FACTORS INFLUENCING ADOPTION OF RECOMMENDED PHOSPHATE FERTILIZER PACKAGE: A CASE OF MAIZE GROWERS IN HAI DISTRICT, KILIMANJARO REGION, TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN AGRICULTURAL EDUCATION AND EXTENSION OF SOKOINE MOROGORO, TANZANIA.

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ABSTRACT

The continuous fall of maize production and low adoption of recommended maize production practices like phosphate fertilizer application in Hai District, Kilimanjaro Region have enhanced to conduct this study. The study investigated factors influencing the adoption of phosphate fertilizers in Hai District. Specifically it aimed at, assessing the current level of adoption of recommended phosphate fertilizer, determine the independent factors that influences the adoption of recommended phosphate fertilizers and finally to determine the intervening factors that influence the adoption of recommended phosphate fertilizers in selected villages in Hai District. Primary data were collected by the use of an interview schedule from 120 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 phosphate fertilizer package in the study area is low. Majority 76% of respondents did not apply phosphate fertilizer at all. Only 9.2% used the recommended rates while 15% of the respondents used phosphate fertilizers below the recommended rate of 50kg or 100kg per acre (125kg or 250kg per Ha) for those who applied DAP and MRP, respectively. Several factors seemed to have influence on the level of adoption. These are age, level of education and farm size of respondent. There is strongly influence of the intervening factors, namely the Efficiency Misperception (EM), Need tension (NT) (regarded as need aspects), awareness (knowledge), and prominence (perception). In general, the adoption of recommended phosphate fertilizer package in the study area is strongly influenced by the intervening variables.

DECLARATION

I, David Eliatosha Lekei, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

20/11/2014

David Eliatosha Lekei — Date

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The above declaration is confirmed

20/11/2014

Dr. C. P. Msuya - Bengesi — Date

(Supervisor)

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Last but not the least I thank all who helped me in one way or another during my academic period until I reached there may Almighty God bless them a lot.

DEDICATION

This dissertation is dedicated:

To the Almighty God, the creator and giver of knowledge

To my parents Mr Eliatosha Sofari Lekei and my mother Mrs Foibe Eliatosha who together laid the foundation of my education.

To my beloved wife Eliaisa David

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LIST OF ABBREVIATIONS AND ACRONYMS

ARI	Agriculture Research Institute
CAN	Calcium Ammonium Nitrate
CIMMYT	Centro Internacional de mejoramiento de maizy trigo (International Maize and wheat improvement centre)
DALDO	District Agriculture and Livestock Development Officer
DAP	Diammonium Phosphate
DED	District Executive Director
DW	Durbin Watson
EM	Efficiency Misperception
FAO	Food and Agriculture Organization
gm	Grams
Ha	Hector
ILO	International Labor Organization
Kg	Kilogram
MAC	Ministry of Agriculture and Cooperative
MAFC	Ministry of Agriculture Food and Cooperative
MDG	Millennium Development Goals
mm	Milimiter
MLR	Multiple Linear Regression
MRP	Minjingu Rock Phosphate
N	Nitrogen
NMRP	National Maize Research Program
NT	Need Tension

P	Phosphate
SA	Sulphate of Ammonia
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
VIF	Variance Inflation Factor

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Agriculture continues to be a fundamental instrument for sustainable development, poverty reduction and enhanced food security in developing countries. It is a vital development tool for achieving the Millennium Development Goals (MDG), one of which is to halve by 2015 the share of people suffering from extreme poverty and hunger (World Bank, 2007). In Africa, agriculture is a strong option for spurring growth, overcoming poverty, and enhancing food security. Agricultural productivity growth is also vital for stimulating growth in other sectors of the economy.

Like in other African countries agriculture occupies a very important place in the lives of Tanzanians as well as the national economy (Food and Agriculture organization - FAO, 2005). Eighty five percent of the Tanzanian population is involved in farming; it is estimated that there are 4.8 million smallholder farmers and nearly 3.9 million households keeping livestock. Those who deal with crops play a big role on supplying food to the national (FAO, 2005). Crops which are mainly grown in Tanzania include cash crops like coffee, sisal, cotton, cashew nut, tea, tobacco and pyrethrum, while food crops includes sorghum, millet, maize, rice, pulses, cassava, banana, beans, groundnuts and sunflower.

Maize is the major cereal crop grown and consumed in Tanzania (Nkonya *et al.*, 2003). It is grown in all regions of Tanzania and it is cultivated on an average of two million hectares, which is about forty five percent of the cultivated area in Tanzania (FAO, 2005). Realizing the importance of the maize crop to the lives of Tanzanians, the government has been committing human and financial resources to enhance maize production and productivity. A National Maize Research Program (NMRP) was started in 1974 with the broad objective of developing cultivars suitable for major maize producing areas. For the improvement of husbandry practices, the NMRP recommended maize production practices namely; use of hybrid/improved maize varieties, proper spacing, application of recommended rate and type of fertilizer, timely weeding, pest and diseases control.

The recommended fertilizer for maize production is phosphates fertilizer for planting like Triple Super Phosphate (TSP), Diammonium Phosphate (DAP) or Minjingu Rock Phgosphate (MRP), and nitrogenous fertilizer for top dressing like Urea and Calcium Ammonium Nitrste (CAN). Despite the recommended type and rate of fertilizers, evidence shows that in Tanzania, among the farmers who apply fertilizer in their fields, majority of them apply at a very low level about 8 kg/Ha (Shetto, 2007). The same situation applies in Hai District where majority of farmers do not apply fertilizer especially phosphate fertilizers in maize production which calls a need to study the factors influencing the adoption of phosphate fertilizers in the study area.

1.2 Problem Statement and Justification of the Study

Tanzania National Agricultural Research System has developed and released several productions –enhancing technologies for many years; but yield of maize crops at the farm level is still low. The average national production is approximately 0.75 tones per hectare instead of 7.2 tones per hectare expected under good management practices (Agriculture Research Institute - ARI Uyole, 2006). This is partly attributed by the fact that the recommended maize production practice like fertilizer application has not significantly been adopted by farmers.

In Hai District where this study was conducted the recommended rate of phosphate fertilizer is 50Kg per acre (125kg per Ha) of Di-Ammonium Phosphate (DAP) or 100Kg per acre (250kg per Ha) of Minjingu Rock Phosphate (MRP) during planting. Nitrogenous fertilizers are recommended during top dressing at the rate of 50Kg per acre (125kg per Ha) of Urea or 100Kg per acre (250kg per Ha) of Calcium Ammonium Nitrate (CAN). Although this is the case, the adoption level of these practices has been low and some farmers do not apply phosphate fertilizer at all. For example more than 80 percent of the farmers do not apply phosphate fertilizer; while others they just apply less than 10kg of phosphate fertilizer per acre (District Agriculture and Livestock Development Officer - DALDO Hai, 2013). For the case of nitrogenous fertilizes, more than 80% of the farmers apply it, as topdressing at recommended rate of 50 Kg per acre or 125 kg per Ha of Urea (DALDO Hai, 2013).

Due to none or low application of fertilizers, especially phosphates fertilizer, the yield of maize has been poor/low. For example for the past five years, the average yield production in Hai District is about two tones per hector (DALDO Hai, 2013), which is very low compared to 7.2 tons per hectare expected under good management practices (ARI Uyole, 2006). In order to improve maize production in the District, there is a need to study factors influencing adoption of phosphate fertilizer on maize production by maize growers in Hai District.

Numerous studies have been conducted to determine factors like farmers characteristics, institutional and technological factors, which influencing adoption of recommended agricultural technologies, but very few have been conducted to determine the influence of intervening factors on the adoption behavior. Due to poor adoption of phosphate fertilizer by maize grower in Hai District, this study intend to determine the intervening and independent factors that influencing application of phosphate fertilizer in the District. Findings from this study will be used by policy makers, researchers and extension agents to design strategies and efforts directed at increasing use of phosphate fertilizer in order to improve maize production and improve food security in Hai District.

1.3 Objectives of the Study

1.3.1 General objective

The main objective of this study was to investigate factors influencing adoption of phosphate fertilizers in Hai District.

1.3.2 Specific objectives

i. To asses the current level of adoption of recommended phosphate fertilizer in selected villages in Hai District.
ii. To determine the independent factors that influences the adoption of recommended phosphate fertilizer in selected villages in Hai District.
iii. To determine the intervening factors that influence the adoption of recommended phosphate fertilizer in selected villages in Hai District

1.4 Conceptual Framework

In this study it is conceptualized that, the adoption of the recommended phosphate fertilizers in Hai District is influence by a combination of factors that are broadly categorized into independent and intervening variables (factors). According to Düvel's model of behavior analysis and change these are regarded as the important determinants of the adoption behavior (Düvel, 1991). The independent variables include attributes associated with farmers and farms characteristics like age, level of education, farm size, gender, income level and tenure arrangement; characteristic of the technology such as cost of inputs and labor requirements; and Institutional characteristic such as availability of credits, extension services, access to outside information, membership in cooperatives, availability of inputs, risk aversion, subsidies and policy effects. The intervening variables include Knowledge, perception and Need. The intervening factors (variables) are assumed to have direct influence on the adoption of phosphate fertilizers, while the independent variables are hypothesized to influence the adoption behavior via intervening variables. The conceptual framework diagram is shown here below.

Independent variable	Intervening variable	Dependent variable
Sex Age Marital status Household size Level of education Area under maize	Knowledge Perception Need	Adoption of recommended phosphate fertilizer

Figure 1: The study conceptual framework adapted from Düvel's (1991) model.

CHAPTER TWO

2.0 LITERATURE REVIEW

This chapter presents an overview of maize production in Tanzania, and reviews literature on fertilizer application in maize production, phosphate fertilizers, phosphorus deficiency, the concept of adoption and factors influencing adoption, which are the independent and the intervening factors.

2.1 An overview of Maize Production in Tanzania

In Tanzania, maize crop is regarded as the major cereal food crop and a shift towards food self – sufficiency in the country depends largely on the improvement of maize production. Maize is not only a staple crop in surplus regions, it is also a cash crop. 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). It is estimated that the annual per capita consumption of maize in Tanzania is 112.5 kg; national maize consumption is estimated to be three million tons per year. In the Northern Zone, the per capita consumption is estimated to be 130 kg per year.

Maize contributes 60% of dietary calories to Tanzanian consumers (FSD, 2012). The cereal also contributes more than 50% of utilizable protein, while beans contribute 38% (Amani, 2004). About 85% of Tanzania's total maize production is grown by peasants whose farms are less than 10 ha. Ten percent of maize is produced on medium-scale commercial farms (10-100 ha), and the remaining 5% is grown on large-scale commercial farms (over 100 ha). As indicated earlier, various practices have been recommended in order to improve maize production. These include field preparation, improved maize seed varieties, early planting, spacing, fertilizers application, weeding, pest and diseases control.

2.2 Fertilizer Application in Maize Production

As indicated earlier fertilizer is one of the very important inputs for maize production. The recommended fertilizers for maize production are phosphate and nitrogenous fertilizers. Phosphates are applied during planting while nitrogenous are applied as top dressing fertilizers. A description of each type of fertilizer is given below.

2.2.1 Phosphate fertilizers

Phosphorus (P) after Nitrogen (N) is the most important macronutrient limiting agricultural production in the tropics (FAO, 2004). Many of the agricultural soils in the tropical and sub tropical regions are low in both total and available P when compared with other major nutrients (Ali *et al.*, 2002). Replenishment of soil P is often problematic as it is often fixed in soils with high sorption capacity rendering it less available. Maize is an exhaustive crop having higher potential than other cereals and absorbs large quantity of nutrients from the soil during different growth stages.

Among the essential nutrients, phosphorus is one of the most important nutrients for higher yield in larger quantity and controls mainly the reproductive growth of plant (FAO, 2007). Plant growth behavior is influenced by the application of phosphorus (Ayub *et al.*, 2002). It is needed for growth, utilization of sugar and starch, photosynthesis, nucleus formation and cell division, fat and albumen formation. Energy from photosynthesis and the metabolism of carbohydrates is stored in phosphate compounds for later use in growth and reproduction (Ayub *et al.*, 2002). It is readily translocated within the plants, moving from older to younger tissues as the plant forms cells and develops roots, stems and leaves (Ali *et al.*, 2002). Adequate P results in rapid growth and earlier maturity and improves the quality of vegetative growth. Generally the application of phosphate fertilizers is considered essential for crop production. Ali *et al.*, (2002) reported significant effect of P application on grain yield of up to 7 tons per Ha; whereas Ayub *et al.*, (2002) observed significant effect of P application on dry matter yield and individual plant characteristics like height, number of leaves and leaf area.

