The comparative role of intervening and independent variables in the adoption behaviour of maize growers in Njombe District, Tanzania

by

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ABSTRACT

The ongoing quest for a better understanding of adoption behaviour, and more specifically the search for relevant, and meaningful behaviour determinants that can be useful in the understanding, analysis and change of adoption behaviour, has prompted this study. It was specifically focused on the role of intervening variables and their influence relative to the commonly used independent variables. A pre-tested, structured questionnaire was used to collect data from 113 farmers randomly selected to represent five percent samples of four villages selected to represent the biggest variation in terms of climatic conditions within the Njombe district of Tanzania. Correlations, chi-square, and regressions were used to determine the relationship between the independent and the dependent variables. The results show that most of the farmers' (97.3 percent) production efficiency falls well below the optimum maize yield of about 40 bags per acre. Various independent and intervening factors were found to influence adoption. In general, the intervening variables show, without exception, much stronger influence relationships with adoption behaviour than is the case with independent variables. Also, unlike what is a common phenomenon among independent variables, these relationships show great consistency, which further supports the research hypothesis. The most convincing evidence in support of the critical role of intervening variables in decision making and adoption behaviour are the regressions, which explain about 73.2 to 93.6 percent of the variation in adoption as compared to the mere 6.0 to 32.9 percent of the independent variables. The explanation for this highly significant difference is that the intervening variables are probably the immediate and direct determinants of adoption behaviour and that the influence of intervening variables only becomes manifested in adoption behaviour via the intervening variables. This explains why the influence of independent variables is much smaller and more inconsistent than that of the intervening variables. The practical implications of these findings are that the emphasis in the analysis and understanding of adoption behaviour should be on the intervening variables. They lend themselves as so-called "forces of change" and thus represent the focus of extension endeavours, but also as criteria for evaluation and monitoring. From the study arise various issues that call for further research like refinement of the measurements.

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ABBREVIATIONS AND SYMBOLS

DALDO	District agricultural and livestock development officer
H	Hybrid
UH	Uyole hybrid
P	Pioneer hybrid
TARO	Tanzania agricultural research organization
TSP	Tri-super phosphate
DAP	Di-ammonium phosphate
MRP	Minjingu rock phosphate
CAN	Calcium ammonium nitrate
NPK	Nitrogen Phosphate Potassium
FYM	Farm yard manure
FAO	Food and agriculture organization
EM	Efficiency misperception
NT	Need tension
NC	Need compatibility
n	Number
N	Total number
Kg	Kilogram
cm	Centimeter
%	Percentage
χ^2	Chi-square
r	Pearson's correlation
p	Probability
df	Degree of freedom
R^2	Regression coefficient

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DEDICATION

This work is dedicated to my precious mother, Hulda Phillip and my beloved brother Winston Phillip who laid the foundation of my education.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Agriculture is the backbone of the Tanzanian economy accounting for about half of the national income and slightly more than half of merchandise exports. Also, about 80 percent of Tanzanians depend on agriculture as a source of food requirements (World Bank, 2001). This implies that progress in reducing poverty, malnutrition and food insecurity in Tanzania depends greatly on the performance of the agricultural sector.

The issue of improving agriculture in order to increase its productivity has been given due weight and attention in Tanzania. For example; after the independence in 1961, the government adopted a number of approaches towards agricultural development. These approaches include the Transformation Approach (1962-1966), the Improvement Approach (1963-1966), the Commodity Approach (1978-1983); while various projects were initiated such as the Sasakawa Global 2000 (1989-1998), the National Agricultural Extension Program (NALERP-1989-1996), the Southern Highlands Extension and Rural Finance Project (1994-2001), the National Agricultural Extension Project Phase II (NAEP-1996-2001), and the FAO Special Program for Food Security (1995 to – date) (Sicilima and Rwenyagira, 2001).

The main cash crops grown in the country include coffee, sisal, cashew, cotton, tobacco and pyrethrum. While the main food crops include maize, sorghum, millet, rice, wheat, pulses (mainly beans), cassava, potatoes and banana. Among these food crops, maize is the most important cereal food crop. This implies that, a shift towards self-sufficiency in food production in Tanzania depends to a greater extent on the improvement of maize production.

Njombe district is one of the districts that is famous for the production and supply of maize in the country. Most of the extension programmes like Sasakawa Global 2000 and others that had the purpose of promoting maize production practices in a package form, were initiated and introduced in areas particularly suited for maize production, like Njombe district. A package consists of the combined use of recommended maize varieties, fertilizers, seed spacing, pesticides application and weed control. Although many practices are recommended, few have been adopted by farmers, as a result low production efficiency has been a common phenomenon (Sicilima and Rwenyagira, 2001).

1.2 PROBLEM STATEMENT

Reasons for the non- or poor adoption of recommend practices have been associated with independent factors like farmers' characteristics and socio-economic, institutional and environmental factors (Rogers, 1983; Okoye, 1989; Anosike and Coughenour, 1990; Obinne, 1991; CIMMYT, 1993; Lugeye, 1994; Machumu, 1995). Due to the inconsistency of the findings as regards the relationship between independent variables and the adoption behaviour, other researchers (Düvel, 1975; Botha, 1985; Düvel and Scholtz, 1986; Koch, 1986; Koch, 1987; Düvel, 1995; Habtemariam, 2004) argue that the intervening variables namely; needs, knowledge and perception are the more direct and immediate precursors of the adoption behaviour. These opposing or even contradicting findings call for further investigations. In view of this, this study is designed with the main aim of comparing the role of independent and intervening variables in predicting the adoption behaviour among the maize growers in the Njombe district.

1.3 OBJECTIVES OF THE STUDY

The general objective of this study is to compare the independent and intervening variables with regard to their influence on the adoption behaviour of recommended maize production practices by maize growers in the Njombe district. Specifically, the study intends:

1. To establish the extent to which the recommended maize production practices are adopted by the farmers

2. To determine the current level of production efficiency which is assumed to be the consequence of the adoption of the various recommended practices.

3. To examine the influence of adoption behaviour on production efficiency attained

4. To evaluate the influence of independent variables on farmers' adoption behaviour in respect of each of the recommended practices

5. To determine the influence of intervening variables on farmers' adoption behaviour in respect of each of the recommended practices

6. To assess the comparative contribution of independent and intervening variables in prediction of the adoption behaviour.

7. To highlight the implication of the findings for future policy, research and extension interventions.

1.4 HYPOTHESES OF THE STUDY

Against the theoretical background, different models and empirical studies reviewed (see chapter 2), the following research hypotheses emerge:

1. The maize production efficiency is a function of the adoption of recommended maize production practices

2. The adoption of recommended maize production practices is influenced by the independent variables like farmer's age, sex, formal education and farm size. More specifically;

   2.1 Age of the respondents is negatively related to the adoption behaviour

2.2 The adoption of recommended maize production practices is higher among men than among women respondents' farmers

2.3 Farmers' formal education has a positive influence on adoption behaviour

2.4 The adoption level is higher among farmers with large farm sizes than those with small farms

3. The adoption of recommended maize production practices is influenced by the needs and perception related intervening variables like farmer's needs and perception, and more specifically;

3.1 the degree to which the own efficiency of adoption is overrated

3.2 the perceived compatibility of recommended maize production practices with needs (e.g. higher production efficiency or yields);

3.3 the perception of the attributes of maize production practices, namely

3.3.1 the overall prominence of the recommended practices relative to other alternatives;

3.3.2 the awareness of relative advantages of recommended maize production practices as is reflected in their number and strength;

3.3.3 the awareness of disadvantages of maize production practices, in the sense that the bigger the concern, reflected in the number and strength of disadvantages, the lower the level of adoption;

3.3.4 the imbalance of positive over negative forces, being the difference between positive and negative forces reflected both in numbers and strength.

