   Age

Farmers age is another characteristic or variable used to determine innovation adoption (Rogers, 1983). Age can influence adoption in one of the several ways. Older farmers may have more experience, resources, or authority while younger one are said to be energetic, venturesome and active that would allow both of them to try the innovation (CIMMYT, 1993; Nanai, 1993; Van den Ban and Hawkins, 1996 cited by Msuya, 2007). Age category from the study area was based on 2002 population census which indicated life expectancy of 45 years of age for both men and women (URT, 2002).

However, in the study area the respondent age ranged between 19 to 90 years. The findings regarding the relationship between age and adoption of fertilizers package is summarized in Table 4.6 below

Table 6:   Distribution of respondents according to their age and adoption of fertilizer package

Fertilizer application categories	Age							
	< 35		35 to 45		> 45		Total	
	N	%	n	%	n	%	n	%
None (Nil)	2	28.6	2	28.6	3	42.8	7	5.2
Low (1 to 8)	31	36.1	15	17.4	40	46.5	86	63.7
Medium (9- 16)	13	31.0	14	33.3	15	35.7	42	31.1

34

High adoption (≥ 17)	0	0.0	0	0.0	0	0.0	0	0.0
Total	46	34.1	31	23.0	58	42.9	135	100

χ2 =4.251; df =4; p =0.373;   r =-0. 038   p = 0. 705

Table 4.6 shows that most of respondents 58 (42.9%) were more than 45 years of age while 46 (34.1%) were below 35 years old. The findings indicate that not a single respondent from different age categories had adopted the recommended fertilizer package. The Chi – square findings indicates that, there is no significance difference (p > 0.05) between age and adoption of the recommended fertilizer application practice. This implies that the adoption of the recommended fertilizer package is not determined by age difference in the study area. The correlation results also indicate that there is no significant relationship (r =-0.038, p = 0.705) between age and adoption of recommended fertilizer practice. The findings are supported by CIMMYT (1993) which contends that adoption of a given innovation may not be strictly correlated with age.

4.2.1.3   Marital status

It is assumed that married couples share experience of maize production technologies. The researcher therefore investigated the influence of marital status with regard to the adoption of recommended fertilizer package application. Table 4.7 summarizes the findings.

Table 7: Distribution of respondents according to their marital status and the adoption of recommended fertilizer package

Fertilizer application package	Marital status									
	Single		Married		Widow		Divorced		Total	
	N	%	n	%	n	%	n	%	n	%
None (Nil)	1	14.3	4	57.1	2	28.6	0	0.0	7	5.2
Low (1to 8)	10	11.6	62	72.1	10	11.6	4	4.7	86	63.7

Medium (9 to 16)	3	7.1	36	85.7	2	4.8	1	2.4	42	31.1
high adoption (≥ 17)	0	0.0	0	0.0	0	0.0	0	0.0	0.0	0.0
Total	14	10.4	102	75.5	14	10.4	5	3.7	135	100

$\chi^2 = 5.988$; df = 6; p = 0.425;   r = -0.061;   p = 0.479

According to results in Table 4.7, about 14 (10.4%) of respondents were single, 102 (75.5%) were married couples, 14 (10.4%) widow and 5 (3.7%) were divorced. However no single category applied the recommended fertilizer type and rate in their maize fields. Although married couples were expected to have high adoption due to shared experience on maize production, the study results show that as compared to other marital status categories, majority of them 4 (57.1%) did not use fertilizer at all in their maize fields. The results of the Chi – square show that there is no significant different (p > 0.05) between marital status and the adoption of recommended fertilizers package.   Further the correlation findings reveals that there is no significant relationship (r =-0.061; p = 0.479) between marital status and adoption of recommended fertilizer practices. This implies that adoption of fertilization package is not determined by marital status in the study area.

4.2.1.4   Number of people in household

Large number of household would be able to provide the labour that might be required by recommended maize practices. Thus household size would be expected to increase the probability of adopting the recommended fertilization practices (Nanyeenya *et al.*, 1997). The findings regarding the relationship between household size and adoption of recommended fertilizer package are summarized in Table 4.8 below.