2.2.2 Phosphorus deficiency

Deficiency of P is usually associated with low supply of available P, soil mineralogical properties and some chemical reactions which might lead to P tied down. Deficiency will slow overall plant growth (Rashid and Memon, 2001). Specifically, Phosphorus deficiency is responsible for crooked and missing rows as kernel twist and produce small ears nubbies in maize. The most striking effects are a reduction in leaf expansion and leaf surface area as well as the number of leaves. Shoot growth is more affected than root growth, which leads to a decrease in the shootroot dry weight ratio. Nonetheless, root growth is also reduced by P deficiency, leading to less root mass to reach water and nutrients. Also, inadequate P slows the processes of carbohydrate utilization, while carbohydrate production through photosynthesis continues (Ayub *et al.*, 2002). This results in a buildup of carbohydrates and the development of a dark green leaf color.

In some plants, P-deficient leaves develop a purple color, tomatoes and maize being two examples. Since P is readily mobilized in the plant, when a deficiency occurs the P is translocated from older tissues to active meristematic tissues, resulting in foliar deficiency symptoms appearing on the older (lower) portion of the plant (Ali *et al.*, 2002). However, such symptoms of P deficiency are seldom observed in the field than loss of yield. Other effects of P deficiency on plant growth include delayed maturity, reduced quality of crops, and decreased disease resistance. Some studies had been conducted to investigate on how to increase soil P level through fertilizer application in order to enhance significant agronomic yield response (Gale, 2000). Although this has been the case, the adoption of phosphate fertilizers in crop production has been poor like in the case of maize growers in Hai District, which is the genesis of this study that investigated factors influence adoption of P fertilizers in the District. The folowing sections review the concept of adoption and factors that influence it.

2.3 Concept of Adoption

Adoption of innovations refers to the decision to apply an improved practice and to continue to use it (Rogers, 1995). Is the degree of use of new innovation in long run equilibrium when a farmer has full information about the new technology and its potential (Feder *et al.*, 1985). This is closely followed by the main options of active rejection, which occurs when farmers consider adoption of innovation (including its trial) but then deciding not to adopt it and passive rejection (also called non-adoption), which consists of never really considering the use of the improved practice. Van den Ban and Hawkins (1996) contended that, adoption is a process, which the decision to adopt usually takes time. The concept of sustainable adoption is defined as the degree to which an innovation continues to be used over time after a diffusion programme ends (Rogers, 1995). This is closely related to the term continued adoption, which is the persistent use of an improved practice.

2.4 Factors that Influence Adoption

As indicated in the study conceptual framework, this section describes the independent and the intervening variables, which influence adoption behavior. The independent factors explained here are farm and farmers' characteristics, institutional and technological factors. While the intervening variables (factors), include need related aspects (efficiency misperception, need compatibility, need tension), knowledge and perception (prominence).

2.4.1 Independent factors

2.4.1.1 Farm and farmer's characteristics

These are characteristics of individual farmers that can be used as explanatory variables in understanding adoption behavior. These factors include sex, age, marital status and education level while farm characteristics include income and farm size of the farmer (Nkonoki, 1994).

(a) Sex

Sex difference has been found to be one of the factors influencing adoption of new technologies (Okuthe *et al.,* 2013). According to International Labour Organization, ILO (2007) women agricultural workers are responsible for half of the worlds' food production. Compared to men, Women often have more difficulties 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). Based on this background, this study assumes that adoption of phosphate fertilizers is high among men than women.

(b) Age

According to Byron *et al.,* (2005), elderly farmers seem to be somewhat less inclined to adopt new practices than younger farmers. Furthermore, some of studies find that there are no relationship between age and the use of recommended production practices (Mussei *et al.*, 2001; Mattee, 2009). Still other studies show that younger farmers are more likely to adopt recommended production practices (Van de Ban and Hawkins, 1996). It is assumed in this study that the age of the respondents has influence on the adoption of the recommended rates of phosphate fertilizer in the sense that the adoption is high among old aged than young farmers.

(c) Marital status

Overholt *et al.,* (1984) observes that married women are rarely consulted when new farming technologies are introduced. Whatever agricultural information 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. So, it is expected that the marital status of the respondents has influence on the adoption of phosphate fertilization whereby married farmers assumed to have high adoption level compared to other marital status categories.

(d) Educational level

Education is one of the most important factors that influence the utilization of new idea and approaches for improving agricultural production and productivity. Education is believed to create a favorable mental attitude for the acceptance of new practices, especially information-intensive and management-intensive practices (Akudugu *et al.*, 2012). Education improves human capital, farm management capacity, the ability to understand and adopt recommended agricultural practices (Bezuayehu *et al.*, 2002). It is expected that better educated farmers are more likely to adopt recommended agricultural practices than less educated farmers (Cary *et al.*, 2002). Mwaseba *et al.*, (2006) report that, education of household head have influence on adoption of recommended agricultural practices especially when the recommended agricultural practices require managerial skills.

(e) Income

Farmers with high income are more likely to be adopters of new practices than farmers with low income (Mattee, 2009). Shivley (2001) found that high income was positively correlated with adoption of hedgerows in the Philippines. Also, according to Mlozi (2010), lack of initial capital among smallholder farmers contributes enormously to rejection of innovations. It is assumed that the adoption of recommended phosphate fertilizer in the study area is influenced by level of income of the respondents whereby those with high income are more likely to have high adoption.

(f) Farm size

Farm size and topography are the farm characteristics that may influence the farmer to adopt agricultural technologies (Parvan, 2010). Farm size does not always have the same effect on adoption; rather, the effects of farm size vary depending on the typology of technology being introduced, and the institutional setting of the local community. The relationship of the farm size and adoption depends on such factors as fixed adoption costs, risk preferences, human capital and credit constraints (Feder *et al.*, 1985). Farm size may act as a proxy for other socio-economic indicators such as access to credit because the larger farm has more collateral value (Parvan, 2010). Looking at soil conservation techniques in the Philippines, Shively (2001) finds that the decision to adopt depends on farm size, partially because soil conservation on small farms is especially costly due to increases in the short-run risk of consumption shortfall with certainty (Shively, 2001). Based on this background, farm size is expected to have influence on the adoption of recommended phosphate fertilizers in the study area whereby those with big farm size are assumed to have high adoption level than small farm holders.

(g) The number of people in a household

Household size is another factor that can influence the adoption of recommended phosphate fertilizer package. 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.

2.4.1.2 Institutional factors

The institutional factors, which may influence farmers adoption or rejection of innovations includes the extension services, availability of credit and availability of market. These factors are derived from publicly operated systems providing research and extension services to farmers. Publicly operated systems providing research and extension of new innovations, sometimes get out of touch with the needs of the recipients they serve as pointed out by El-osta and Morehart (1999), and consequently result into low adoption of recommended technologies.

(a) Availability of credit

Any investment requires the use of own or borrowed capital. Hence, the adoption of any technology, which requires a large initial investment, may be hampered by lack of borrowing capacity (El-osta and Morehart, 1999). Therefore unavailability of credit and input supply services can be limiting factors for adoption of recommended agricultural practices (Purcell and Anderson, 1997).

(b) Extension

The ministry of agriculture use agricultural extension as one of the instrument to promote agricultural development. Agricultural Extension organizations have to supply useful information about agriculture technologies (Christopolos, 2010). For the matter, access to such sources of information is crucial in adoption of improved maize technologies like fertilizer application (Liberio, 2012).

(c) Availability of market

Market access plays an increasingly important role in determining the level of adoption. Availability of market for agricultural produce means opportunity to sell farmer's produce at an attractive price and this will increase adoption of agricultural technologies (Swanson, 2006).

2.4.2 The intervening variable (factors)

Intervening variables are factors that have been identified as being strongly related to, and influential in the occurrence and magnitude of substance use problems and consequences. Intervening variables are individual traits or experiences, which drive their behaviors (Van den Ban and Hawkins, 1996). According to Düvel (1991), these are regarded as the precursor of the adoption behavior. The intervening variables discussed in this section are farmers' knowledge, perception and needs.

2.4.2.1 Farmers knowledge

Knowledge is a familiarity with someone or something, which can include facts, information, descriptions, or skills acquired through experience or education. It can refer to the theoretical or practical understanding of a subject (Amir, 2006). A lack of understanding or knowledge about the recommended practices and or production efficiency is a strong barrier to the adoption of recommended practices or innovations (Düvel, 1991).

2.4.2.2 Perception

Perception is the organization, identification, and interpretation of sensory information in order to fabricate a mental representation through the process of transduction, which sensor in the body transform signals from the environment into encoded neural signals (Gray, 2006). Also according to Van de Ban and Hawkin (1996), Perception is the process by which a person receives information or stimuli from the environment and transforms it into psychological awareness. According to Düvel, 1991 one of the perception aspects is prominence.

2.4.2.3 Prominence

Prominence 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 and Msuya, 2007). For instance, different recommended agricultural practices adoption studies conducted by (Msuya, 2007 and Mlyuka, 2011) indicated positive relationship between Prominence and adoption of recommended agricultural practices.

2.4.2.4 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 energize behavior and give it direction. Research results show existence of relationship between need related aspects like efficiency misperceptions, need compatibility, need tension and adoption behavior (Düvel, 1991).

(a) 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. Düvel (2004) noted that, there is a tendency of individuals to overrate (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 agricultural practices.

(b) Need compatibility

Need compatibility is a measure of whether the suggested solutions in terms of increased efficiency or introduced practice are compatible with individual needs. Düvel (1991), contend that non - adoption behavior results when suggested solutions do not fit into the psychological field or need situation of an individual. The reviewed studies (Habtemarian, 2004; Msuya, 2007) indicated a positive relationship between this variable and adoption behavior.

(c) Need tension

Need Tension is defined as a perceived discrepancy between the present situation and the desired situation or level of aspiration. This variable has been shown by different research studies to have a direct and positive relationship with the adoption behaviour (Duvel and Botha, 1999; Msuya, 2007; Mlyuka, 2011). 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).

CHAPTER THREE

3.0 METHODOLOGY

3.1 The Study Area

This study was done in Hai District, which is located on the western part of Kilimanjaro Region. It is bordered by Arumeru District to the west, Simanjiro District to the south, Moshi District to the east and Siha District to the north. The District has three ecological zones, which are high, mid and low land. Also the District is subdivided into three divisions, namely: Lyamungo, Machame and Masama where all of them spread in all ecological zones. There are 14 wards where 3 are situated in high land, 4 in mid and 7 in low land (Fig. 2). On the other hand there are 60 villages, 12 in high land, 21 in mid and 27 in low land. Also there are 11 urban streets, which are situated in mid ecological zones. According to the 2012 national census, the District had a population of 210 533. The major economic activity is agriculture whereas maize is the main staple food grown. Others are banana, beans, sunflower and rice used both as food and cash crops while the major cash crop grown is coffee.

There are two main rain seasons, which are the long rains season and the short rains season. The long rains season begins in March ending in June, while the short rains season starts in November ending in December. On average the District receives 700 mm of rainfall in the lowlands, 1250 mm in the mid zone and 1750 mm in the upper zone.