4. The influence of intervening variables on adoption behaviour is higher than that of independent variables

1.5 SIGNIFICANCE OF THE STUDY

Although the study focuses on maize production and the adoption behaviour of maize farmers, the significance of the study goes well beyond it. In Tanzania's quest for food self-sufficiency and improved production efficiency, the behaviour insights gained from this study can prove useful not only for maize production but for extension in all fields of agriculture. Regarding maize production, the recommended production packages can be assessed in terms of their appropriateness regarding the production and economic performance as well as in terms of their acceptability by farmers (farmers adoption behaviour).

The results of this study can, therefore, provide a useful guide for policy formulation, identification of research priorities and for improving extension approaches, strategies and programs., This will enhance adoption of recommended packages and subsequently increase agricultural production efficiency, which is the primary objective of the country.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews the various models of behaviour change and also the empirical studies conducted in the area of independent and intervening variables in determining adoption behaviour. The review provides a theoretical background that facilitates in formulation of research hypotheses and determines the conceptual model and research focus of this study.

2.1 MODELS OF BEHAVIOUR CHANGE

According to Berelson and Steiner (1964) human behaviour is far more variable and therefore less predictable. The range of behaviour available to any given man, as well as the range that exists across men, is far broader than anywhere else in the animal kingdom. This is due to the fact that human behaviour is more dependent upon learning and less regulated by instinct or other innate behavioural predispositions than the behaviour of lower animals. Albert Einstein is quoted by Jacobsen (1983) to have said: "It is harder to understand the behaviour of human beings than to understand that of atoms" (Düvel, 1991).

Due to the complex nature of human behaviour various theories and models have been developed in an attempt to understand and predict human behaviour. Some of these theories and models include the Traditional Approaches, the Classical 5-Stage Adoption process, the Campbell Model, the Innovation Decision-Making process, the field theory, the Tollman-Model, the Theory of Reasoned action, and Düvel's Behaviour Analysis model. These models will be discussed briefly.

2.1.1 Traditional Approach

In a critical analysis of adoption research development, Albrecht (1964) as quoted by Düvel (1991), identified five distinguishable approaches. These are the teaching method approach, socio-cultural approach, atomistic communication approach, socio-structural communication approach and situational-functional approach.
In all approaches, except the last, generalisations are made regarding the influence of certain categories of variables, but these could not be upheld. The distinct contribution of the situational-functional approach lies in the fact that behaviour change is not regarded as the cause of a single factor like methodology of teaching, cultural ties or communication, but rather the function of an interplay of a number of dynamic inter-dependent factors making up the situation (Düvel, 1991).

2.1.2 The 5-Stage or "Classical" adoption Process

Wilkening (1953) and Bohlen (1957) as quoted by Semgalawe (1998), maintain that, consciously or unconsciously, every person goes through certain mental steps during the learning process. Based on this and other research findings the North Central Rural Committee (1961) developed a model consisting of five stages that an individual passes through before complete adoption of an innovation (Düvel, 1991). These are:

1. Awareness: The individual gets to know about the existence of the innovation but has little or no information about it.

2. Interest: The individual becomes interested in the idea and seeks more information about it.

3. Evaluation: The individual mentally applies the innovation to his present and anticipated future situation, and then decides whether or not to try it.

4. Trial: The individual uses the innovation on a small scale in order to determine its utility in his own situation. He may seek specific information about the method of using the innovation at the trial stage.

5. Adoption: At this stage the individual decides to continue the full use of the innovation.

However, the classical adoption process model has been criticized from various quarters, with the main criticism being that the process does not necessarily begin with an awareness of an innovation, that it does not provide for non-rational processes, that the evaluation can take place at different stages and that it does not necessarily end with adoption as the adoption process implies.

2.1.3 The Campbell-Model

Based on the criticisms of the 5-stage of classical adoption process, Campbell (1966) came up with a new model with significant modifications to the above. According to him the process can start by the awareness of a problem, or the awareness of an innovation, which may create a problem or dissonance. He thus made a distinction between problem-oriented decisions and innovation - oriented decisions another adaptation he made is provision for the fact that adoption decisions can be rational or non-rational. By combining the various alternatives, he came up with four types within the adoption process (Fig 2.1).

In each type, he also proposed various stages that an individual can pass as follows:

1. Rational – Problem oriented type
Stages: i) Problem ii) Awareness iii) Evaluation iv) Rejection or Trial v) Adoption or rejection

2. Rational - Innovation oriented
Stages: i) Awareness ii) Interest iii) Evaluation iv) Rejection or Trial v) Adoption or rejection

3. Non - Rational – Problem – Oriented
Stages: i) Problem ii) Awareness iii) Adoption or Rejection iv) Resolution (Including information seeking)

4. Non- Rational –Innovation- Oriented

Stages: i) Awareness ii) Adoption or Rejection iii) Resolution (Including information seeking).

However, most decisions do not fall clearly into the extremes of either of the two dichotomies. A typical process may have elements of rationality – non-rationality and problem solving and innovation orientation in it. This means the majority of decisions fall somewhere in between the four extreme points. The four points can be used as heuristic devices from which to measure actual decisions (Campbell, 1966).

Although the model explains the possible steps that an individual can pass through in the process of adopting an innovation the emphasis is still on how change occurs rather than on how it can be brought about. However, Campbell's (1966) main contribution, namely that the process is initiated by the awareness of a problem, must be honoured and was a significant step forward.

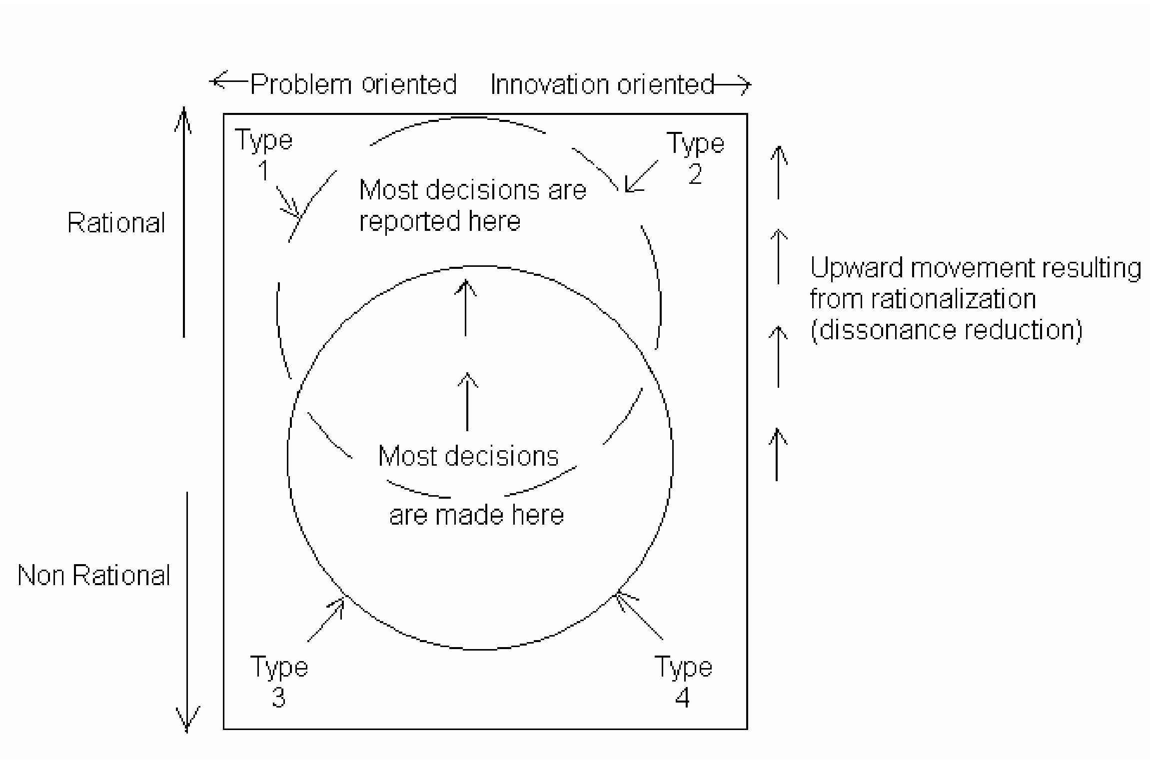

Figure 2. 1: A paradigm of Individual decision-making and adoption (Campbell, 1966)