Table 8: Distribution of respondents according to their number of people in household and adoption of the recommended fertilizer package

Fertilizer application categories	Number of people in household							
	1 to 3		4 to 6		Above 6		Total	
	n	%	n	%	n	%	n	%
None (Nil)	4	57.1	2	28.6	1	14.3	7	5.2
Low (1 to 8)	41	47.7	26	30.2	19	22.1	86	63.7
Medium (9 to 16)	18	42.9	13	31	11	26.1	42	31.1
high adoption (≥ 17)	0	0.0	0	0.0	0	0.0	0	0.0
Total	63	46.7	41	30.3	31	23.0	135	100

$\chi^2 = 0.775$; df = 4; p = 0.942; r = 0.070; p = 0.419

Table 4.8 indicates that the majority of respondents 63 (46.7%) had 1 to 3 number of people in their households. Others 41 (30. 3%) had 4 to 6 people and 31 (23%) had more than 6 people. The findings reveal that not a single respondent from different household size categories had adopted the recommended fertilizer package. As compared to other household categories, very few respondents 11 (26.1%) with large number of people in their household (above 6) fall under medium adoption category.

According to Chi square results, there is no significant difference ($\chi^2 = 0.775$; df = 4; p = 0.942) between household size and the adoption of recommended fertilization package. This implies that in this study adoption of recommended fertilizer package (type and rate) does not differ with the number of people in a household. The findings also reveal that, there is no significant correlation (r = 0.070; p = 0.419) between household size and the adoption of recommended fertilizer package.

This implies that the adoption of recommended fertilizer package might be influenced by other factors such as income of the people, needs and perception towards fertilizer package.

4.2.1.5   Education level

Exposure to education increases the farmers' ability to obtain and use information relevant to the adoption of an innovation. Thus education is thought to increase the probability that a farmer will adopt the recommended fertilizers technology package (Nanyeenya *et al.,* 1997). An overview of respondent education with regard to adoption is summarized in the Table 4.9 below.

Table 9:   Distribution of respondents according to their education level and adoption of the recommended fertilizer package

Fertilizer application	Highest education level									
Package	No education		Primary education		Secondary education		Diploma		Total	
	n	%	n	%	n	%	n	%	N	%
None (Nil)	3	42.9	4	57.1	0	0.0	0	0.0	7	5.2
Low (1 to 8)	11	12.8	67	77.9	7	8.1	1	0.1	86	63.7
Medium (9 to 16)	3	7.1	35	83.3	4	9.5	0	0.0	42	31.1
High adoption (≥ 17)	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	17	12.6	106	78.5	11	8.2	1	0.7	135	100

$\chi^2 = 7.858$; df = 6; p = 0.249;   r = 0.142; p = 0.099

The results in Table 4.9 show that the majority of respondents 106 (78.5%) had primary education as their highest level of education and 17 (12.6%) had no education. Only 11 (8.2%) and 1 (0.7%) had attained secondary and diploma education, respectively. According to the results not a single respondent from different education categories had full adopted the recommended fertilizer package represented by ≥ 17 scale point.

The Chi - square results reveal that there is no significant difference ($\chi^2 = 7.858$; df = 6; p = 0.249) between education level and the adoption of recommended fertilizer package. This implies that different education level does not differs significantly in

their level of adopting recommended fertilizer package. The correlation results also show that there is no significant relationship (r = 0.142; p = 0.099) between farmers' education level and the adoption of recommended fertilizers application in maize field. This could be attributed to the fact that the relationship is not linear. For example majority of respondents with primary education 35 (83.3%) fall under medium adoption category and very few 4(9.5%) and 0 (0%) with secondary education and diploma, respectively fall under this category. Van de Ban and Hawkins (1996) found that educated people take their education as tool for employment in Civil Servant or other satisfactory jobs despite their education qualification. In this way they turn to agriculture frustrated and often achieve less than those who had always intended staying in agriculture.

4.2.1.6 Farm size

Farm size is an indicator of wealth and perhaps a proxy for social status and influence within a community. Literatures provide evidence that farm size has positive influences on the adoption of recommended practices (Bisanda *et al.,* 1998; Kumar, 1994; Nanyeenya *et al.,* 1997; and Morris *et al.,* 1999). Table 4.10 below gives the summary of respondent distribution according to their farm size and adoption of recommended fertilizer package in the study area.