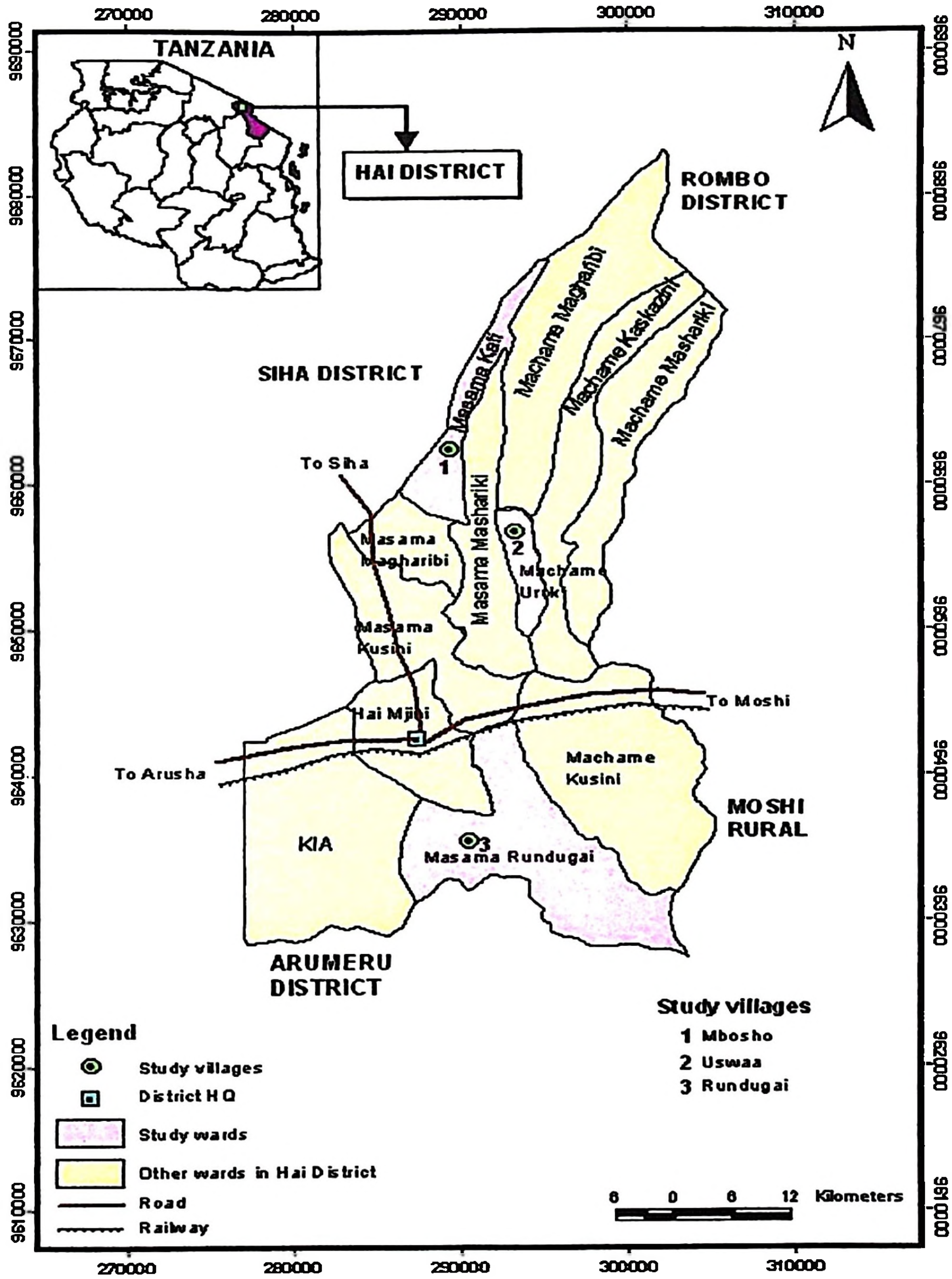

Figure 2: A map of Hai District showing the study Wards

3.2 Research Design

A cross-sectional research design was used to collect data for this study. According to (International Development Research Centre - IDRC, 2003) this design enables the researcher to collect data at a single point in time from a sample that is selected to describe the larger population. The design is suitable for purpose of description as well as for determination of relations between variables. The design is also considered favorable due to limited resources like manpower, finance and time for collecting data.

3.3 The Population and Sampling Procedure

The population for this study was composed of maize growers from three selected villages of Hai District Council of Kilimanjaro Region. A purposive sampling was employed to select two divisions namely, Masama and Machame. These were selected due to the fact that they spread in all ecological zones and are potential in maize production. From selected divisions three wards each from different ecological zones were selected randomly, then, one village from each ward was selected randomly making a total of three villages. The villages selected were Uswaa from Machame Uroki, Mbosho from masama Kati and Rundugai from Masama Rundugai.

3.4 Sample Size

A total of 120 respondents were randomly selected, 24 from high zone (Uswaa), 42 from mid zone (Mbosho) and 54 from low land ecological zone (Rundugai). This sample size is considered to be desirable according to Matata *et al.* (2001), who arques that 80-120 respondents are adequate for most socio-economic studies in Sub- Saharan Africa household.

3.5 Instrumentation

An interview schedule was used to collect quantitative data from farmers. Data were collected on the level of adoption of recommended phosphate fertilizer package and the independent and intervening factors that influenced the adoption of recommended phosphate fertilizer package in the Hai District of Kilimanjaro Region.

3.6 Pre-testing

An interview schedule was pre-tested to ensure its validity and reliability. This exercise was done in two places, namely Kia village and Msikitini Street, where six respondents were drawn from each area. The main objective of pre-testing was to evaluate whether questions were clear, specific, coherent and relevant to the study objectives. After pretesting relevant modifications on instrument were done to suit the intended quality of the research.

3.7 Data Collection Method

Both primary and secondary data were collected as detailed in section 3.7.1 and 3.7.2

3.7.1 Primary data collection

Primary data were collected using an interview schedule by the researcher assisted by two enumerators at the respondents' homesteads. The enumerators were trained during pre testing of the research instrument. Data were collected from each selected maize grower's respondent and each response was carefully recorded in an interview schedule.

3.7.2 Secondary data

Secondary data were obtained from various sources including Hai District Agricultural Office, Kilimanjaro Regional Agricultural Office, Selian Agriculture Research Institute, Ministry of Agriculture and Food Security, Extension Department Libraries and Sokoine National Agriculture 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, farm size and area under maize crop.

3.8.1.1 Sex

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

3.8.1.2 Age

The respondents' age were categorized in to three groups of age namely < 36 years as youth, 36 – 56 years as adults and above 56 years of age. This was the total number of years that a person had lived since his / her birth to the time when this survey was done.

3.8.1.3 Formal education

The respondent education were categorized into four groups as follows; primary education, secondary education, certificate and diploma. This was measured on basis of an individual education attained over period of time at school.

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

In this study it referred to the number of people living in a household. The 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

This is the whole land for agriculture owned by the respondent. The individual respondent was requesting to indicate his / her farm size owned. Farm size were recategorised into three categories namely < 2 acres, 2 to 4 acres and above 4 acres.

3.8.1.7 Area under maize

Farmers were asked to indicate the area, which was grown maize from the farm size owned. Area under maize was then categorized as <2.0 acres, 2.0 to 2.5 acres and above 2.5 acres.

3.8.2 Intervening variables

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

3.8.2.1 Efficiency misperception

To capture this parameter, the respondents were asked to estimate their own efficiency in a four-point scale (0 to 3) and the enumerator did similar rating based on the objective (researched) criteria. The four point scale was used to assist in calculating farmers' degree of misperceptions (overrating or underrating).

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

Percentage of overrating / underrating = (A – B) ÷ 3 × 100

Where

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

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

3 = the difference between the highest and lowest scale point (3 - 0).

The percentages obtained were categorized into; underrating, assess correctly, 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 (Düvel, 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 phosphate fertilizer on maize production. 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 the 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 (Düvel, 2004). For this case, awareness refers as knowledge of recommended phosphate fertilizer package in the study area. Farmers' awareness therefore was measured by requesting them to indicate the recommended phosphate 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 Need compatibility

Need compatibility is a measure of whether the recommended solution fits into the need situation of an individual or contributes towards the attainment of his/her needs. This variable was measured by requesting the respondents to estimate the level of production efficiency they would have attained if they had used (or not used) the suggested practices. The percentage changes in production efficiency were then calculated using the formula below. Based on the obtained results the respondents were categorized into low, medium and high need compatibility.

$A = C - B/B * 100$

Where: A = Percentage change in production efficiency

B = Current production efficiency

C = Production efficiency they would have attained if not used or used the suggested practices.

3.8.2.5 Prominence

Prominence is defined as the degree to which an innovation is perceived as being better than the idea it supersedes. Based on this definition farmers were asked to indicate what they regarded to be the best practices in phosphate fertilizer on maize production in their area. Farmers were then categorized into three groups as low prominence, medium and high prominence.

3.8.3 Dependent Variable

In this study the dependent variable was the adoption of recommended Phosphate fertilizer package. Phosphate fertilizer is one of the most important nutrients in maize production. Full adoption of phosphate fertilizer was measured by considering the type of phosphate fertilizer applied, rates per acre, rates per hole and method or way of application.

(a) Type of phosphate fertilizers

In the study area phosphate fertilizers such as Di-Ammonium Phosphate (DAP) and Minjingu Rock Phosphate (MRP) are recommended to be applied during planting as basal fertilizers. In order to measure this variable respondents were asked to indicate the type of fertilizers used for planting in their maize fields in season 2012/13 and the answers were categorized as:

(0) None

(1) NPK

(2) TSP

(3) MRP or DAP

(b) Recommended rates of phosphate fertilizer per acre

In the study area the recommended rates of phosphate fertilizer for planting maize is 50kg/acre (125kg/Ha) of DAP or 100 kg/acre (250kg /Ha) of MRP. In order to measure this variable, respondent were asked to indicate the amount of fertilizer used for planting in their maize fields. The answers obtained were categorized as shown in Table 1 below.

Table 1: Recommended rates of phosphate fertilizer in Kg / acre

Scale point	DAP	MRP
0	Nil	Nil
1	≤ 10	≤ 20
2	11 – 19	21 – 39
3	20 – 29	40 – 59
4	30 – 39	60 – 79
5	40 – 49	80 – 99
6	≥ 50	≥ 100

(c) Recommended rates of phosphate fertilizer per hole

The recommended rates per hole of phosphate fertilizer for planting maize in the study area is 10grms of DAP or 20grms of MRP. To measure this variable respondents were requested to indicate the amount of fertilizer used per hole during the planting and the answers obtained were categorized in Table 2.

Table 2: Recommended rates of phosphate fertilizer in gms per hole

Scale point	DAP	MRP
0	Nil	Nil
1	<2	< 4
2	2 – 3	4 – 7
3	4 –5	8 – 11
4	6 – 7	12 – 15
5	8 – 9	16 – 19
6	≥ 10	≥ 20

(d) Recommended method of phosphate fertilizers application

In the study area, the recommended method of application of phosphate fertilizer is by mixing well with soil in the hole during planting. In order to measure this variable respondent were asked to indicate how they applied phosphate fertilizer during planting in their maize fields and the answers obtained were categorized as shown below:

0. None
1. By mixing with seed
2. By broadcasting
3. By mixing with soil

(e) Total phosphate fertilization package adoption

The Full adoption of phosphate fertilizer was measured by considering the type of phosphate, rates per acre, rates per hole and method or ways of application. As indicated earlier, for Phosphate the recommended type is DAP or MRP, at a rate of 50 kg per acre (125kg / Ha) for DAP or 100kg per acre (250 kg/Ha) of MRP, while rate per hole is 10gms for DAP or 20grms for MRP. It is recommended to mix fertilizers with soil for effective germination. The adoption of total phosphate fertilization package was obtained by adding scale points for the type of phosphate in part (a), which is 3, rates per acre in part (b), which is 6, rates per hole in part (c), which is 6 and method or way of application used in part (d) which is 3. This makes a total of 18 scale points. The categorization was done by considering different ranges where by 0 was categorized as nil, ≤ 9 was categorized as low, 10 – 17 was categorized as medium and ≥18 was categorized as high adoption rate. Therefore the scale for recommended total Phosphate fertilizer adoption assessment were categorize as:

(0) Nil

(1) Low

(2) Medium

(3) High

3.9 Data Analysis

Data analysis is the process of evaluating data using analytical and logical reasoning to examine each component of the data provided (Dogbe, 2006). For this study, the collected primary data were coded, entered, cleansed, and analyzed using the statistical 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. A multiple linear regression model (Equation 1) was used to test the influence of independent variables (sex, age, level of education, marital status, farm size, area under maize and number of the people in a household) and intervening variables (efficiency misperception; need tension, awareness, need compatibility and perception aspects like prominence) on the adoption of recommended phosphate fertilizers.

Equation 1: $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k + \mu$......................................(1)

Where **Y** is the predicted value on the dependant variable, β_0 is the intercept of the regression equation (constant), X_1 to X_k represent the various independent variables (of which there are k), and β_1 **to** β_s are the coefficients assigned to each of the independent variables during regression and μ is error term.

For independent variables, equation 2 was used based on equation 1

$Y = \beta_0 + \beta_1\, SEX + \beta_2\, AGE + \beta_3\, HLEDU + \beta_4\, MARSTAT + \beta_5\, FARSIZE + \beta_6\, ARUMAIZ + \beta_7\, HHSIZE + \mu$..(2)

Where;

Y= Adoption of recommended phosphate fertilizers.

β_0	=	Intercept of the regression equation
SEX	=	Sex of respondents
AGE	=	Age of the respondents
LEDU	=	level of education attained of respondents
MARSTAT	=	Marital status of respondents
FARSIZE	=	Farm size of the respondents
ARUMAIZ		Area under maize of the respondents
HHSIZE	=	Household size of the respondents
$\beta_1 - \beta_7$	=	Unstandardized coefficients of explanatory / independent variables
μ	=	Random error term

For intervening variables equation 3 was used based on equation 1

$Y = \beta_0 + \beta_1\, EM + \beta_2\, NT + \beta_3\, AW + \beta_4\, NC + \beta_5\, PROM + \mu$...(3)

Where;

Y= Adoption of recommended phosphate fertilizers.