2.1.4 The Innovation - Decision Process Model

In response to earlier models and the criticism leveled against them, Rogers (1983) developed the innovation-decision process as the process through which an individual (or other decision making unit) passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision.

He proposed five stages (Fig 2.1) that an individual or other decision-making unit passes through in the process of innovation adoption:

1) Knowledge: Occurs when an individual (or other decision-making unit) is exposed to the innovations existence and gains some understanding of how it functions.

2) Persuasion: Occurs when an individual (or other decision-making unit) forms a favorable or unfavorable attitude toward the innovation

3) Decision: Occurs when an individual (or other decision-making unit) engages in activities that lead to a choice to adopt or reject the innovation

4) Implementation: Occurs when an individual (or other decision-making unit) puts an innovation into use.

5) Confirmation: Occurs when an individual (or other decision making unit) seeks reinforcement of an innovation decision already made, but he or she may reverse this previous decision if exposed to conflicting messages about the innovation.

In his model, Rogers (1983) recognizes the importance of felt needs or problems in adoption behaviour but they fall under "prior conditions" rather than being critical or key dimension in behaviour change (Düvel, 1991). However, Rogers is not clear on whether needs or awareness of the innovation initiate the process or whether it is the knowledge of an innovation or new idea. He referred to this as a chicken or egg problem.

As far as the stages are concerned, Van den Ban and Hawkins (1988) point out that the innovation – decision process does not always follow this sequence in practice and also that there is insufficient evidence to prove these stages of innovation decision exist. Rogers (1983) solved the problem of the sequence of the phases, by reducing them to only two before decision-making. However this does not offer much help as a guide to bring about change and is a further model that only explains how change takes place (Düvel, 1991).

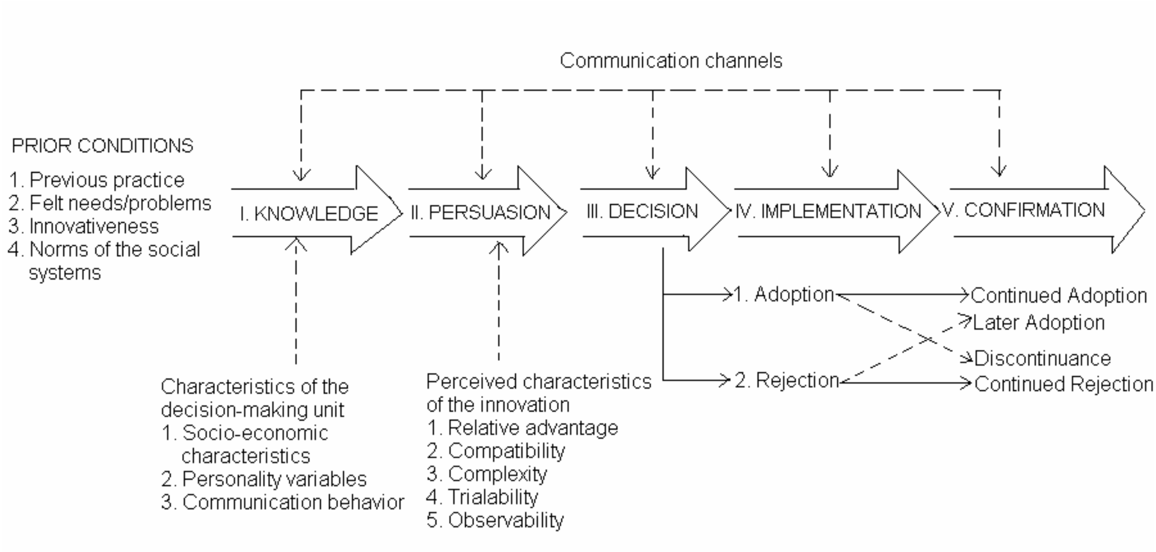

Figure 2. 2: A model of stages in the innovation-decision process (Rogers, 1983)

2.1.5 The psychological field theory of Lewin

In order to use scientific constructs in the dynamic analysis of behaviour, field theory holds that the analysis must begin with the situation as a whole. This means, instead of beginning with isolated elements of the situation and later attempting to organize them into an integrated system, field theory begins with a description of the situation as a whole. Therefore the most fundamental construct in Lewin's theory is the Life space (psychological field). The life space of an individual consists of the person and the psychological environment, as it exists for him. It is the totality of all psychological factors that influence the individual at any given moment (Shaw and Costanzo, 1970).

Hruschka (1969), quoted by Düvel (1991), identified the field theory of Lewin (1951) and made it accessible as probably the most appropriate for extension purposes. The most relevant and important features and principles of Lewin's (1951) theory making it useful as a conceptual framework for understanding and bringing about behaviour change are the following:

1. The basic motivation of every organism is to maintain equilibrium

2. A disturbed equilibrium is experienced as a need tension, that is a felt need to reduce the tension. In this state the person tends to mobilize forces or energy to reduce the tension and to re-establish a new equilibrium under the given conditions.

3. The re-establishment of equilibrium takes the form of movement (locomotion), physical or psychological, which continues until the equilibrium has been reestablished. The effects of a felt tension on perception, cognition and action are therefore such as to change the field in order to restore the tension-reduced situation.

4. Anything in the situation that is perceived by the person as a goal or as a path or barrier to a goal is understood as a force operating on the person's behaviour. This force can be positive or negative.

5. Behaviour (B) is a function of the person (P) in the perceived environment (E).

B-f (P, E)

6. There is no fixed, invariable relation between stimulus and response.

7. The factors of both the environment and the personality can become behavioural determinants. Thus the same facts and objects of the environment or personality may cause different actions

8. The co-existing forces are dynamically interdependent constituting the so called force field which is subjective, time specific and determines behaviour

9. Change or the lack thereof, is, in principle, explainable by the same concept: namely the constellation of interacting forces. Change can be brought about and directed by changing the force field, i.e. by adding or strengthening driving forces (positive forces) and/ or by eliminating or weakening restraining forces (negative forces).

Düvel (1991) points out the advantages of the field theory of behaviour for practical purposes as follows:

1. It provides a concept in terms of which the complexity of any real life situation, in respect of behaviour relevant factors can be analyzed

2. The theory is not limited to change but also explains non-change. It provides guidelines not only for situation analysis explaining behaviour but also for planning change and for evaluation

3. It is useful also for analysis of greater social units as groups of clients, organizations and also for planning change with them

4. It is easy to understand

5. It is an interdisciplinary theory, which is not confined to any one of the disciplines of the social sciences.

As compared to other behaviour models that focused mainly on explaining the process of behaviour change, the field theory of Lewin provides guidelines as to how behaviour change can be brought about. Its sound theoretical basis also represents a foundation for further models like those of Tolman (1967) and Düvel (1991). However, the field theory does not distinguish between the critical or immediate and relatively less important behaviour determinants.