Table 10: Distribution of respondents according to their farm size and adoption of the recommended fertilizer package

Fertilizer application package	Farm category(acres)							
	<5		5 to 10		Above 10		Total	
	n	%	n	%	n	%	n	%
None **(Nil)**	3	42.9	3	42.9	1	14.2	7	5.2
Low **(1 to 8)**	33	38.4	41	47.7	12	14.9	86	63.7

Medium (9 to 16)	15	35.7	18	42.9	9	21.4	42	31.1
High adoption (≥ 17)	0	0.0	0	0.0	0	0.0	0	0.0
Total	51	37.8	62	45.9	22	16.3	135	100

$\chi^2 = 1.247$; df = 4; p = 0.870; r = 0.064; p = 0.462

According to Table 4.10, about 51 (37.8%) of the respondents had farm size less than 5 acres whereas 62 (45.9%) their farm size were between 5 to 10 acres and 22 (16.3%) had more than 10 acres. Although it is expected that farmers with large farm size have high chance to adopt recommended fertilizer package, the findings show that, not a single farmer in this category had adopted recommended fertilizers package represented by ≥ 17 scale points.

As compared to other farm size categories, very few farmers 9 (21.4%) with large farm area (above 10 acres) fall under medium adoption category represented by 9 to 16 scale point. The findings are proved by a non significant correlation (r = 0.064; p = 0.462) between farm size and the adoption of recommended fertilizers. This implies that there is no relationship between farm size and the adoption of recommended fertilizer package in the study area. The Chi − square result also shows that there is no significant difference ($\chi^2 = 1.247$; df = 4; p = 0.870) between farm size and the adoption of fertilizers package. Similar findings were reported by Kummar (1994) and Nanyeenya *et al.* (1997) who found farm size to have no significant influence on the adoption of inorganic fertilizers.

Generally most of the investigated independent variables in this study (except − sex of the respondents) seemed to have no significant association with the adoption of fertilizer package as supported by other literature (Matata *et al.*, 2001; Mtenga, 1999 and Nanai, 1993). The adoption could be influenced by other factors like needs,

perception and knowledge. According to (Msuya, 2007; Duvel and Botha, 1999; Duvel, 1991 and Koch, 1987) these are the intervening variables regarded to be the most determinants of the adoption behaviour. This study therefore examined the intervening variables that influence adoption of recommended fertilizer package in the study area. The following section explores the investigated intervening variables.

4.2.2 Intervening variables that influence the adoption of fertilization package

As stated earlier, the investigated intervening variables in this study include need related aspects like efficiency misperception and need tension. Others include awareness (knowledge) and perception aspects like prominence.

4.2.2.1 Efficiency misperception (EM)

As highlighted in the literature review, efficiency misperception (EM) is one of the intervening variables that determine farmer's adoption behaviour in several ways namely non adoption, low, medium or high adoption. According to Duvel (1991), the more the efficiency is overrated, the smaller the problem scope or need tension becomes and thus the smaller the incentive to adopt the recommended innovation and the vise versa. Table 4.12 shows the relationship between EM and adoption of recommended fertilizers in the study area.

Table 11: **Distribution of respondents according to their EM and adoption of recommended fertilizer package**

| Fertilizers application package | Efficiency misperception | | | | | | | | | | Total | |
| | Underrate | | Slightly underrate | | Assess correctly | | Slight Overrated | | Overrated | | | |
	N	%	N	%	N	%	N	%	n	%	n	%
None (Nil)	0	0.0	0	0.0	6	85.7	1	14.3	0	0.0	7	5.2
Low (1 to 8)	2	2.3	48	55.8	29	33.7	6	7.0	1	1.2	86	63.7
Medium	14	33.3	16	38.1	11	26.2	1	2.4	0	0.0	42	31.1

(9to16) High adoption (≥ 17)	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**
Total		**11.9**	**64**								**13**	
	16			**47.4**	**46**	**34.1**	**8**	**5.9**	**1**	**0.7**	**5**	**100**