β_0	=	Intercept of the regression equation
EM	=	Efficiency misperception of respondents
NT	=	Need tension of respondents
AW	=	Awareness (knowledge) of respondents
NC	=	Need compatibility of respondents
PROM	=	Prominence (perception aspects) of the respondents
$\beta_1 - \beta_5$	=	Unstandardized coefficients of explanatory / intervening variables
μ	=	Random error term

Before running the linear regression model (LRM), data were tested for multicolinearity, autocorelation and heteroscedasticity to check the fitness of the model.

Testing for Multicollinearity: The effects of multicollinearity were tested using Variance Inflation Factor (VIF). Multicollinearity is a statistical phenomenon in which two or more predictor variables in a multiple regression model are highly correlated (O'Brien, 2007; Hollar, 2010). Multicollinearity does not reduce the predictive power or reliability of the model as a whole, at least within the sample data themselves; it only affects calculations regarding individual predictors. According to Gujarati (2009) there are various indicators of multicollinearity and no single diagnostic give us a complete handle over the collinearity problem. The variance inflation factor (VIF) test is regarded as one of the most rigorous diagnostic test for multicollinearity in the regression model. Multicollinearity is a problem if the VIF is greater than 10 (Gujarati, 2009; Wooldridge, 2001).

Testing for heteroscedasticity: Another assumption of regression is that the variance of the residuals is homogeneous across levels of the predicted values, also known as homoscedasticity. If the model is well-fited, there should be no pattern to the residuals plotted against the fitted values. If the variance of the residuals is non-constant then the residual variance is said to be "heteroscedastic", and the model will not fit (Gujarati and Porter, 2009).

Testing for Autocorrelation: The autocorrelation is the similarity between observations as a function of the time separation between them (Wooldridge, 2001). It refers to the correlation of a time series with its own past and future values. It is a mathematical tool for finding repeating patterns. In other way, this is the condition occurring when successive items in a series are correlated and they are not independent. The Durbin–Watson test (DW) is often used to detect the presence of autocorrelation. If a value is close to two, it is indication that there is no autocorrelation problem in the model (Gujarati, 2009). In this study autocorrelation was tested by Durbin Watson test (DW).

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

4.1 Level of Adoption of Recommended Phosphate Fertilizers

Various researches recommend the use of fertilizer in maize production in order to attain optimum yield. Maize is an exhaustive crop having higher potential than other cereals and absorbs large quantity of nutrients from the soil during different growth stages. Among the essential nutrients, phosphorus is one of the most important nutrients for higher yield in larger quantity (Ali *et al.,* 2002). Phosphorus supplements in the form of fertilizers are most often used to guarantee healthy corn plants and large corn yields. It stimulates root development, promote early flowering and provides more grains. As indicated earlier in background information the recommended source of Phosphate fertilizers in the study area are DAP at a rate of 50 kg per acre (125kg per Ha), 10 grams per hole, by mixing with the soil or Minjingu Rock Phosphate (MRP) at a rate of 100 kg per acre (250kg per Ha), 20 grams per hole, by mixing with the soil (DALDO, 2013). Farmers were requested to indicate the level of adoption of each practice as described in the following sections.

4.1.1 Recommended type of phosphate fertilizers

Respondents were asked to indicate type of phosphate fertilizers applied in their maize field and the results obtained are summarized in Table 3.

Table 3: Distribution of respondents by their adoption of recommended type of Phosphate fertilizers (n=120)

Scale point	Type of Phosphates fertilizer	Frequency	Percent
0	Nil	91	75.8
1	NPK	0	0.0
2	TSP	0	0.0
3.	DAP or MRP	29	24.2
Total		120	100.0

The result which presented in Table 3 Shows that the majority 75.8% of respondents did not apply Phosphate fertilizer at all. Only 24.2% adopted the recommended type of Phosphate fertilizer, which is DAP or MRP. These results are supported by findings obtained by Mlyuka (2011) who found low adoption of recommended phosphate fertilizers among maize growers in Namtumbo District.

4.1.2 Recommended rates of phosphate fertilizers per acre

Applying the recommended type of phosphate fertilizer is one thing and applying the recommended rate is another thing. Experience show that, farmers may apply the recommended type of fertilizer, without adhering to the recommended rates. Therefore recommended rate per acre were among the components considered in full adoption of phosphate fertilization package in Hai District. Study results regarding this aspect are summarized in Table 4.

According to the findings which are presented in Table 4, about 76% of respondents did not apply phosphate fertilizers at all. Only 9.2% used the recommended rates while 15% of the respondents used phosphate fertilizers below the recommended rate of 50kg or 100kg per acre (125kg or 250kg per Ha) for those who applied DAP and MRP, respectively. This is in agreement with Mlyuka (2011) who found that most of the farmers do not apply fertilizers in their maize fields and those who apply do at lower level below the recommended rate.

Table 4: Distribution of respondents by adoption of recommended rates of Phosphate fertilizers per acre (n=120)

Scale point	Phosphates fertilizer (Kg/ acre)		Frequency	Percent
	DAP	MRP		
0	Nil	Nil	91	75.8
1	≤ 10	≤ 20	0	0.0
2	11 – 19	21 – 39	2	1.7
3	20 – 29	40 – 59	14	11.6
4	30 – 39	60 – 79	2	1.7
5	40 – 49	80 – 99	0	0.0
6	≥50	≥100	11	9.2
Total			**120**	**100.0**

4.1.3 Recommended rates of phosphate fertilizers per hole

Rate of phosphate fertilizer per hole was also considered as other criteria for total adoption of total phosphate fertilizer package in the study area. The respondents were therefore requested to indicate the rates used as summarized in Table 5.

Table 5: Distribution of respondents by adoption of recommended rates of Phosphate fertilizers per hole (n=120)

Scale point	Rate per indicated fertilizer (grams per hole)		Frequency	Percent
	DAP	MRP		
0	Nil	Nil	91	75.8
1	< 2	<4	0	0.0
2	2 – 3	4 – 7	2	1.7
3	4 – 5	8 – 11	14	11.6
4	6 – 7	12 – 15	2	1.7
5	8 – 9	16 – 19	0	0.0
6	≥10	≥20	11	9.2
Total			120	100.0

Study findings as presented in Table 5 reveal that, out of 120 respondents interviewed, only 9.2% used 10 grams of DAP or 20 grams of MRP which is a recommended amount per hole. The rest, 15% used less than 10grams of DAP or less than 20grams of MRP which is below the recommended rate.

4.1.4 Recommended method of phosphate fertilizers application

Phosphate fertilizers are applied during planting and therefore the method of application has impact in seed germination as well as the performance of the plant. It is recommended that phosphate fertilizers should be mixed with soil when planting maize seeds. Respondents were therefore asked to indicate the methods of phosphate fertilizer application used in their maize field. Results as summarized in Table 6 reveal that all respondents 24.2% who applied phosphate fertilizers; they mixed Phosphate fertilizers with soil during planting.

Table 6: Distribution of respondents by their adoption of recommended method of Phosphate fertilizers application (n=120)

Scale point	Phosphates fertilizer (grams/ whole)	Frequency	Percent
0	Nil	91	75.8
1	By mixing with seed	0	0.0
2	By broadcasting	0	0.0
3	By mixing with soil	29	24.2
Total		120	100

4.1.5 Adoption of recommended total phosphate fertilizers package

The total phosphate fertilization package, involves the use of recommended types of phosphate fertilizers, recommended rates of phosphate fertilizer per acre, recommended rates of phosphate fertilizers per hole and recommended method of application of phosphate fertilizer. As indicated earlier in section 4.1.1, 4.1.2, 4.1.3 and 4.1.4 for recommended phosphate fertilizer type is DAP or MRP, recommended rates of phosphate fertilizer per acre is 50kg (125kg/Ha) for DAP and 100kg (250kg/Ha) for MRP, recommended rates of phosphate fertilizer per hole is 10grams for DAP and 20grams for MRP and recommended method of application of phosphate fertilizer is by mixing with soil.

The scale used to assess the adoption of total phosphate fertilization package was obtained by adding scale points for recommended phosphate type (Table 3), recommended rates of phosphate fertilizer per acre (Table 4), recommended rates of phosphate fertilizer per hole (Table 5) and recommended method of application (Table 6). For example a respondent farmer who applied 50 kg/acre of DAP at the rate of 10grms per hole and mixed fertilizer well with soil, his / her level of adoption of total phosphate fertilizer package was obtained by adding the following scale points 3 + 6 + 6 + 3 = 18 scale points. 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 – 9 for low adoption, 10 – 17 medium adoption and ≥ 18 for high or full adoption of recommended total phosphate fertilization package. Table 7 presents the findings of the analysis.

Table 7: Distribution of respondents by their adoption of recommended Phosphate fertilizer package (n=120)

Level of fertilizer application	Scale point	Frequency	Percentage
Nil	0	91	75.8
Low	≤9	2	1.7
Medium	10 - 17	16	13.3
High	≥18	11	9.2
Total		120	100

The results summarized in Table 7 indicate that 75.8% of the respondents did not use phosphate fertilizer at all. About 1.7% falls under low adoption level represented by ≤ 9 scale point, while 13.3% fall under medium adoption represented by the scale point of 10 to 17. Only 9.2% of respondents fall under high adoption level, represented by the scale point of ≥ 18. These findings are in line with (Msuya *et al.*, 2013) who reported low adoption of recommended phosphate fertilizers among maize growers in the Njombe District. The study went further to investigate the reasons for none or low adoption as explained below.

4.2 Factors that Influence the Adoption of Recommended Phosphate Fertilizer

This study investigated further the independent and intervening factors influencing adoption of phosphate fertilization in Hai District council. The following section explores the independent factors that influence the adoption of recommended phosphate fertilization package in the study area.

4.2.1 Independent Factors

The independent factors considered in this study were sex, age, level of education, marital status, farm size, area under maize and number of people in a household. Each variable was assessed separately to determine its influence on the adoption of recommended phosphate fertilizer in maize production in the study area.

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 are summarized in Table 8.

Table 8: Distribution of respondents by sex and adoption of recommended phosphate fertilizers (n=120)

Sex	Phosphate Fertilizer application									
	None (Nil)		Low		Medium		High		Total	
	n	%	n	%	n	%	n	%	n	%
Male	46	71.9	2	3.1	10	15.6	6	9.4	64	53.3
Female	45	80.4	0	0.0	6	10.7	5	8.9	56	46.7
Total	91	75.8	2	1.7	16	13.3	11	9.2	120	100.0

$\chi 2 = 2.580$, df = 2; p = 0.641; r = - 0.061; p = 0.543

Table 8 shows that 53.3% of the interviewees were men and 46.7% were woman. The results further show that out of 9.2% respondents who had adopted the recommended phosphate fertilization in their maize fields; 9.4% were males and the rest, 8.9% were women. On the other hand out of 75.8% of the respondents who did not use phosphate fertilizers the majority of them 80.4% were women. This implies that females are less capable in adopting recommended phosphate fertilizers as compared to their male counterparts. The negative correlation results indicate that the adoption is higher in male than in women although not significant as indicated in the correlation results. These results are in line with Furahisha (2013) and Adesina *et al.* (2000) who found high adoption of fertilizer among men than women farmers.

4.2.1.2 Age

Farmers' age is said to be a primary latent characteristic in adoption decisions. However there is a contention on the direction of the effect of age on adoption. Young and energetic farmers have proved to be active and ready to try new innovations (Cary *et al.*, 2002). On the other hand Amir and Pannel, 1999 state that older farmers have more experience, resources and authority that would give them more possibilities for trying new innovations. This is contrary to Dogbe (2006) who argue that though older people have experience and resources, their receptivity to new ideas and technologies decreases with age. Other researchers Nkonya and Norman (2003) further argue that the effect of age on adoption tend to be location and technology specific. Due to the inconsistency of findings regarding the relationship between age and adoption, Düvel (1999) insist that there is a need to research on factors that seem to be best determinants of the adoption behaviour.

In this study the respondents were requested to indicate their age. Age category of respondents ranged between 20 to 75 years. The findings regarding the relationship between age and adoption of phosphate fertilizers package is summarized in Table 9.