2.1.6 The Tolman Model

Tolman's theory seems to be a successful combination of the majority of more modern theories and accommodates many of the principles that apply in Lewin's field theory. Tolman (1932) cited by Düvel (1994) contends that the resemblance between the theories of Tolman and Lewin is evident from the following corner stones of Tolman's model:

1. Behaviour is intentional that is behind the specific behaviour or action, there must be a reason of motive

2. Behaviour is governed by expectancies about the environment. These expectations are based on either observations of specific stimulus situations (sense perception) or on earlier experiences, which present the individual with an idea as to which methods (means) should be used in order to achieve the one or other goal (memory trace arousal)

3. The immediate precursor to action is the "behaviour space"; defined as "a particularized complex of perceptions (memories and inferences) as to objects and relations" and the "behaving self", evoked by the given environmental stimulus situation and by a controlling and activated behaviour-value matrix and implies a mental vicarious trial-and-error behaviour. The objects can have positive or negative valences.

Tolman (1951) differentiates according to his model, three sets of variables, namely the independent, the dependent and the intervening variables (Fig 2.3). He defined the independent variables as the initiating causes of the individual's action.

The dependent variables are conceived as consisting of responses which, from the point of view of a purely physiological analysis, are merely combinations of verbal, skeletal, and visceral reactions; but which from the point of the present action schema are identified and defined not in terms of their underlying physiology but in terms of their "action meanings".

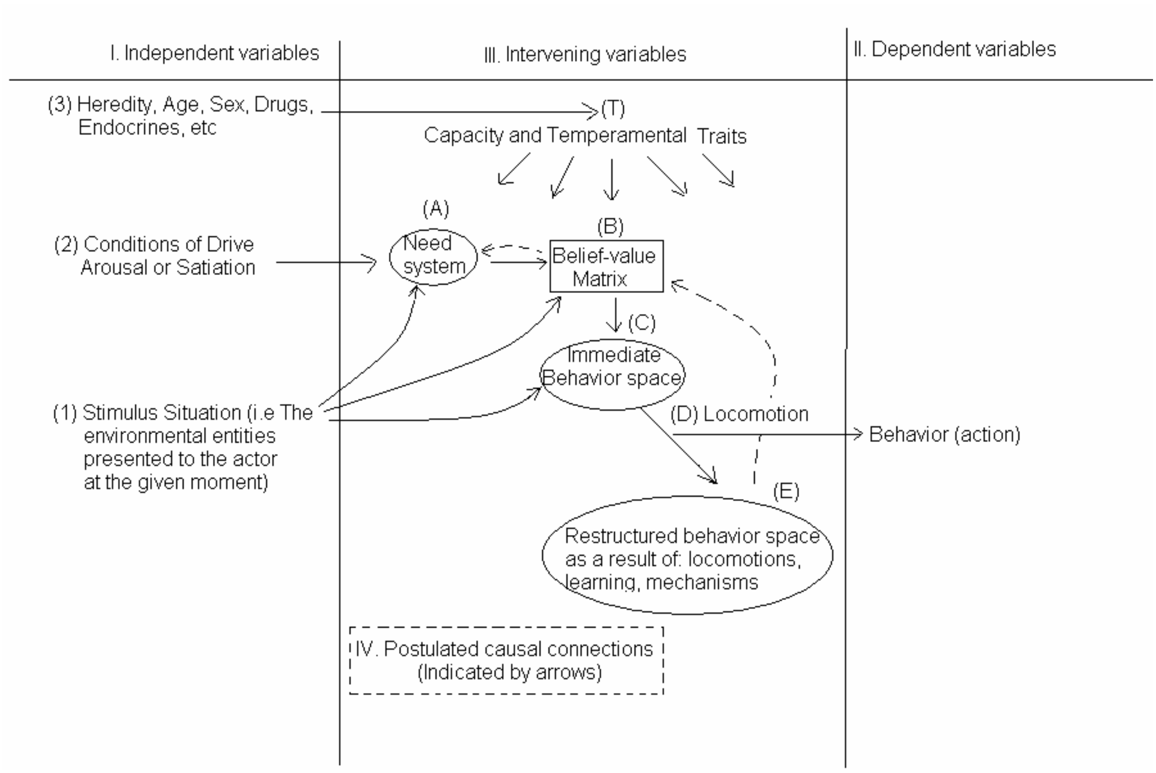

Figure 2. 3: The Tolmans Model (Source: Tolman, 1951)

The intervening variables are postulated explanatory entities conceived to be connected by one set of causal functions to the independent variables, on the one side, and by another set of functions to the dependent variable of behaviour, on the other (Tolman, 1951). Both independent and dependent variables are regarded as observable while intervening variables are not accessible to observation.

Although his model has been criticized for his intervening variables to be invisible and difficult to measure, the contribution of Tolman's model is appreciated for associating the intervening variables (field forces in case of Lewin's model) with the immediate causes of the behaviour (Düvel, 1991).

2.1.7 The Theory of Reasoned Action (Ajzen and Fishbein , 1980).

The theory is based on the assumption that human beings are usually quite rational and make systematic use of the information available to them. The theory argues that people consider the implications of their actions before they decide to engage or not to engage in a given behaviour (Ajzen and Fishbein, 1980).

Beliefs are the fundamental building blocks of the authors conceptual model (Fig 2.4). That is the totality of a persons belief serves as the informational base that ultimately determines his attitudes, intentions, and behaviours (Fishbein and Ajzen, 1975). Generally a person forms beliefs about an object by associating it with various characteristics, qualities and attributes and automatically and simultaneously acquires an attitude toward that object (Ajzen and Fishbein, 1980). This means a person who believes that performing a given behaviour will lead to mostly positive outcomes will hold a favorable attitude toward performing the behaviour, while a person who believes that performing the behaviour will lead to mostly negative outcomes will hold an unfavorable attitude toward performing the behaviour (Ajzen and Fishbein, 1980). Knowledge of a person's belief and attitude, therefore, permits prediction of one or more specific behaviours (Fishbein and Ajzen, 1975).

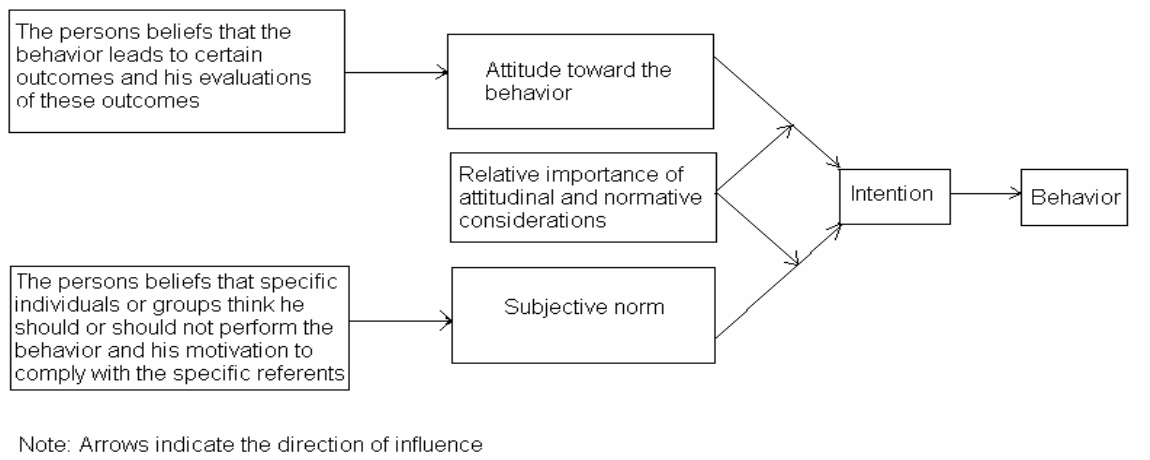

Figure 2. 4: Factors determining a person's behaviour (Fishbein and Ajzen, 1975)

The theory views a person's intention to perform (or to not perform) a behaviour as the immediate determinant of the action. On the other hand, a person’s intention is a function of attitude toward the behaviour (the individual’s positive or negative evaluation of performing the behaviour) and subjective norm (social influence on ones attitude).