χ^2 = 38.830; df = 8; p = 0.000; r = -0.358; p = 0.000

According to Table 4.12, the majority 80 (59.3%) of respondents underrated their EM, 46 (34.1%) assessed correct, while few 9 (6.6%) overrated. The results further reveal that, not a single respondent adopted full the recommended fertilizer package. As far as medium adoption is concerned 14 (33.3%) of respondents who underrated their fertilizer application fall under this category, while not a single respondent who overrated his / her adoption efficiency fall under medium adoption category. These findings are supported by a highly significant negative correlation (r = -0.358; p = 0.000) which reflects that efficiency misperception influence the adoption of recommended fertilizer package. The negative sign of the correlation coefficient indicates that the adoption rate decreases as the current efficiency of recommended fertilizers adoption is overrated. The Chi – square findings further reveal that, there is a significant difference (p = 0.000) between different efficiency misperception (EM) categories as far as fertilizer application is concerned.

4.2.2.2 Need tension (NT)

As stated earlier, need tension is defined as the problem scope or perceived discrepancy between the current and the desired or potential situation (Duvel, 1991). This is an intervening parameter, which is expected to have positive influence on the adoption behavior. In this study need tension is assumed to have positively

relationship with adoption of recommended fertilizer package. Table 4.13 summarizes the results of the analysis.

Table 12: Distribution of respondents according to their NT and adoption of recommended fertilizer package

Fertilizer application package	Need tension							
		Low		Medium		High		Total
	N	%	n	%	n	%	n	%
None (Nil)	5	71.4	1	14.3	1	14.3	7	5.2
Low (1 to 8)	54	62.8	21	24.4	11	12.8	86	63.7
Medium (9 to 16)	2	4.8	21	50.0	19	45.2	42	31.1
High adoption (≥ 17)	0	0.0	0	0.0	0	0.0	0	0.0
Total	61	45.2	43	31.8	31	23.0	135	100

$\chi^2 = 41.848$; df = 4; p = 0.000;   r = 0.524;   p = 0.000

The results in Table 4.13, shows that 61 (45.2%) of the respondent had low need tension (NT), 43 (31.8%) had medium need tension and 31 (23.0%) had high need tension. The results also show that there is a significant difference ($\chi^2 = 41.848$; df = 4; p = 0.000) between different need tension categories and adoption of fertilizers. Furthermore correlation findings indicate that there is significant relationship between NT and adoption of recommended fertilizer application (r = 0.524; p = 0.000).

This implies that the low the NT, the low the adoption tends to be and vise versa. For example the majority of respondents with low NT had non or low adoption of fertilizers compared to those with high NT.

4.2.2.3   Awareness

This is defined as the awareness of the recommended solution or optimum level that is achievable in terms of efficiency. The respondents were asked to indicate their

awareness of recommended fertilizers package for maize production in their area. The findings show that the majority of respondents are not aware as summarized in Table 4.14

Table 13:   Distribution of respondents according to their awareness and adoption of recommended fertilizer package

Fertilizers application package		Awareness				Total	
		Not aware		Aware			
		n	%	n	%	N	%
None	**(Nil)**	**5**	**71.4**	**2**	**28.6**	**7**	**5.2**
Low	**(1 to 8)**	**58**	**67.4**	**28**	**32.6**	**86**	**63.7**
Medium	**(9 to 16)**	**16**	**38.1**	**26**	**61.9**	**42**	**31.1**
High adoption	**(≥ 17)**	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**
Total		**79**	**58.5**	**56**	**41.5**	**135**	**100**

$\chi 2 = 10.519$; df = 2; = 0.005;   r = 0.270;   p = 0.002

The results in Table 4.14 show that, majority 79 (58.5%) of respondents were not aware of recommended fertilizers package versus 56 (41.5%) who were well knowledgeable of the recommended fertilizers package in their area. The Chi - square indicates that there is significant difference ($\chi^2 = 10.519$; df = 2; p = 0.005) between awareness of the recommended fertilizers and adoption.

The correlation results also show that there is significant relationship (r = 0.270; p = 0.002) between awareness and adoption of recommended fertilizers. This implies that the level of adoption increases with awareness of the recommended fertilizer package.

4.2.2.4   Prominence

Prominence is synonymous with Rodgers (1983) concept of relative advantage, which he defines as the degree to which an innovation is perceived as being better than the idea it supersedes. It is another intervening variable which was used to

determine the adoption behaviour of the recommended fertilizer package in this study. It is hypothesized that, the more innovation is being perceived to be better than the one it supersedes, the higher the adoption is likely to be (Duvel, 1991; 2004; Duvel, 2007 and Msuya, 2007). Table 4.15 summarizes the survey results.