Table 9: Distribution of respondents by age and adoption of recommended phosphate fertilizer package (n=120)

Age	Phosphate Fertilizer application									
	None (Nil)		Low		Medium		High		Total	
	n	%	n	%	n	%	n	%	n	%
< 36 (Youth)	15	100.0	0	0.0	0	0.0	0	0.0	15	12.5
36 – 56 (Adults)	20	80.0	0	0.0	4	16.0	1	4.0	25	20.8
> 56 (Old)	56	70.0	2	2.5	12	15.0	10	12.5	80	66.7
Total	91	75.8	2	1.7	16	13.3	11	9.2	120	100.0

$\chi 2 = 7.944$, df = 6; p = 0.242; r = 0.226; p = 0.013

The results from the study indicate that 66.7% of the respondents were more than 56 years and were categorized as old, others 20.8% were between 36 and 56 years and categorized as adult and 12.5% were below 36 years and categorized as youth (Table 9). The findings show that 12.5% respondents from older age category had adopted the recommended phosphate fertilizer package and only 4% from adult category also adopted, while not a single respondent from youth age category had adopted the recommended phosphate fertilizer package. For the case of non adopters, all youth 100% interviewed fell under this category; Although the study indicates that there is no statistically significance difference ($\chi 2$=7.944, df=6; p= 0.242) between age and adoption of the recommended phosphate fertilizer package, the correlation analysis show a significant positive correlation (r= 0.226; p=0.013) between age and adoption of recommended phosphate fertilizer in the study area. This implies that the age of respondents influence the adoption of the recommended phosphate fertilizer in the sense that adoption amongst older farmers is relatively higher than that of younger farmers. The results are in line with Amir and Pannel (1999) who found that there is a positive relationship between age and the adoption of recommended production practices.

4.2.1.3 Marital status

Married couples are likely to be more productive in maize production due to sharing of experience and labour supply (Mgonzo, 2011). In this study it is also assumed that married couples share experience in adoption of recommended agricultural technologies. The results concerning marital status and adoption of recommended phosphate fertilizer package are indicated in Table 10.

Table 10: Distribution of respondents by marital status and adoption of recommended phosphate fertilizer package (n=120)

Marital status	Phosphate Fertilizer application									
	None (Nil)		Low		Medium		High		Total	
	n	%	n	%	n	%	n	%	n	%
Single	7	100.0	0	0.0	0	0.0	0	0.0	7	5.8
Married	75	73.5	2	2.0	14	13.7	11	10.8	102	85.0
Widowed	9	90.0	0	0.0	1	10.0	0	0.0	10	8.3
Divorce	0	0.0	0	0.0	1	100.0	0	0.0	1	0.8
Total	91	75.8	2	1.7	16	13.3	11	9.2	120	100

$\chi2 = 10.589$, $df = 9$; $p = 0.305$; $r = 0.062$; $p = 0.499$

The results presented in Table 10 show that 5.8% of the respondents were single, 85.0% were married, 8.3% were widowed and 0.8 % was divorced. Findings further show that not a single respondent from single, widowed and divorced category applied the recommended phosphate fertilizers in their maize fields. Only 10.8% respondents from married category adopted the recommended phosphate fertilizer. However the results of the chi – square analysis ($\chi2$ = 10.589, df = 9; p = 0.062) show that there is no significant difference between marital status and the adoption of recommended phosphate fertilizers package. Also the correlation findings indicate that there is no significant relationship (r = 0.062; p = 0.499) between marital status and adoption of recommended phosphate fertilizer package. This implies that adoption of phosphate fertilization package is not determined by marital status in the study area. This is probably due to the fact that the largest percentage of married couple 73.5% falls under non adoption category. These results are supported by Ani *et al.*, (2004), Mlyuka (2011), and Furahisha (2013) who found that adoption of fertilization package is not determined by marital status.

4.2.1.4 Household size

Large number of people in household would be able to provide the labour that might be required by recommended phosphate fertilizer application in maize production. The findings regarding the relationship between household size and adoption of recommended phosphate fertilizer package are summarized in Table 11.

Table 11: Distribution of respondents by household size and adoption of recommended phosphate fertilizers package (n=120)

Category of household size	Phosphate Fertilizer application									
	None (Nil)		Low		Medium		High		Total	
	n	%	n	%	n	%	n	%	n	%
1 – 3	19	90.5	0	0.0	1	4.8	1	4.8	21	17.5
4 – 6	53	73.6	2	2.8	10	13.9	7	9.7	72	60.0
More than 6	19	70.4	0	0.0	5	18.5	3	11.1	27	22.5
Total	91	75.8	2	1.7	16	13.3	11	9.2	120	100

$\chi2$ = 3.739, df = 6; p = 0.626; r = 0.137; p = 0.137

The results presented in Table 11 show that 60.0% of respondents had 4 to 6 people in their household, 22.5% had more than 6 people in their household and 17.5% had 1 to 3 people in their household. According to chi square results, there is no significant difference ($\chi2 = 3.739$, df = 6; p = 0.626) between household size and the adoption of recommended phosphate fertilization package. This implies that in this study adoption of recommended phosphate fertilizer package (type, rate per acre, rate per hole and method of application) does not differ with the number of people in a household. The findings also reveal that, there is no significant correlation (r = 0.137; p = 0.137) between household size and the adoption of recommended phosphate fertilizer package. The adoption of recommended phosphate fertilizer package might be influenced by other factors such as needs and perception towards phosphate fertilizer package. These results disagree with findings that were reported by Polson and Spencer (1991) as well as Shiferaw and Holden (1998) who indicated that family size is significantly related to the adoption of technologies.

4.2.1.5 Education level

Education not only endows one with the power to read and hence informed, but it also allows one to communicate. Farmers' educational background is a potential factor in determining the readiness to accept and properly use of an innovation (Amir, 2006). It is suggested that farmers with higher education possess higher abilities and are able to adjust faster to farm and technologies adoption conditions. Croook *et al.* (2011) contends that, farmers with higher levels of education adopt new technologies more rapidly than farmers with low education. The results regarding the relationship between education level and adoption of phosphate fertilizers package are summarized in Table 12.

Table 12: Distribution of respondents by level of education and adoption of recommended phosphate fertilizers package (n=120)

Level of education	Phosphate Fertilizer application									
	None (Nil)		Low		Medium		High		Total	
	n	%	n	%	n	%	n	%	n	%
Primary education	60	84.5	1	1.4	7	9.9	3	4.2	71	59.2
Secondary education	12	66.7	1	5.6	4	22.2	1	5.6	18	15.0
Certificate	4	66.7	0	0.0	1	16.7	1	16.7	6	5.0
Diploma	15	60.0	0	0.0	4	16.0	6	24.0	25	20.8
Total	91	75.8	2	1.7	16	13.3	11	9.2	120	100.0

$\chi2$ =14.384, df = 6; p = 0.109; r = 0.277; p = 0.002

The results summarized in Table 12 show that the majority of respondents 59.2% had primary education as their highest level of education. Others 15%, 5.0% and 20.8% had attained secondary, certificate and diploma education, respectively. According to the results presented in Table 12, the highest percentage of respondents 24.0% with diploma education had full adopted the recommended phosphate fertilizers, while the highest percentage of respondents with primary education had not adopted phosphate fertilizers.

The chi - square results reveal that there is no significant difference (χ^2 = 14.384; df = 6; p = 0.109) between education level and the adoption of recommended phosphate fertilizer package. This implies that different education levels do not differ significantly in their level of adopting recommended phosphate fertilizer package. But correlation results (r = 0.277; p = 0.002) indicate that there is a relationship between education level and adoption of recommended phosphate fertilizer package. The positive correlation implies that those respondents with high education level had high adoption of phosphate fertilizers, which is in line with similar observation by Amir (2006).

4.2.1.6 Farm size

Farm size is among the factors measured when modelling adoption processes. Land as a factor of production and storage of wealth is the most important asset influencing adoption (Shively, 1999). Farm size does not always have the same effect on adoption; rather, the effects of farm size vary depending on the typology, characteristics of technology being introduced, and the institutional setting of the local community. The relationship between farm size and adoption also depends on factors such as fixed adoption costs, risk preferences, human capital, credit constraints, labour requirements and tenure arrangements (Feder *et al.*, 1985). Farmers with larger farms are more likely to adopt new technologies because they can spread the costs over a wide range of outputs than it is possible for small-scale farmers. Oluwasola (2010) found that farmers with large farms were able to adopt rain water harvesting technologies in their farms than those with small farms. Findings presented in Table 13 gives the summary of respondent distribution according to their farm size and adoption of recommended phosphate fertilizer package in the study area.

Table 13: Distribution of respondents by farm size and adoption of recommended phosphate fertilizer package (n=120)

Farm size category	Phosphate Fertilizer application									
	None (Nil)		Low		Medium		High		Total	
	n	%	n	%	n	%	n	%	n	%
<2	34	89.5	1	2.6	1	2.6	2	5.3	38	31.7
2 – 4	33	75.0	0	0.0	6	13.6	5	11.4	44	36.7
>4	24	63.2	1	2.6	9	23.7	4	10.5	38	31.7
Total	91	75.8	2	1.7	16	13.3	11	9.2	120	100.0

$\chi 2 = 10.160$, df = 6; p = 0.118; r = 0.223; p = 0.014

According to results presented in Table 13, about 68% of the respondents had small farms less than 5 acres, that is common to the majority of farmers in Tanzania and Africa in general (FAO, 2007). Few respondents 31.7% indicated that they own more than four (4) acres. Although it is expected that farmers with large farm size have high chance to adopt recommended phosphate fertilizer package, the findings show that, the highest percentage of respondents with farm size between 2 to 4 acres 11.4% had adopted recommended phosphate fertilizers package compared to those who had farm size of more than 4 acres. The chi – square results show that there is no significant difference (χ^2 = 10.160; df = 6; p = 0.118) between different farm categories and the adoption of recommended phosphate fertilizer package. On the other hand, correlation results show that, there is a significant correlation (r = 0.223; p = 0.014) between farm size and the adoption of recommended phosphate fertilizer package. The results are in line with the studies done by Msuya *et al.*, (2013) who found that there is a positive relationship between farm size and the adoption of recommended phosphate fertilization.

4.2.1.7 Area under maize

This is the part of area, which was used to grow maize from the whole piece of land for agriculture owned by a respondent. Area under maize was also expected to have influence on the adoption of recommended fertilizer package in the study area. Table 14 shows research findings.

Table 14: Distribution of respondents by area under maize and adoption of recommended phosphate fertilizer package (n=120)

Area under maize categories	Phosphate Fertilizer application									
	None (Nil)		Low		Medium		High		Total	
	n	%	n	%	n	%	n	%	n	%
<2	16	84.2	0	0.0	1	5.3	2	10.5	19	15.8
2 - 2.5	53	74.6	1	1.4	11	15.5	6	8.5	71	59.2
>2.5	22	73.3	1	3.3	4	13.3	3	10.0	30	25.0
Total	91	75.8	2	1.7	16	13.3	11	9.2	120	100.0

$\chi 2$ = 2.336, df = 6; p = 0.886; r = 0.049; p = 0.593

Study findings show that the majority of respondents 59.2% had small areas under maize production that ranged between 2 to 2.5 acres. Only 25.0% had more than 2.5 acres of area under maize. Other respondents 15.8% indicated that they owned less than 2 acres. The findings further show that, Adoption of recommended phosphate fertilizer package is

10.5% for those with small area under maize production (below 2 acre), 8.5% for respondents with farm size ranging from 2 to 2.5 acres and 10 % for those with farms above 2.5 acres. The percentages are not linear as supported by correlation results that show inexistence of linear relationship between farm size and adoption of phosphate fertilizers. This implies that area under maize is not a determinant of the adoption of recommended phosphate fertilizer package in the study area. The adoption of recommended phosphate fertilizer package may be influenced by other factors such as the cost of technology, timely availability of technology, lack of information of that technology, needs, perception and knowledge. The chi – square test results also indicate that there is no significant difference ($p > 0.05$) between different area under maize categories and adoption of recommended phosphate fertilizers. The correlation results also show no relationship ($r = 0.049$; $p = 0.593$) between area under maize and the adoption of recommended phosphate fertilizers.

4.2.1.8 Total influence of independent variables

In investigating the total influence of all independent variables (factors) investigated in the study, the linear regression model was used. The independent variables included are age, sex, level of education, farm size and area under maize. Before testing the modal, data were tested for multicollinearity, heteroscedaticity and autocorrelation where by the model was free from these problems. As far as autocorellation is concerned, Durbin Watson- test (DW) value is 2.247. According to (Gujarati and Porter, 2009) a value which is close to two indicate that there is no autocorrelation. Also the VIF test shows that all the variance inflation factors are smaller than 10, indicating that there is no serious multicollinearity problem. Data were also tested for heteroscedasticity before running the regressing modal.The results show that the pattern of the data points is getting a little narrower towards the right end, an indication of mild heteroscedaticity (Fig. 3).