In contrast to most other approaches of behaviour analysis, their approach has not attempted to explain behaviour by referring to external variables (Independent variables) like personality traits, attitudes toward people or institutions, or demographic variables. However they appreciate that the external variables can affect behaviour only indirectly (Fig 2.4). That is, external variables will be related to behaviour only if they are related to one or more of the variables specified by the theory (Ajzen and Fishbein, 1980).

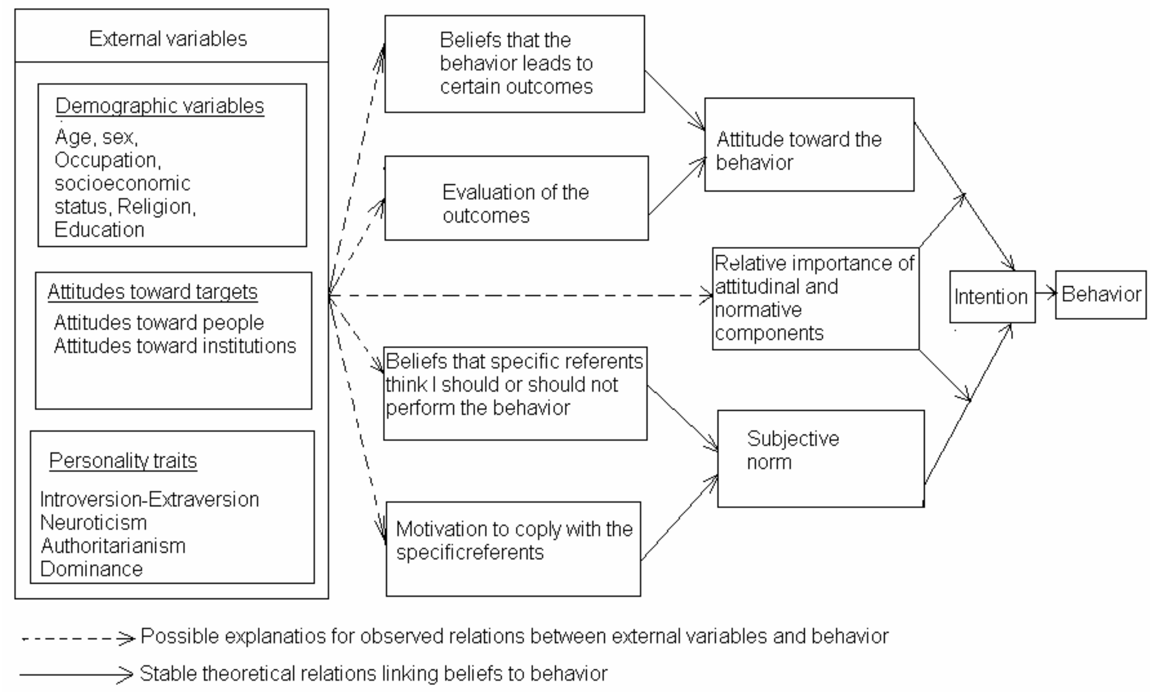

Figure 2. 5: Indirect effects of external variables on behaviour (Ajzen and Fishbein, 1980)

Of the view that independent variables have only an indirect influence is similar to that of Tolman (1951) and Düvel (1991). Also the concept of invisible nature of behaviour determinants is similar to Tolman's (1951) concept of intervening variables as being covert constructs. However, Fishbein and Ajzen did not touch on some of the salient features of Tolman's (1951) and Lewin's (1951) behaviour space, while the variety of intervening variables is limited and less appropriate for purposes of adoption behaviour.

On closer analysis of the theory, some of the concepts like beliefs and attitudes seem to overlap with concept of perception in Düvel's (1991) model. This is due to the fact that in an attempt to measure attitudes toward an object, the first step involves identification of a set of attributes relevant for that object as a result of which a favourable or unfavourable attitude is formed toward the object (Fishbein and Ajzen, 1975). On the other hand Düvel (1991) analyzed perception on the basis of attributes of an innovation like relative advantages, prominence and compatibility with the situation, which indicates a similarity between the concepts.

2.1.8 Düvel's Model for Behaviour Analysis and change.

According to Düvel (1991), any model or theory, in order to be acceptable, must make provision for the complexity and variability of human behaviour. This is the case where behaviour is regarded as a function of an extensive number of dynamically interdependent personal and environmental factors, which, depending on the situation can potentially become functional in various combinations and directions. Based on Lewin's psychological field forces and Tolman's concepts of intervening variables, Düvel (1991) formulated the model of behaviour analysis and change. His great concern was to find a basis whereby the great number of variables already found to have been correlated with behaviour, could be effectively reduced to a checklist that is surveyable and still sufficiently comprehensive to directly or indirectly make provision for all causes of behaviour.

Influenced by Tolman's concept of intervening variables, he achieved this by concentrating on those variables or determinants that are the most immanent and direct fore-runners of behaviour, namely the intervening variables (Düvel, 1991) and argues that they can be associated with the forces of change (Lewin, 1951), while the independent personal and environmental factors have an influence on these forces, but do not represent forces as such. These behaviour determinants and their influence relationship in the context of behaviour change and the results of behaviour change are illustrated in the following diagram (Fig. 2.6).

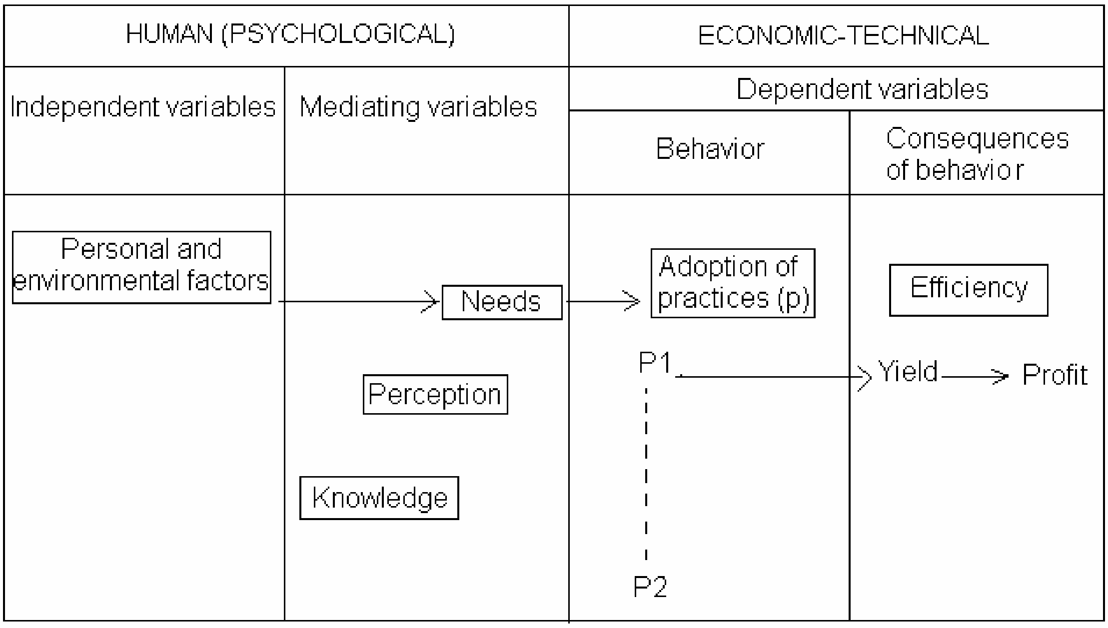

Figure 2. 6: The relationship Between Behaviour determining variables in Agricultural Development (Düvel, 1991)