Table 14: **Distribution of respondents according to their prominence and adoption of fertilizer package**

Fertilizers	application package	Prominence							
		Low		Medium		High		Total	
		N	%	n	%	n	%	N	%
None	**(Nil)**	2	28.6	2	28.6	3	42.8	7	5.2
Low	**(1 to 8)**	26	30.2	28	32.6	32	32.2	86	63.7
Medium	**(9 to 16)**	1	2.4	14	33.3	27	64.3	42	31.1
High	**($\geq$ 17)**	0	0.0	0	0.0	0	0.0	0	0.0
Total		29	21.5	44	32.6	62	45.9	135	100

$\chi 2$ = 14.924; df = 4; p = 0.005;   r = 0.289;   p = 0.001

The summarized survey results show that, about 62 (45.9%) of respondents perceived the recommended fertilizer package to have high prominence relative to their own practices while 29.5 (21.5%) perceive it to have low prominence.

Only 1 (2.4%) of the respondents regarded the package to have low prominence had medium adoption compared to 27 (64.3%) with high prominence who fall under the same category (medium adoption). This is supported by highly positive significant correlation (r = 0.289; p = 0.001) implying that the adoption of fertilizers is influenced by perceived prominence.

CHAPTER FIVE

5.0   CONCLUSION AND RECOMMENDATIONS

5.1   Conclusions

The continuous fall of maize production and non or low adoption of recommended maize production practices like fertilizer application in Namtumbo District have enhanced to conduct this study. The study investigated the adoption level of the recommended fertilizer package that is Phosphate, Nitrogen fertilizers and time of Nitrogen application. Also, the study determined the independent and intervening

factors that influence the adoption of recommended fertilizer package in the study area. The findings generated from this study, are expected to help farmers and other stakeholders to address factors associated with non or low adoption of recommended fertilizer package. This will help to promote maize production and ultimately increase food self sufficiency and income among farmers in Namtumbo District of Ruvuma Region.

The primary data were collected by the use of structured questionnaire and the sample size for this study was 135 respondents selected at random. The collected data were analysed using statistical package for social science (SPSS) computer program where descriptive statistics such as frequency and percentage were used to determine distribution of the study variables. Correlation was used to determine relationship between independent and dependent variables while Chi – square tested the significance difference between investigated variables.

The findings reveal that majority 118 (87.4%) of farmers did not apply Phosphate fertilizer at all. Only 5 (3.7%) applied the recommended amount of Phosphate fertilizer which is 50 kg/ac. On Nitrogen fertilizer about 36 (26.7%) of farmers applied the recommended rate of 100 kg of urea per acre at once as topdressing. Non of them adhered to the recommended rate and time of Nitrogen fertilize application. That is 25 kg at planting and 75 kg as topdressing. About 7 (5.2%) of the interviewed respondents did not apply any fertilizer at all.

For the total fertilization package, the findings show that not a single farmer applied the recommended fertilizer package that is 50 kg of Phosphate mixed with 25 kg of Nitrogen fertilizer at the time of planting followed by 75 kg of Nitrogen fertilizer during topdressing. Majority 128 (94.8%) of farmers applied fertilizers at different levels below the recommended rate, and about 7 (5.2%) of farmers did not apply at all. From this result it can be concluded that, the adoption level of the recommended fertilizer practices like Phosphate, Nitrogen and time of Nitrogen application in the study area is low and non of the respondents adopted the recommended fertilizer package. There is a need for awareness creation to maize farmers on the importance of applying the recommended fertilizer package in their maize fields.

As far as factors influencing the adoption of recommended fertilizer package are concerned, among the independent variables investigated, sex is the only variable that has shown significance difference (p = 0.015) between men and women in the adoption of recommended fertilizers package. As indicated in the results, the adoption of recommended fertilizer package is higher in men than women.
On the other hand, variables like age, marital status, and number of the people in a household, education level and farm size had no contribution/influence on adoption of fertilizer package. This provides evidence that most of the independent factors investigated in this study are not important in determining the adoption of recommended fertilizer package in the study area.