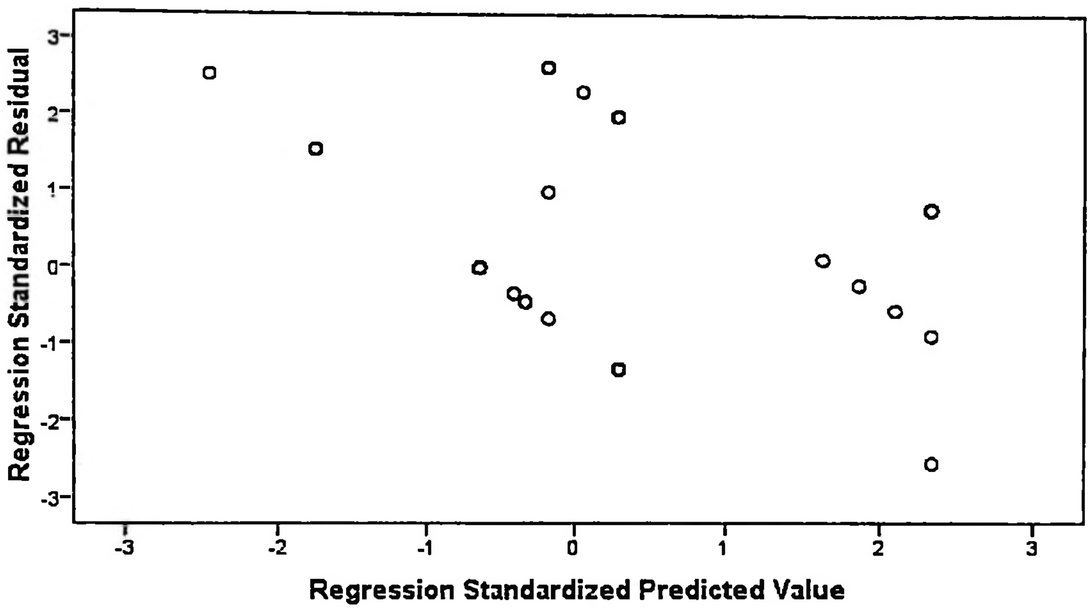

Figure 3: Testing for heteroscedasticity on independent variables

After testing for multicollinearity, heteroscedaticity and autocorrelation the study went further to test the multiple linear regression model and the results of this analysis are summarized in Table 15.

Table 15: Linear regression analysis showing the relationship between independent variables and adoption of recommended phosphate fertilizer package (n=120)

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
(Constant)	-.977	.658		-1.485	.140		
Sex	.095	.197	.046	.483	.630	.823	1.215
Age	.241	.141	.165	1.710	.090	.805	1.243
Marital status	.040	.231	.016	.175	.861	.863	1.159
Household size)	.155	.147	.095	1.053	.295	.930	1.075
Education level	.195	.078	.228	2.484	.014	.889	1.125
Farm size	.359	.175	.277	2.057	.042	.413	2.422
Area under maize	-.428	.210	-.262	-2.041	.044	.454	2.203

$R^2 = 0.160$; Adjusted $R^2 = 0.108$; $p = 0.006$; DW = 2.247

According to results summarized in Table 15, age of respondents, education level, farm size and area under maize are confirmed to be the variables contributing most significantly to the adoption of recommended phosphate fertilizer package in the study area represented by (Beta = 0.165, p = 0.09), (Beta = 0.228, p = 0.01), (Beta = 0.277, p = 0.04) and (Beta -0.262, p = 0.04), respectively. On the other hand other variables like sex, marital status and household size seem to have no significant contribution to the adoption of recommended phosphate fertilizer package in the study area. Moreover the overall contribution of independent variables towards explaining the variance of phosphate fertilization adoption rate is only 16 % (R^2) and 10.8% (Adjusted R^2) for the sample and the population, respectively which is significant (p = 0.006).

4.2.2 Intervening variables that influence the adoption of phosphate fertilization package

The intervening variables investigated in this study include efficiency misperception; need tension, awareness (knowledge), need compatibility and perception aspects like prominence.

4.2.2.1 Efficiency misperception

Efficiency misperception (EM) is the degree to which the individuals incorrectly rate (usually overrate) their efficiency of adopting new technologies (Düvel, 2004). This is one of the intervening variables that determine farmer's adoption behavior due to the fact that the more efficiency is overrated, the smaller the problem scope or need tension becomes and thus the smaller the incentive to adopt the recommended innovations. How a farmer perceives the efficiency of recommended phosphate fertilizer package adoption is expected to have influence in his/ her adoption behavior in several ways. These include none, low, medium or high adoption. The relationship between EM and adoption of recommended phosphate fertilizer package is summarized in Table 16.

Table 16: Distribution of respondents according to their Efficiency misperception and adoption of recommended phosphate fertilizer package (n=120)

Efficiency misperception	Phosphate Fertilizer application									
	None (Nil)		Low		Medium		High		Total	
	n	%	n	%	n	%	n	%	n	%
Underrate	0	0.0	1	6.3	4	25.0	11	68.8	16	13.3
Asses correct	89	87.3	1	1.0	12	11.8	0	0.0	102	85.0
Overrate	2	100.0	0	0.0	0	0.0	0	0.0	2	1.7
Total	91	75.8	2	1.7	16	13.3	11	9.2	120	100.0

$\chi 2$ = 89.968, df = 6; p = 0.000; r = - 0.748; p = 0.000

Findings presented in Table 16 show that, the majority (85.0%) of respondents assessed correct their EM, 13.3% underrated, while few 1.7% overrated their EM. The results further reveal that, full adoption of the recommended phosphate fertilizer package, was adopted only by 68.8% respondents who underrated their phosphate fertilizer application package. On the other hand none of the respondents (0.0%) who underrate their efficiency fall under non adopters' category. It is surprisingly to note that there are respondents who assessed correctly their efficiency 87.3% but did not apply at all phosphate fertilizers which is contrary to (Düvel, 1991; Düvel, 2004; Düvel, 2007 and Msuya, 2007) who contended that correct assessment of farmers' own efficiency is associated with its adoption. This is probably due to the fear of destroying the soil as some of the farmers mentioned. However the correlation results show that there is highly significant negative correlation (r = -0.748; p = 0.000) between EM and adoption, which reflects that efficiency misperception influence the adoption of recommended phosphate fertilizer package in the study area. The negative sign of the correlation coefficient indicates that the adoption rate of recommended phosphate fertilizers decreases as the current efficiency adoption is overrated and vice versa. The chi – square findings further reveal that, there is a significant difference (p = 0.000) between different efficiency misperception (EM) categories as far as phosphate fertilizer package application is concerned.

4.2.2.2 Need tension

The need tension is defined as the problem scope or perceived discrepancy between the current and the desired or potential situation (Düvel, 1991). This variable has been found to have positive influence on the adoption behavior (Msuya, 2007; Mlyuka, 2011; Furahisha, 2013). In this study need tension is also assumed to have positive relationship with adoption of recommended phosphate fertilizer package. Table 17 summarizes the results.

Table 17: Distribution of respondents according to their Need tension and adoption of recommended phosphate fertilizer package (n=120)

Need Tension	Phosphate Fertilizer application									
	None (Nil)		Low		Medium		High		Total	
	n	%	n	%	n	%	n	%	n	%
Low	24	49.0	1	2.0	13	26.5	11	22.4	49	40.8
Medium	1	20.0	1	20.0	3	60.0	0	0.0	5	4.2
High	66	100.0	0	0.0	0	0.0	0	0.0	66	55.0
Total	91	75.8	2	1.7	16	13.3	11	9.2	120	100.0

$\chi 2 = 32.329$, df = 6; p = 0.006; r = -0.580; p = 0.000

The results presented in Table 17, show that 55.0% of the respondents had high need tension (NT), 49 (40.8%) had low need tension and only 4.2% had medium need tension. The results also show that none of the respondents from medium and high need tension had adopted the recommended phosphate fertilizer package. Only 22.4% of the respondents with low need tension adopted the recommended phosphate fertilizer package. On the other hand, 100% of respondents with high need tension fall under none adoption category. The findings are supported by negative correlation (r = - 0.580; p = 0.000), which indicates that there is negative significant relationship between NT and adoption of recommended phosphate fertilizer package application against what was expected. According to Habtemariam (2004); Düvel (2004) and Furahisha (2011), negative correlations in the case of several variables related with the perceived problem discrepancy (need tension) between the current and desired situation can be attributed to especially the less effective respondents over - rating their own efficiency and/or need satisfaction. The results also show that there is a significant difference (χ^2 = 32.329; df = 6; p = 0.000) between different need tension categories and adoption of recommended phosphate fertilizers.

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 (Düvel, 2004). The respondents were asked to indicate their awareness of recommended phosphate fertilizer package for maize production in their area. The findings show that the majority of respondents are not aware as shown in Table 18.

Table 18: Distribution of respondents according to their awareness and adoption of recommended phosphate fertilizer package (n=120)

Awareness	Phosphate Fertilizer application									
	None (Nil)		Low		Medium		High		Total	
	n	%	n	%	n	n	%	N	%	n
Not aware	91	85.0	2	1.9	14	13.1	0	0.0	107	89.17
Aware	0	0.0	0	0.0	2	15.4	11	84.6	13	10.83
Total	91	75.8	2	1.7	16	13.3	11	9.2	120	100

$\chi2$ = 101.9, df = 3; p = 0.000; r = 0.773; p = 0.000

The results summarized in Table 18 show that, majority 89.17% of respondents were not aware of recommended phosphate fertilizers package versus 10.83% who were aware of the recommended phosphate fertilizers package in their area. All respondents who had not adopted the use of fertilizer at all 85.0% were not aware of recommended phosphate fertilizer package. While not a single respondent who was aware fall under non adoption category. On the other hand all respondents 84.6% who adopted the recommended phosphate fertilizer package were aware of it. The chi - square indicates that there is significant difference ($\chi2$ = 101.9, df = 3; p = 0.000) between different awareness categories (aware and not aware) and adoption of recommended phosphate fertilizers package. The correlation results also show that there is significant relationship (r = 0.773; p = 0.000) between awareness and adoption of recommended phosphate fertilizer package. This implies that awareness has influence on adoption of recommended phosphate fertilizer package in maize production in the study area. These results are in line with findings by (Msuya, 2007, Mlyuka, 2011 and Furahisha, 2013) who found that the level of adoption increases with awareness of the recommended fertilizer package.

4.2.2.4 Need compatibility

This is the measure of whether the suggested solutions in terms of increased efficiency or introduced practice are compatible with individual needs. Düvel (1991), contend that non adoption behavior results when suggested solutions do not fit into the psychological field or need situation of an individual. The results on the relationship between need compatibility and the adoption of recommended phosphate fertilizer package for maize production are presented in Table 19.

Table 19: Distribution of respondents according to their need compatibility and adoption of recommended phosphate fertilizer package (n=120)

Need compatibility	Phosphate Fertilizer application									
	None (Nil)		Low		Medium		High		Total	
	n	%	n	%	n	%	N	%	n	%
Low	24	51.1	1	2.1	11	23.4	11	23.4	47	39.2
Medium	4	44.4	1	11.1	4	44.4	0	0.0	9	7.5
High	63	98.4	0	0.0	1	1.6	0	0.0	64	53.3
Total	91	75.8	2	1.7	16	13.3	11	9.2	120	100.0

$\chi2$ = 49.071, df = 6; p = 0.000; r= -0.539; p = 0.000

The results presented in Table 19, shows that 53.3% of the respondents had high need compatibility, 39.2% had low need compatibility and only 7.5% had medium need compatibility. The results also show that none of the respondents from medium and high need compatibility have adopted the recommended phosphate fertilizer package. On the other hand all respondents who full adopted phosphate fertilizer package had low need compatibility. The findings are also supported by negative correlation ($r = -0.539$; $p = 0.000$) which indicates that there is negative significant relationship between need compatibility and adoption of recommended phosphate fertilizer package in the study area. These results disagree with findings that were reported by (Düvel, 1991 and Msuya, 2007) who found positive significant relationship between need compatibility and adoption, which calls a need for further investigation of this variable. Chi- square results further show that there is a significant difference ($\chi^2 = 49.071$; df = 6; $p = 0.000$) between different need compatibility categories and adoption of recommended phosphate fertilizer package.

4.2.2.5 Prominence

Prominence is synonymous with Rodgers (1995) 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 (Düvel, 1991; Msuya, 2007; Mlyuka, 2011 and Furahisha, 2013). Table 20 summarizes the survey results on the relationship between prominence and adoption of recommended phosphate fertilizers package.

Findings presented in Table 20 shows that, about 51.7% of respondents perceived the recommended phosphate fertilizer package to have low prominence relative to their own practices, while 10.8% perceive it to have medium prominence and 37.5% perceive it to have high prominence.