According to him the intervening variables (Needs, perception and knowledge) indicated in the model are only those determinants which have been found to be important in the analysis, understanding, and prediction of behaviour based on extensive research done by various researchers like Düvel, 1975; Louw and Düvel, 1978; De Klerk and Düvel, 1982; Düvel and Scholtz, 1986; Botha, 1985; Düvel and Botha, 1990; Brockman, 1990; etc.

In general, behavioural scientists have made important contributions to the understanding of man and also have affected man’s image of himself (Berelson and Steiner, 1964). This has been possible through various theories and models of behaviour change that have been developed (some explained above). Although most of the models reviewed explain how change occurs, they offer little guidelines as to how change can be brought about.

Manifestations of the latter are recognisable in Lewin's (1951) model or concept of field forces (forces of change). If, at the same time, these forces are not associated with all determinants of change, but only with those having a direct influence, namely the intervening variables, then the foundation is laid for a practical model that can be used in extension for purposes of behaviour analysis (surveys), behaviour change (extension programmes) and evaluation of change (monitoring and evaluation of extension). Against these background assumptions Düvel developed his model (See Fig. 2.7).

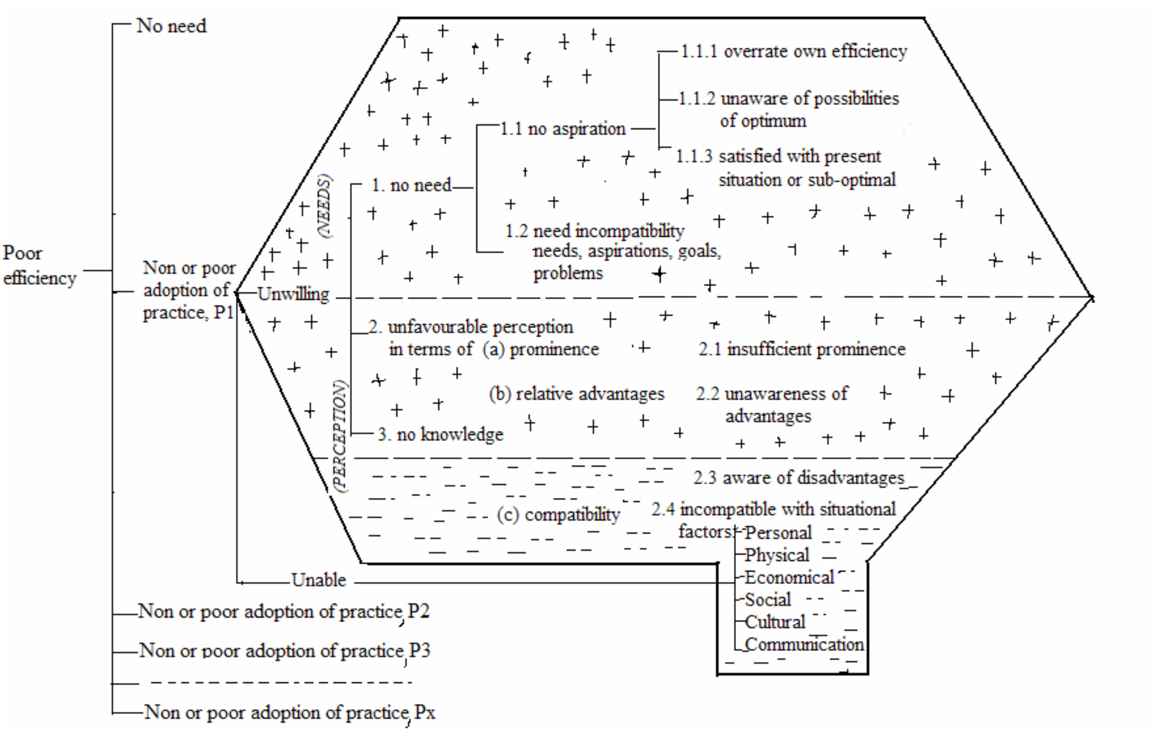

Figure 2. 7: Framework for problem conceptualization as technique in identifying the relevant causal factors in a situation analysis (Source: Düvel, 1991)

According to Düvel's model (Fig. 2.7), poor efficiency is a function of non-or poor adoption of the recommended practices. Farmers unwilling or unable to adopt cause this poor adotion. The unwillingness is influenced by several factors like need related aspects, knowledge and perception as explained below.

Need related aspects

The more direct need-related causes specified in Fig. 2.7 are the following:

(a) Lacking aspiration (1.1)

Insufficient or absent aspiration as far as any aspect of agricultural development or the adoption of a specific practice relates to or is a function of the following (Fig. 2.7):

- Overrating (or underrating) own efficiency (1.1.1)
- Being unaware of possibilities or the optimum (1.1.2)
- Being satisfied with the present situation or having a sub-optimal aspiration (1.1.3)

In a sense these aspects all have to do with problem perception where a problem is regarded as being the difference between "what is" (present situation) and "what can be" or is strived at (desired situation). Figure 2.8 is an illustration of a perceived problem, showing how the extent or magnitude of the problem (or need tension) is determined by the extent of the gap between the existing and desired situation.

If the existing situation eg. Efficiency of production or efficiency of practice adoption is over-estimated due to misperception (see 1.1.1 in Fig. 2.7), the perceived scope of the problem or potential need tension is reduced. If at the same time, there is limited knowledge concerning the optimum that is achievable (1.1.2), the potential problem and need can be further reduced to an insignificant level.

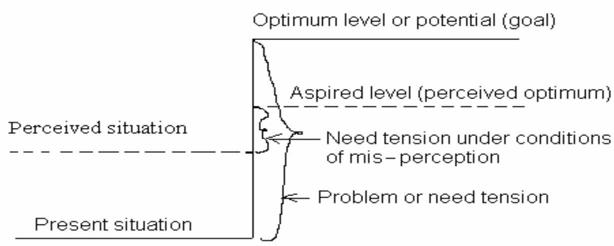

Figure 2. 8: Diagrammatic illustration of problem magnitude or need tension as influenced by perception (Düvel, 1991)

On the other hand, it is possible that the problem is correctly perceived, but that, for various reasons, the individual is satisfied with the situation (1.1.3). The opposite is also possible, namely that the individual underrates himself in terms of efficiency, and in extreme cases the goal object may consequently appear out of reach or unattainable, resulting in resignation or frustration on the part of the individual.

(b) Need incompatibility (see 1.2 Fig. 2.7)

Another need related cause of non-adoption is that the suggested solution, in terms of increased efficiency or a specific innovation or practice, is not compatible with the individual's needs, aspirations, goals or problems. Basically this means that it does not fit into the psychological field or need situation, in so far as that it is not perceived as either a need related goal, or as a means of achieving such a goal.