All the intervening variables investigated namely Efficiency misperception (EM), Need tension (NT), Awareness, and prominence seemed to have significant influence

on adoption of fertilizer package. In the case of EM, adoption level seemed to be higher among respondents who underrated their efficiency than those who overrated their efficiency. This is supported by a highly significant negative correlation (r = -0.358; p = 0.000) which reflects that the adoption rate decreases as the current efficiency of fertilizer package adoption is overrated.

As far as Need tension is concerned, the result show that, the majority of respondents had low NT. Correlation results indicates that there is high significant relationship (r = 0.524; p = 0.000) between NT and adoption of recommended fertilizer package. As need tension becomes low, the adoption rate decreases and vise versa. From this point of view, it can be concluded that, low NT is one of the factor that cause low adoption of recommended fertilizer package in the study area.

In the case of awareness, majority of the respondents were not aware of the recommended fertilizers package in their area. The majority of them did not apply or applied below the recommended amount of fertilizers in their maize fields.
The results are supported by correlation which shows significant relationship (r = 0.270; p = 0.002) between awareness and adoption of recommended fertilizers. This result provides evidence that the level of adoption increases with awareness of the recommended fertilizer package. This concludes that, lack of knowledge accelerated the problem of non or low adoption of recommended fertilizer package in the study area.

In the context of prominence, majority of the respondents perceived the recommended fertilizer package to have high prominence relative to their own practices. The findings are supported by highly positive significant correlation (r = 0.289; p = 0.001) implying that the adoption of fertilizers is influenced by perceived prominence.

In general, the adoption of recommended fertilizer package in the study area is strongly influenced by the intervening variables. In this essence, it can be concluded that the intervening variables are more important in determining the adoption of recommended fertilizer package than the independent variables in the study area.

5.2   Recommendations

Recommendations are made based on the study findings as follows: The results show that, the adoption of recommended fertilizer package is determined by the independent factors like sex difference that men are more adopters than women in the study area. Recommendations is made to the stakeholders namely the policy makers, administrators, agricultural researchers and extension officers to put more emphasis by involving more women when conducting research or disseminating the knowledge on the recommended fertilizer type, rate, and time of application.

As stated before, the adoption of recommended fertilizer package in the study area is strongly influenced by the intervening factors (variables) namely the Efficiency misperception, Need tension, Awareness and Prominence. In this essence, it is

recommended that more emphasis should be on the intervening factors in order to address the problem of low adoption in the study area.

As far as Efficiency Misperception is concerned, the agricultural extension should embark on removing the unfavourable perception that may cause farmers overrating of their efficiency on fertilizer application. This can be achieved by a tactful disillusionment that involves the avoidance of public exposure. For example providing convincing evidence about the optimum adoption and production level that can be attained

In the case of Knowledge, the results show that majority of farmers were unaware of the recommended fertilizer package. It is recommended that knowledge regarding the recommended fertilizer package should be disseminated to create the awareness and skills that will enable farmers to adopt the recommended fertilizer package in their maize fields.

In the study area, low level of adoption is associated with the misperception and insufficient aspiration of the recommended fertilizer package which leads to small need tension. To overcome this situation it is recommended that farmers should be given sufficient information about the optimum level or potential of the recommended fertilizer package. This can be achieved by conducting trials, demonstration and farmer field schools of the recommended fertilizer package in their respective maize fields. This helps farmer to differentiate between the present

level and the aspired level by seeing and doing since seeing is believing and by doing you remember.

For the prominence, majority of respondents in the study area showed that the recommended fertilizer package was better than their own practices. From this point of view, it is recommended that constraints that limit the full adoption of the recommended fertilizer package should be addressed by training farmers to overcome problems of low knowledge concerning application of the recommended fertilizer package.

Numerous studies have been conducted in the area of independent variables (farmers characteristics namely the sex, age, marital status, education level, family size). But few studies have been conducted in the area of intervening factors. This calls a need to conduct more research on this area.

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APPENDICES

Appendix 1: Interview schedule

A. General information

Name of the respondent……………………..

Respondent number   --------------

Ward…………… ☐ V1   Village…… ☐ V2

Name of Interviewer…………………………… Date of interview…………...