Table 20: Distribution of respondents according to their prominence and adoption of recommended phosphate fertilizer package (n=120)

Prominence	Phosphate Fertilizer application									
	None (Nil)		Low		Medium		High		Total	
	n	%	n	%	n	%	n	%	n	%
Low	61	98.4	0	0.0	1	1.6	0	0.0	62	51.7
Medium	8	61.5	1	7.7	4	30.8	0	0.0	13	10.8
High	22	48.9	1	2.2	11	24.4	11	24.4	45	37.5
Total	91	75.8	2	1.7	16	13.3	11	9.2	120	100.0

$\chi 2 = 44.618$, df = 6; p = 0.000; r = 0.550; p = 0.000

Only the respondents with high prominence 24.4% have adopted the recommended phosphate fertilizer package while none of the respondents with low and medium prominence adopted the recommended phosphate fertilizer package. On the other hand the highest percentages of respondents with low prominence fall in the category of non adopters. The results are supported by a highly positive significant correlation (r = 0.550; p = 0.000) implying that the adoption of phosphate fertilizer package is influenced by perceived prominence. The chi – square analysis results ($\chi 2 = 44.618$, df = 6; p = 0.000) also indicate a highly significant difference between different prominence categories and adoption of recommended phosphate fertilizer package in the study area.

4.2.2.6 Total influence of intervening variables

The total influence of all intervening variables discussed in the previous section (Efficient misperception, Need tension, Knowledge, Need compatibility and Prominence) was assessed by regression analysis. Before regression analysis data were tested for multicollineality and autocorrelation and test results show absence of both problems. The findings summarized in Table 21, show that Durbin Watson - test (DW) value is close to two (2.156) which indicate absence of autocorrelation. Also the VIF test shows that all the variance inflation factors are smaller than 6.760, indicating that there is no serious multicollinearity problem. The litrature state that multicollinearity is a problem if the VIF is greater than 10 (Gujarati, 2009;Wooldridge, 2001). As far as heteroscedasticity is concerned, the results show that the pattern of the data points is getting a little narrower towards the right end, an indication of mild heteroscedasticity as indicated in Fig. 4.

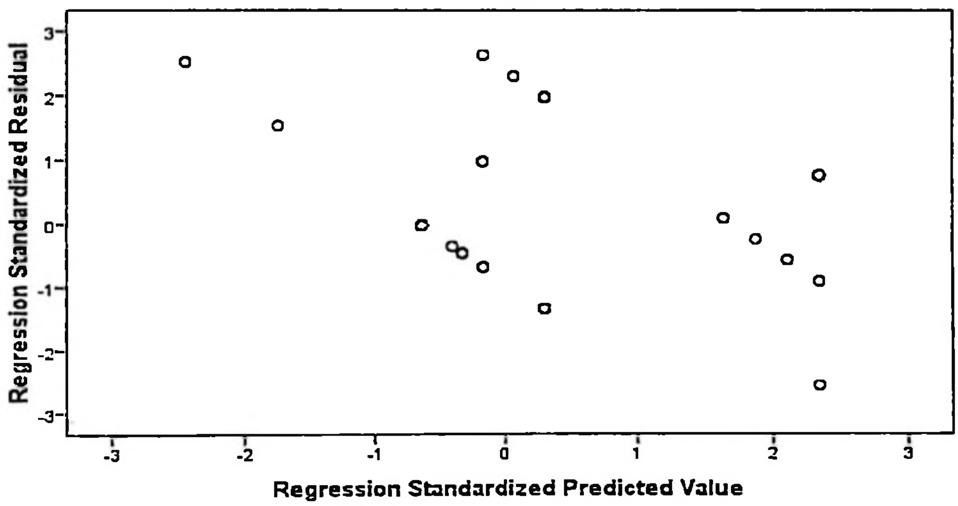

Figure 4: Testing for heteroscedasticity on intervening variables

After testing for multicollinearity, heteroscedaticity and autocorrelation the study went further to test the multiple linear regression model and the results of this analysis are summarized in Table 21. Results presented in Table 21 show that, the intervening variables contribute 76.3% (R^2) and 75.2% (Adjusted R^2) of the variation in the adoption of phosphate fertilization for study sample and population, respectively, which is highly significant (p=0.000). The difference between the variance explained by the sample and the population is only 1.1%, this study considers the sample reasonably represented the characteristics of interest of the population. The findings further show that three intervening variables (Efficient misperception, Need tension and Knowledge) contribute very significantly to the adoption of phosphate fertilizer on maize production in the study area. This is represented by Beta = -0.311, p = 0.000, Beta = -0.580, p = 0.009 and Beta = 0.225, p = 0.000, respectively.

Table 21: Linear regression analysis showing the relationship between intervening variables and adoption of recommended phosphate fertilizer package (n=120)

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
(Constant)	-.046	.762		-.060	.952		
Efficiency misperception	-.434	.097	-.311	-4.479	.000	.431	2.320
Need tension	-.618	.232	-.580	-2.661	.009	.790	1.265
Knowledge	1.481	.225	.446	6.581	.000	.452	2.212
Need compatibility	.513	.275	.474	1.866	.065	.172	5.828
Prominence	.209	.153	.189	1.362	.176	.148	6.760

R^2 = 0.763; Adjusted R^2 = 0.752; p = 0.000; DW = 2.156

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The general objective of the study was to investigate factors influencing the adoption of phosphate fertilizers package in Hai District. Specifically the study intended to: (i) asses the current level of adoption of recommended phosphate fertilizer in selected villages in Hai District (ii) determine the independent factors that influences the adoption of recommended phosphate fertilizer in selected villages in Hai District (iii) determine the intervening factors that influence the adoption of recommended phosphate fertilizer in selected villages in Hai District.

Based on the study the following are the major conclusions drawn from the findings of this study:

(i) The current level of adoption of the recommended phosphate fertilizer package on maize production in the study area is low.

(ii) Three (3) independent factors; age of respondent, farm size and education level of respondents seem to be statistically significant to adoption of recommended phosphate fertilizer while the rest independent variables that are sex of the respondent, marital status, household and area under maize are not important in determining the adoption of recommended phosphates fertilizer package on maize production in Hai District.

(iii) The adoption of recommended phosphate fertilizer package in the study area is strongly influenced by the efficiency misperception; need tension, awareness, and Prominence. Generally, by comparing independent and intervening variables, this study concludes that most of the investigated intervening variables are more important in determining the adoption of recommended phosphate fertilizer package in Hai District than independent variables. The same applied to the overall contribution of independent and intervening variable in explaining the adoption behavior. The later explain highly compared to former one. It can therefore be concluded that the intervening variables are the best predictors of adoption of phosphate fertilizers in the study area.

(iv) The information about recommended phosphate fertilizer in the study area like type of phosphate fertilizer, rates per acre, rates per hole and method or way of application is not clear.

5.2 Recommendations

From the study conclusion the following recommendations are made.

i. Agriculture stakeholders namely policy makers, administrators, agricultural researchers and extension officers to put more emphasis by involving more women when conducting research or disseminating knowledge on the recommended phosphate fertilizer package on maize production.

ii. More emphasis should be on the efficiency misperception; need tension, awareness, and Prominence factors in order to address the problem of low adoption of phosphate fertilizer package in the study area.

iii. Knowledge regarding the recommended phosphate fertilizer package like type of phosphate fertilizer, rates per acre, rates per hole and method or way of application should be disseminated by policy makers, administrators, agricultural researchers and extension officers to create the awareness and skills that will enable farmers to adopt the recommended phosphate fertilizer package in their maize fields.

iv. Farmer should be given sufficient information by policy makers, administrators, agricultural researchers and extension officers about the optimum level of the recommended phosphate fertilizer package. This can be achieved by conducting trials, demonstration and farmer field schools of the recommended phosphate fertilizer package in their respective maize fields. This will avoid the problem of overrating that was common to majority of none or poor adopters.

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APPENDICES

Appendix 1: Questionnaire

TTITLE: FACTORS INFLUENCING THE ADOPTION OF PHOSPHATE FERTILIZER: A CASE OF MAIZE GROWERS IN HAI DISTRICT

General Instructions to Enumerators

Make brief introduction to each respondents before starting any question, get introduced to the farmers (greet them in the local way) get his / her name; tell them yours, the institutions you are working for, and make clear purpose and objective of study (build rapport). Please fill up the questionnaire according to the respondents reply (do not put your own reply/ feeling). Please ask each question so clearly and patiently until the respondent understands clearly (get your points). Please do not try to use technical terms while discussing with the respondents (use local language for better communication). During the process put the answer of each respondent both on the space provided.

Objectives of the Research

i. To assess the current level of adoption of recommended phosphate fertilizer in selected villages in Hai District.

ii. To determine the independent and intervening factors that influences the adoption of recommended phosphate fertilizers in selected villages in Hai District.

A. General information

Please tick or write the appropriate answer where applicable.

Name of the respondent............................Respondent number ....

Ward..Village...

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

B. Farmers characteristic

1. Sex of the respondent......... 1.Male [ ] 2. Female [ ]

2. How old are you? ....

3. What is your marital status?

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

4. What is number of people in your household? (Actual number) ....

5. What is your highest education level?

1. No education [ ]
2. Primary education [ ]
3. Secondary education [ ]
4. Certificate [ ]
5. Diploma [ ]

6. What is your farm size (in acres) ....

7. A) what area of your farm did you use to grow maize in 2012 season?

....

7. B) **Production efficiency**

(I) what yield (in bags / roba) did you obtain in 2012 season?

Total no. of bags / roba ....

(II) What is the size of the bag/roba............................

(III) Number of bags/acre ....

1) 1 - 7 [ ]

2) 8 - 14 [ ]

3) 15 - 21 [ ]

4) 22 - 28 [ ]

(IV) Were there any natural hazards that affected your yield in the 2012 season?

1. No [ ] 2 Yes [ ]

(V) If yes, what were the hazards?

1) Flood [ ]

2) Drought [ ]

3) Locust [ ]

4) Arm worms [ ]

5) Others (specify)………………………………………………………………..

(VI) a) If your yield was affected what yield do you normally get? (Total number of bags)………….

b) What is the size of the bag/roba…………………

c) Number of bags/acre ……………………………………

1) 1 - 7 [ ]

2) 8 - 14 [ ]

3) 15 - 21 [ ]

4) 22 - 28 [ ]

Perceived current efficiency

(VII) How do you rate on the 4 point scale the efficient of your yield?

(1)	(2)	(3)	(4)

Key: 1. Not efficient 2.Low efficient 3. Efficient 4. Very efficient

Need Tension

(VIII) Do you intend to strive to increase your yield?

1) No [ ] 2) Yes [ ]

(IX) If yes, to what yield level?

a) Total number of bags/roba....................................

b) What is the size of the bag/roba..............................

c) Number of bags/acre ....

1) 1 - 7 [ ]

2) 8 - 14 [ ]

3) 15 - 21 [ ]

4) 22 - 28 [ ]

Need compatibility

(X) a) Do you think high yield can cause any problem to you?

1. No 2. Yes

b) If yes what problems?..

Knowledge

(XI) What is the optimum yield that one can attain when use recommended practices? (Mention them to respondent)

a) Total number of bags/roba.................................

b) What is the size of the bag/roba...........................

c) Number of bags/acre ....

1) 1 - 7 [ ]

2) 8 - 14 [ ]

3) 15 - 21 [ ]

4) 22 - 28 [ ]

C. Adoption of fertilizers

8. Did you use fertilizer in your maize field last season?

1 No [ ]

2Yes [ ]

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	
	Kg / Acre	Total for the farm (Kg)	Kg / Acre	Total for the farm (Kg)
Nil				
TSP				
DAP				
MRP				
CAN				
UREA				
S/A				
FYD/compo				
Others (specify)				

Phosphate fertilizer

9. B) Type of Phosphate fertilizers

(0) None [ ]

(1) NPK [ ]

(2) TSP [ ]

(3) MRP or DAP [ ]

9. C) The rates of phosphate fertilizers (Kg/acre) used

DAP	MRP
(0) Nil	(0) Nil
(1) <10	(1) <20
(2) 10 -19	(2) 20-39
(3) 20 -29	(3) 40-59
(4) 30 –39	(4) 60 – 79
(5) 40 – 49	(5) 80 – 99
(6) $\geq$ 50	(6) $\geq$ 100

9. D) what rate do you apply per whole (gms)

DAP	MRP
(0) Nil	(0) Nil
(1) <2	(1) <4
(2) 2 – 3	(2) 4 – 7
(3) 4 – 5	(3) 8 - 11
(4) 6 – 7	(4) 12 – 15
(5) 8 – 9	(5) 16 - 19
(6) ≥ 10	(6) ≥ 20

9. E) How do you apply phosphate fertilizers

0. None [ ]
1. By mixing with seed [ ]
2. By broadcasting [ ]
3. By mixing with soil [ ]

9. F) Total Phosphate fertilizer assessment

Total adoption score

(0) Nil [ ]

(1) ≤ 10 [ ]

(2) 11 - 17 [ ]

(3) ≥18 [ ]

D. Need related factors

Perceived current efficiency

10. A) How do you rate on the following scale your general level of phosphate fertilizer application efficiency?

Nil (0)	Low (1)	Medium(2)	High (3)