Perception

An unfavorable perception as cause of unwillingness to adopt can have the following causes:

(a) Insufficient prominence (2.1 Fig. 2.7)

Insufficient prominence is defined as the degree to which an innovation is perceived as being not better than the idea it supersedes (Düvel, 2004).

(b) Relative advantages

An unfavourable perception concerning the relative advantages refers to both advantages as well as disadvantages of the innovation or practice as such. The possible causes of non-adoption could thus be

- Unawareness of the advantages (2.2 Fig 2.7)
- Awareness of disadvantages (2.3 Fig. 2.7).

(c) Incompatibility (2.4 Fig 2.7)

Where advantages and disadvantages refer to an innovation or goal-object as such, compatibility relates more to situational aspects i.e the relevancy of the innovation in the individual's specific situation. Compatibility or incompatibility can refer to a wide range of aspects eg. personal, economical, social, cultural etc.

This category of behaviour determinants does not include compatibility of needs for which separate provision has been made in item 1.2 (Fig. 2.7). The reasoning behind this is that need compatibility represents the basic positive forces, where as the other compatibility aspects largely represent constraints en route to the goal. By implication this means that the compatibility aspects are potentially only negative forces.

Knowledge

Knowledge that is relevant in the case of innovation or practice adoption can be categorized as follows:

(i) Basic knowledge or knowledge of principles

(ii) Knowledge associated with the awareness of relative advantages

(iii) Knowledge in respect of the application of an innovation or practices

Generally, Düvel's behaviour analysis models (Fig. 2.6 & Fig. 2.7) are appreciated for successfully making provision for all causes of adoption behaviour. However, there are outstanding challenges where more research is essential. As far as need tension is concerned, this variable has some complications in that it is valid before behaviour change; but it disappears or decreases with need accomplishment or behaviour change. Another complicating factor is that the need tension is not independent of the perceived current efficiency, which the less efficient farmers tend to overrate their efficiencies more than the more efficient ones, thus undermining or significantly reducing the present need tension leading to the opposing tendency.

Due to this fact this study will concentrate only on assessing the influence of efficiency misperception or the degree of overrating (instead of perceived current efficiency) in determining the adoption behaviour. Furthermore, the model assumes that the possible causes of non-adoption could be the awareness of disadvantages (2.3 Fig. 2.7). It appears that the adopters and non-adopters are both aware of the disadvantages because the former have undergone through the adoption process that enabled them to be aware of them. However, this study will test this assumption.

2.2 THE STUDY CONCEPTUAL MODEL

After reviewing various models of behaviour change focusing on their contributions, strengths and weaknesses the conceptual model for this study will base on Düvel's (1991) model (Fig. 2.7). The model seems a successful combination of more modern theories like Lewin's (1951) field theory and Tollman's (1967) model.

It also appears to offer practical guidelines for a systematic and scientific approach in the analysis of adoption behaviour, evaluation of extension programs and consequential systematic change.

Selecting the Düvel Model as theoretical foundation for this study has a threefold purpose:

- To explain the adoption behaviour or lack of it with regard to maize production in the Njombe District,
- to evaluate the validity and appropriateness of the model in a different country and culture, and
- to contribute to the further development and refinement of the model

2.3 EMPIRICAL STUDIES CONDUCTED IN THE AREA OF INDEPENDENT AND INTERVENING VARIABLES

Studies on independent factors affecting the adoption of innovations are numerous and the literature is too diversified to be reviewed here. Due to this fact only those variables, which are considered in this study will be reviewed. On the other hand, relatively few studies have been done on the influence of intervening variables on the adoption behaviour. This could be attributed to the recent awareness of the importance of these variables in behaviour analysis.

2.3.1 Independent variables and adoption

The reviewed literature indicates that there is inconsistency of findings on the relationship between independent variables and the adoption behaviour. Although some of these variables appear to have a bigger influence, it is very common to find that certain studies support the influence relationship, while other show no influence and in some cases even a negative influence or relationship. (Rogers, 1983; Adesina and Baidu-Forson, 1995; Ekoja, 2004).

2.3.1.1 Age

Farmers' age has been found to influence the adoption behaviour in several ways. For example, a number of studies assert that there is a negative correlation between age and level of adoption of recommended practices, implying that the adoption is lower among the old age group than in the case of young ones (Rogers, 1983; Polson and Spencer, 1991; CIMMYT, 1993; Nanai, 1993; John, 1995; Van den Ban and Hawkins, 1996; Amir and Pannel, 1999; Foltz and Chang, 2002). On the other hand researchers like Adesina & Baidu-Forson (1995) and Senkondo *et al*., (1998) have found contradicting results and argue that the age of the respondent is positively related to the adoption behaviour.

Other studies (Kalineza, 2000; Habtemariam, 2004) report that the adoption level tends to be highest at middle age group, thereby implying a non-linear relationship. This could go a long way in explaining why researchers like Okoye (1989) and Bwana (1996) found no significant correlation coefficient.

2.3.1.2 Sex

The great role played by women in agriculture is increasingly acknowledged, but studies like that of Wambura (1992) reveal that the women's access to agricultural information is still very limited with their husbands representing the main source. This makes them to belong to a disadvantaged group when it comes to the introduction of new technology. A number of studies reveal that the level of adoption of recommended practices tends to be lower among women than men (Jefremovas, 1991; Stephens, 1992; Kalineza, 2000; Mensah and Seepersad, 1992 quoted by Habtemarium, 2004). But other studies (Temu, 1996; Bwana, 1996; Habtemariam, 2004) report that there is no relationship between sex and adoption.

2.3.1.3 Formal education

In most of the reviewed literature formal education is reported to impact positively on the adoption of recommended practices (Levinger and Drahman, 1980; Rogers, 1983; Okoye, 1989; Anosike and Coughenour, 1990; Obinne, 1991; CIMMYT, 1993;

Lugeye, 1994). This implies that the higher the level of formal education, the higher the adoption rate tends to be. However, there are studies showing no or only a very limited relationship between education and adoption (CIMMYT, 1993; Machumu, 1995). For example Senkondo *et al.,* (1998) found that adoption of rainwater harvesting technologies was not significantly explained by education but rather by other factors such as experience in farming and perceived technology characteristics.

2.3.1.4 Farm size

The size of the farm reflects the scale of agricultural production that can take place on a farm (Kipaka, 2000). With respect to the adoption of recommended practices, it has been argued that small and large farm operators differ in the speed of adoption (Polson and Spencer, 1991). Large-scale farmers can easily obtain credit, information and other inputs that facilitate their adoption behaviour. Evidence of this relationship has been provided by, amongst others, Rogers, 1983; Jamison and Laurance, 1982; Wambura, 1988; Thakre and Bansode, 1990; Hussain *et al.,* 1994; Senkondo *et al.,* 1998 and Kalineza, 2000. On the other hand, Mensah and Seepersad (1992) quoted by Habtemariam (2004) reveal that there is a negative relationship between farm size and adoption, while researchers like Temu (1996) and Habtemariam (2004) found no relationship between farm size and adoption behaviour.

2.3.2 Intervening variables

In general, a review of the literature indicates a greater degree of consistency of research results regarding the intervening variables than is the case with independent variables. Most of the studies reviewed show a positive relationship between intervening variables (perception, knowledge and need related aspects like need compatibility, efficiency misperception, need tension) and adoption behaviour.