B. Farmers characteristic
1. Sex of the respondent……… 1.Male 2. Female   [ ] V3

2. How old are you? …………………   [ ]   V4a

        Age Categories……………………   [ ]   V4b
3. What is your marital status?
        1. Single
        2. Married
        3. Widowed   [ ] V5
        4. Divorced

4. What is number of people in your household?
        1. Below 2
        2. 2 – 4
        3. 4 – 6   [ ] V6
        4..Above 6

5. What is your highest education level?
        1. No education
        2. Primary education
        3. Secondary education   [ ] V7
        4. Certificate
        5.Diploma

6. What is your farm size? (In acres)   [ ] V8a

        Farm size categories   ……………   [ ] V8b

7. What area of your farm did you use to grow maize in 2008 / 09 season?
                                                        [ ] V9a

        Area under maize category   [ ]   V9b

   C. Adoption of recommended practices
        Practice: Use of fertilizers

 8. Did you use fertilizer in your maize field last season?
        1 No
        2Yes   [ ] V10

9. a) If yes, what type of fertilizer did you use?(a) at planting – How much, (b) as
   top dressing – How much. (Fill in the table below)

Type of fertilizers	Planting		Top dressing		Variables
	Kg / Acre	Total for the farm (Kg)	Kg / Acre	Total for the farm (Kg)	
Nil					
TSP					11 - 14
DAP					15 – 18
MRP					19 – 22
CAN					23 – 26
UREA					27 - 30
S/A					31 – 34
FYD/compost					35 – 38
Others (specify)					39 - 42

10. b) Phosphate fertilizers (**TSP**,**DAP and MRP (Kg**)
   0. Nil
   1. ≤ 10
   2. 11 – 19
   3. 20 – 29
   4. 30 – 39
   5. 40 – 49
   6. ≥ 50

V43

10. c) Nitrogen fertilizers (CAN or UREA or FYM)
   CAN or UREA (Kg)
   0. Nil
   1. ≤ 20
   2. 21 – 39
   3. 40 – 59
   4. 60 – 79
   5. 80 – 99
   6. ≥ 100

V44

10. d) Please indicate the time when Nitrogen fertilizers are used?
   0. Nil
   1. 1 – 25 Kg as top dressing
   2. 26 – 50 Kg as top dressing
   3. 51 – 75 Kg as top dressing
   4. 76 – 100 Kg as top dressing

V45

5. 25 Kg at planting and 75 Kg as topdressing

10. e) Total fertilization assessment ☐ V46

Total adoption score
- (0) Nil
- (1) 1 – 4
- (2) 5 - 8
- (3) 9 – 12
- (4) 13 – 16
- (5) ≥17

☐ V47

Need related factors

Perceived current efficiency

11. How do you rate yourself on the scale below your efficiency of fertilizers use?

Nil	Very Low				Very High
0	1	2	3	4	5

$[(A- B) -0] \div 5 \times 100$ ☐ V 48

Need Tension

12. Do you expect to change the use of fertilizers in the season of 2009 / 2010?
   - 0. No
   - 1. Yes ☐ V49

13. a) If yes, which fertilizers you intend to use and by how many Kg? Fill in the table below).

13. b)	S / No.	Type of fertilizers	Planting		Top dressing		Variables
			Kg / Acre	Total for the farm (Kg)	Kg/ Acre	Total for the farm (Kg)	
	1	Nil					
	2	TSP					50 - 53
	3	DAP					54 – 57
	4	MRP					58 – 61
	5	CAN					62 – 65
	6	UREA					66 - 69
	7	S/A					70 - 73
	8	FYD/compost					74 – 77
	9	Others (specify)					78 - 81

Phosphate fertilizers (**TSP**,**DAP and MRP (Kg**)

     0. Nil
     1. ≤10
     2. 11 – 19
     3. 20 – 29
     4. 30 – 39
     5. 40 – 49   V82
     6. ≥ 50

13. c) Nitrogen fertilizers (CAN or UREA or FYM)
     CAN or UREA (Kg)
     0. Nil
     1. ≤ 20
     2. 21 – 39
     3. 40 – 49   V 83
     4. 60 – 79
     5. 80 – 99
     6. ≥ 100