Need Tension

10. B) Do you expect to change the use of phosphate fertilizers in the next season?

0. No [ ]

1. Yes [ ]

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

Type of fertilizers	Planting		Top dressing	
	Kg / Acre	Total for the farm (Kg)	Kg / Acre	Total for the farm(Kg)
Nil				
TSP				
DAP				
MRP				
CAN				
UREA				
S/A				
FYD/compo				
Others (specify)				

10. D) Type of Phosphate fertilizers intended to use

(0) None [ ]

(1) NPK [ ]

(2) TSP [ ]

(3) MRP or DAP [ ]

10. E) The rates of phosphate fertilizers (Kg/acre) intended to use

DAP	MRP
(0) Nil	(0) Nil
(1) ≤10	(1) ≤20
(2) 11 -19	(2) 21-39
(3) 20 -29	(3) 40-59
(4) 30 –39	(4) 60 – 79
(5) 40 – 49	(5) 80 – 99
(6) ≥ 50	(6) ≥ 100

Need Tension

10. B) Do you expect to change the use of phosphate fertilizers in the next season?

0. No [ ]

1. Yes [ ]

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

Type of fertilizers	**Planting**		**Top dressing**	
	Kg / Acre	**Total for the farm (Kg)**	**Kg / Acre**	**Total for the farm(Kg)**
Nil				
TSP				
DAP				
MRP				
CAN				
UREA				
S/A				
FYD/compo				
Others (specify)				

10. D) Type of Phosphate fertilizers intended to use

(0) None [ ]

(1) NPK [ ]

(2) TSP [ ]

(3) MRP or DAP [ ]

10. E) The rates of phosphate fertilizers (Kg/acre) intended to use

DAP	**MRP**
(0) Nil	(0) Nil
(1) ≤10	(1) ≤20
(2) 11 -19	(2) 21-39
(3) 20 -29	(3) 40-59
(4) 30 –39	(4) 60 – 79
(5) 40 – 49	(5) 80 – 99
(6) ≥ 50	(6) ≥ 100

10. F) What rate do you intend to apply per whole (gms)

DAP	MRP
(0) Nil	(0) Nil
(1) <2	(1) <4
(2) 2 – 3	(2) 4 – 7
(3) 4 – 5	(3) 8 - 11
(4) 6 – 7	(4) 12 – 15
(5) 8 – 9	(5) 16 - 19
(6) $\geq$ 10	(6) $\geq$ 20

10. G) How do you intend to apply phosphate fertilizers

0. None [ ]
1. By mixing with seed [ ]
2. By broadcasting [ ]
3. By mixing with soil [ ]

10. H) Total Phosphate fertilizer assessment

(0) Nil [ ]

(1) $\leq$ 10 [ ]

(2) 11 - 17 [ ]

(3) $\geq$18 [ ]

E. Knowledge

11. A) what are the recommended fertilizers and the recommended rates of application in your area? (Fill in the table below).

Type of fertilizers	Planting		Top dressing	
	Kg / Acre	Total for the farm (Kg)	Kg / Acre	Total for the farm (Kg)
Nil				
TSP				
DAP				
MRP				
CAN				
UREA				
S/A				
FYD/compo				
Others (specify)				

11. B) Awareness of the recommended types of phosphate fertilizers

(0) None [ ]

(1) NPK [ ]

(2) TSP [ ]

(3) MRP or DAP [ ]

11. C) Awareness of the recommended rates of phosphate fertilizers (Kg/acre) used

DAP	MRP
(0) Nil	(0) Nil
(1) ≤10	(1) ≤20
(2) 11 -19	(2) 21-39
(3) 20 -29	(3) 40-59
(4) 30 –39	(4) 60 – 79
(5) 40 – 49	(5) 80 – 99
(6) ≥ 50	(6) ≥ 100

11. D) What is the recommended rate of Phosphate fertilizers per whole? (gms)

DAP	MRP
(0) Nil	(0) Nil
(1) <2	(1) <4
(2) 2 – 3	(2) 4 – 7
(3) 4 – 5	(3) 8 - 11
(4) 6 – 7	(4) 12 – 15
(5) 8 – 9	(5) 16 - 19
(6) ≥ 10	(6) ≥ 20

11. E) What is the recommended method of Phosphate fertilizers application?

0. None [ ]

1. By mixing with seed [ ]

2. By broadcasting [ ]

3. By mixing with soil [ ]

11. F) Awareness of recommended total phosphate fertilization assessment

(0) Nil [ ]

(1) ≤ 10 [ ]

(2) 11 - 17 [ ]

(3) ≥ 18 [ ]

Need compatibility

12. A) (For those who used the recommended phosphate fertilization)

You told me that your yield was.......................................bags

(i) What do you think it would have been if you had not used any phosphate fertilizers?

....

12. B) For those who did not fully use the recommended phosphate fertilization;

(i) What do you think it would have been if you had used the recommended type and rates of phosphate fertilization?

....

(ii) What do you think it would have been if you had used no phosphate fertilizer at all?

....

(iii) Why don't you adopt the recommended phosphate fertilization?

....

Nitrogen fertilizer

13. A) Type of Nitrogen fertilizers

(0) None [ ]

(1) S/A [ ]

(2) UREA or CAN [ ]

13. B) Please indicate the rate and the time when Nitrogen fertilizers are used? (Kg/acre)

UREA	CAN
(0) Nil	(0) Nil
(1) ≤10 as top dressing	(1) ≤20 as top dressing
(2) 11 -19 as top dressing	(2) 21-39 as top dressing
(3) 20 -29 as top dressing	(3) 40-59 as top dressing
(4) 30 – 39 as top dressing	(4) 60 – 79 as top dressing
(5) 40 – 49 as top dressing	(5) 80 – 99 as top dressing
(6) ≥ 50 as top dressing at knee height – For those use DAP at planting 50 at planting and 50 as top dressing at knee height – for those use MRP at planting	6) ≥ 100 as top dressing at knee height – For those use DAP at planting 50 (urea) at planting and 100 (CAN) as top dressing at knee height for those use MRP at planting

13. C) Total Nitrogen fertilizer assessment

Total adoption score

(0) Nil [ ]

(1) ≤ 4 [ ]

(2) 5 - 7 [ ]

(3) ≥ 8 [ ]

13. D) Total fertilizer application (phosphate and nitrogen fertilizers)

Total adoption score

(0) Nil [ ]

(1) ≤ 13 [ ]

(2) 14 - 25 [ ]

(3) ≥26 [ ]

Need related factors

Perceived current efficiency

14. A) How do you rate on the following scale your general level of nitrogen fertilizer application efficiency?

Nil (0)	Low (1)	Medium(2)	High (3)

14. B) How do you rate on the following scale your general level of total fertilization efficiency?

Nil (0)	Low (1)	Medium(2)	High (3)

Need Tension

15. A) Do you expect to change the rate of nitrogen fertilizers in the next season

0. No [ ]

1. Yes [ ]

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

Type of fertilizers	Planting		Top dressing	
	Kg / Acre	Total for the farm (Kg)	Kg / Acre	Total for the farm (Kg)
Nil				
TSP				
DAP				
MRP				
CAN				
UREA				
S/A				
FYD/compo				
Others (specify)				

15. C) Type of Nitrogen fertilizers intended to use

(0) None [ ]

(1) S/A [ ]

(2) UREA or CAN [ ]

15. D) Rate and the time of Nitrogen fertilizers (Kg/acrer) intended to use

UREA	CAN
(0) Nil	(0) Nil
(1) ≤10 as top dressing	(1) ≤20 as top dressing
(2) 11 -19 as top dressing	(2) 21-39 as top dressing
(3) 20 -29 as top dressing	(3) 40-59 as top dressing
(4) 30 – 39 as top dressing	(4) 60 – 79 as top dressing
(5) 40 – 49 as top dressing	(5) 80 – 99 as top dressing
(6) ≥ 50 as top dressing at knee height – For those use DAP at planting 50 at planting and 50 as top dressing at knee height – for those use MRP at planting	6) ≥ 100 as top dressing at knee height – For those use DAP at planting 50 (urea) at planting and 100 (CAN) as top dressing at knee height for those use MRP at planting

15. E) Total Nitrogen fertilizer intended to use assessment

(0) Nil [ ]

(1) ≤ 4 [ ]

(2) 5 - 7 [ ]

(3) ≥ 8 [ ]

15. F) Total fertilizer intended to use (phosphate and nitrogen fertilizers)

(0) Nil [ ]

(1) ≤ 13 [ ]

(2) 14 - 25 [ ]

(3) ≥26 [ ]

Need compatibility

16. A) (For those who used the recommended nitrogen fertilization ;)

You told me that your yield was..bags

(i) What do you think it would have been if you had not used any nitrogen fertilizers?

....

....

16. B) For those who did not fully use the recommended nitrogen fertilization;

(i) What do you think it would have been if you had used the recommended type and rates of nitrogen fertilization?

....

(ii) What do you think it would have been if you had used no nitrogen fertilizer at all?

....

(iii) Why don't you adopt the recommended nitrogen fertilization?

....

16. C) (For those who used the recommended fertilization (phosphate and nitrogen)

You told me that your yield was..bags

(i) What do you think it would have been if you had not used any fertilizers?

....

16. D) For those who did not fully use the recommended fertilization; (phosphate and nitrogen)

(i) What do you think it would have been if you had used the recommended type and rates of total fertilization? (Phosphate and nitrogen)

....

(ii) What do you think it would have been if you had used no fertilizer at all?

....

(iii) Why don't you adopt the recommended total fertilization? (Phosphate and nitrogen)

....

Knowledge

17. A) Awareness of the recommended type of Nitrogen fertilizers

(0) None [ ]

(1) S/A [ ]

(2) UREA or CAN [ ]

17. B) Awareness of recommended rate and the time for application of Nitrogen fertilizers (Kg/acre)

UREA	CAN
(0) Nil	(0) Nil
(1) ≤10 as top dressing	(1) ≤20 as top dressing
(2) 11 -19 as top dressing	(2) 21-39 as top dressing
(3) 20 -29 as top dressing	(3) 40-59 as top dressing
(4) 30 – 39 as top dressing	(4) 60 – 79 as top dressing
(5) 40 – 49 as top dressing	(5) 80 – 99 as top dressing
(6) ≥ 50 as top dressing at knee height – For those use DAP at planting 50 at planting and 50 as top dressing at knee height – for those use MRP at planting	6) ≥ 100 as top dressing at knee height – For those use DAP at planting 50 (urea) at planting and 100 (CAN) as top dressing at knee height for those use MRP at planting

17. C) Awareness of recommended total Nitrogen fertilization assessment

(0) Nil [ ]

(1) ≤ 4 [ ]

(2) 5 - 7 [ ]

(3) ≥ 8 [ ]

17. D) Awareness of recommended total fertilization assessment (phosphate and nitrogen)

(0) Nil [ ]

(1) ≤ 13 [ ]

(2) 14 - 25 [ ]

(3) ≥26 [ ]

Perception: Prominence

18. A) what in your view is the best fertilization (type, rate and time of application?)

Type of fertilizers	**Planting**		**Top dressing**	
	Kg / Acre	**Total for the farm (Kg)**	**Kg / Acre**	**Total for the farm (Kg)**
Nil				
TSP				
DAP				
MRP				
CAN				
UREA				
S/A				
FYD/compo				
Others (specify)				

18. B) Type of Nitrogen fertilizers

(0) None [ ]

(1) S/A [ ]

(2) UREA or CAN [ ]

18. C) What in your view is the best rate and the time for application of Nitrogen fertilizers? (Kg/acre)

UREA	CAN
(0) Nil	(0) Nil
(1) ≤10 as top dressing	(1) ≤20 as top dressing
(2) 11 -19 as top dressing	(2) 21-39 as top dressing
(3) 20 -29 as top dressing	(3) 40-59 as top dressing
(4) 30 – 39 as top dressing	(4) 60 – 79 as top dressing
(5) 40 – 49 as top dressing	(5) 80 – 99 as top dressing
(6) ≥ 50 as top dressing at knee height – For those use DAP at planting 50 at planting and 50 as top dressing at knee height – for those use MRP at planting	6) ≥ 100 as top dressing at knee height – For those use DAP at planting 50 (urea) at planting and 100 (CAN) as top dressing at knee height for those use MRP at planting

18. D) The best total Nitrogen fertilization assessment

(0)	Nil	[ ]
(1)	≤ 4	[ ]
(2)	5 - 7	[ ]
(3)	≥ 8	[ ]

18. E) The best total fertilization assessment (phosphate and nitrogen)

(0)	Nil	[ ]
(1)	≤ 13	[ ]
(2)	14 - 25	[ ]
(3)	≥26	[ ]

"THANK YOU FOR YOUR COOPERATION"