13. d) Please indicate the time when Nitrogen fertilizers are used?
     0. Nil
     1. 1 – 25Kg as top dressing
     2. 26 – 50Kg as topdressing
     3. 51 – 75Kg as top dressing
     4. 76 – 100Kg as top dressing   V84
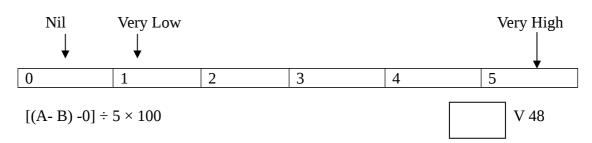   5. 25 Kg at planting and 75 Kg as topdressing
13. e) Total fertilization assessment   V85

     Total adoption score
     (0) Nil
     (1) 1 – 4
     (2) 5 - 8
     (3) 9 – 12
     (4) 13 – 16   V86

(5) ≥17

Knowledge

Awareness of the recommended fertilizers

14. What type of fertilizer(s) recommended to be used in your area for planting or top dressing? (Fill in the table below).

S / No.	Type of fertilizers	Planting		Top dressing		
		Kg/ Acre	Total for the farm (Kg)	Kg/ Acre	Total for the farm (Kg)	Variables
1	Nil					
2	TSP					87 – 90
3	DAP					91 – 94
4	MRP					95 - 98
5	CAN					99 – 92
6	UREA					93 – 96
7	S/A					97 – 100
8	FYD/compost					101 – 104
9	Others (specify)					105 - 108

14. b)   b) Phosphate fertilizers (**TSP**,**DAP and MRP (Kg**)

   0. Nil
   1. ≤10
   2. 11 – 19
   3. 20 – 29
   4. 30 – 39
   5. 40 – 49   V109
   6. ≥50

14. c) Nitrogen fertilizers (CAN or UREA or FYM)

   CAN or UREA (Kg)
   0. Nil
   1. ≤ 20
   2. 21 – 39
   3. 40 – 59   V110
   4. 60 – 79
   5. 80 – 99
   6. ≥ 100

14. d) Please indicate the time when Nitrogen fertilizers are used?

   0. Nil
   1. 1 - 25 Kg as topdressing
   2. 26 - 50 Kg as topdressing
   3. 51 - 75 Kg as topdressing
   4. 76 – 100 Kg as topdressing
   5. 25 Kg at planting and 75 Kg as topdressing   V111

14 e) Total fertilization assessment   V112

Total adoption score
    (0) Nil
    (1) 1 – 4
    (2) 5 - 8
    (3) 9 – 12   V113
    (4) 13 - 16
    (5) ≥17

Perception: Prominence

16. a) What in your view is the best fertilization (type, rate and time of application?)

S / No.	Type of fertilizers	Planting		Top dressing		Variables
		Kg / Acre	Total for the farm (Kg)	Kg / Acre	Total for the farm (Kg)	
1	Nil					114 – 117
2	TSP					118 – 121
3	DAP					122 – 125
4	MRP					126 – 129
5	CAN					130 – 133
6	UREA					134 – 137
7	S/A					138 – 141
8	FYD/compost					142 – 145
9	Others (specify)					146 - 149

16. b) Phosphate fertilizers (**TSP,DAP and MRP (Kg**)
    0. Nil
    1. ≤10
    2. 11 – 19
    3. 20 – 29
    4. 30 – 39
    5. 40 – 49
    6. ≥50   V150

16 c) Nitrogen fertilizers (CAN or UREA or FYM)
    CAN or UREA (Kg)
    0. Nil
    1. ≤ 20
    2. 21 – 39
    3. 40 – 59   V151
    4. 60 – 79
    5. 80 – 99
    6. ≥ 100

16. d) Please indicate the time when Nitrogen fertilizers are used?
       0. Nil
       1. 1 - 25 Kg as topdressing
       2. 26 - 50 Kg as topdressing
       3. 51 - 75 Kg as topdressing
       4. 76 – 100 Kg as topdressing
       5. 25 Kg at planting and 75 Kg as topdressing   V152

16. e) Total fertilization assessment   V153

    Total adoption score
      (0) Nil
      (1) 1 – 4
      (2) 5 - 8
      (3) 9 – 12
      (4) 13 – 16   V154
      (5) ≥17