2.3.2.1 Need compatibility

Need compatibility is a measure of whether the suggested solutions in terms of increased efficiency or introduced practices are compatible with individuals needs.

Düvel (1991) contends that non-adoption behaviour results when suggested solutions do not fit into the psychological field or need situation of an individual. The reviewed studies on need compatibility indicated a positive relationship between this variable and adoption behaviour (Louw and Düvel 1993; Düvel and Botha, 1999; Habtemariam, 2004).

2.3.2.2 Need Tension

Need tension or problem perception is another need related aspect that is important in determining the adoption behaviour. According to Düvel (1991), it is defined as the perceived difference between "what is" (present situation) and "what can be" or is strived at (desired situation) (See Fig. 2.8). In other words it is a perceived discrepancy between the present situation and the desired situation or level of aspiration.

This concept has been shown by different studies to be a key dimension in behaviour change or adoption behaviour (Koch, 1987; Düvel and Botha, 1999; Düvel and Scholtz, 1986). Distorted problem perceptions around the objective (Factual) situation could lead to irrational decision-making that may include non-adoption, under adoption or even over adoption (Düvel, 1995). Need tension is normally hypothesized to have a positive relationship with adoption behaviour. However, studies done by Koch (1987) and Habtemariam (2004) found a negative relationship. This opposing tendency is due to the fact that the poor adopters tend to overrate themselves more, resulting in many cases in lower need tension, which approaches that of adopters whose need tension may not be as high anymore, because of the higher "current level" of efficiency.

2.3.2.3 Efficiency misperception

Efficiency misperception refers to the degree to which individuals incorrectly (usually overrate) their efficiency (Düvel, 2004). Düvel (1991) notes that there is a tendency of individuals to overrating (or underrating) their own production and/or practice adoption efficiency.

This has been argued by the author to have a tremendous effect on adoption behaviour due to the fact that the more the current efficiency is overrated, the smaller the problem scope or need tension becomes and thus the smaller the incentive to adopt recommended innovations.

2.3.2.4 Awareness

It refers to an awareness of recommended solutions or the optimum that is achievable in terms of efficiency. In this case awareness refers as the knowledge of recommended maize production practices or, as far as production efficiency is concerned, to the respondents knowledge of the optimum yields attainable in the study area. This is an intervening variable that, so far, has only been found to have a positive influence relationship with adoption behaviour (Düvel, 1991; Düvel, 2004).

2.3.2.5 Perception

The underlying hypothesis regarding the role of perception is that the decision making whether or not to adopt an innovation will depend on how it is perceived by the decision maker. Against this background Düvel (1975) tried to associate forces of change with the attributes of innovations as formulated by Rogers (1983). He therefore identified three categories of attributes as relative advantages (i.e unawareness of the advantages and/or awareness of disadvantages), prominence and compatibility with situation.

Studies done by Botha (1986); Koch (1986); Düvel and Scholtz (1986); Louw and Düvel (1993); Düvel and Bother (1999) indicated a positive relationship between perception of total innovation attributes and farmers adoption behaviour. However, on the study done by Habtemariam (2004) reveals that there is no relationship between disadvantages expressed as the total numbers and the adoption behaviour.

2.3.2.6 Prominence

Prominence is defined as the degree to which an innovation is perceived as being better than the idea it supersedes.

It is contended that the more an innovation or a practice is perceived to be relatively better than the traditional practices, the higher the adoption is likely to be (Düvel, 1991; Düvel, 2004).

As said earlier, so far few empirical studies have been conducted in the area of intervening variables but it is believed that the review of various studies so far conducted will provide a sound basis for this study and also will provide the room for more contribution into the area.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Chapter three begins by providing a brief description of the Njombe district, where the study was conducted. This is followed by the description of the population and sampling procedures, instrumentation and data collection, definition of the study variables and finally the statistical analyses procedure used.

3.2 DESCRIPTION OF THE STUDY AREA

The study was confined to the Njombe district in the Iringa Region of the Southern highlands of Tanzania. The district is located between 8.8^0 and 9.8^0 South of the equator, and 34.5^0 and 35.8^0 Longitudes. Its altitude is between 1000 and 2000m above sea level; and hence has a cool climate with the possibilities of frost during the months of June and July, causing scorching of some crops that are still in a vegetative stage. The district receives up to 1600mm of rainfall per annum mainly from November/ December to April/ May. The dry season is from June to October.

The main activity carried out by people in the Njombe district is Agriculture. The major food crops grown include maize, beans, wheat and potatoes where as the major cash crops are maize, potatoes and pyrethrum. This means that the district depends largely on maize as food as well as cash crop. Several types of livestock like goats, sheep, pigs, local (indigenous) chicken and small numbers of cattle are kept.

3.2.1 Reasons for choosing Njombe district.

The reasons why Njombe was chosen as survey and study area are the following:

- It is one of the districts where the improved agricultural packages for grain production like maize has been introduced.

- It is famous and important for the production of maize and is one of the areas that the country mainly depends on for supplying food grains like maize.

- It was easily accessible for the researcher and thus more affordable as far as traveling expenses are concerned. The area also has good roads that are passable throughout the year.

3.3 THE POPULATION AND SAMPLING PROCEDURE

In view of limited financial resources placing limitations on the number of interviews, the survey sample was ultimately restricted to 113 maize growers, which were randomly drawn and represented five percent samples of four [1]villages selected to represent the biggest variation in terms of climatic conditions within the Njombe district of Tanzania. Justification for the compromise between the sample percentage and the number of villages was based on the contention of Boyd *et al.,* (1981), namely that a sample size of about five percent is a fairly representative one.

3.4 INSTRUMENTATION AND DATA COLLECTION

Primary data collection began by a preliminary/reconnaissance survey that involved familiarization visits, introduction of the study objectives and informal discussion with farmers, village leaders and extension staffs in the study area. The main objective was to get a better understanding of the study area that helped in refining the research problem, identifying the major information gaps and guiding the sampling process. In addition the questionnaire was thoroughly discussed with researchers and extension officers, then pre-tested and thereafter the main survey commenced where by the final version of the pre-tested questionnaire (Appendix 1) was used to collect data from sampled respondents.

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[1] The villages were purposefully selected on the basis of their accessibility

Secondary data for this study were obtained from books, journals, reports and other documents from Library at the University of Pretoria, Sokoine University of Agriculture, Regional and District agricultural offices, Internet and other related sources.

3.5 VARIABLES AND THEIR MEASUREMENT

3.5.1 Independent variables

Some of the independent variables considered in this study are among the ones that have been identified as important in determining the adoption behaviour by numerous studies (Rogers, 1983; Mattee and Mvena, 1988; Gass and Bigs, 1993; Lyatuu, 1994; Machumu, 1995; Amir and Pannel, 1999; Sicilima and Rwenyagira, 2001). These include the individual socio-economic and personal characteristics of farmers like age, sex, formal education, farm size and area under maize.

Age:

Age of the respondent was measured in terms of the total number of years one had lived from his/her birth to the period when the survey was conducted. The respondents' ages were then categorized into three age groups namely; young (less than 36 years), middle (36-56 years) and old (more than 56 years).

Sex:

Sex was measured by grouping the respondents into their state of being a male or a female therefore two categories were used.

Formal education:

Measured in terms of the number of years of formal schooling attained by the time of the survey. These were then categorized into the following categories:
1. Those who had not attended formal schooling at all
2. 1-7 years of schooling
3. More than 7 years of schooling

Farm size:

Farm size was determined by asking the respondents to indicate the size of the land they own. Most of the farmers in the study area, and Tanzania in general, are subsistence farmers with small farm sizes, which were categorized as small (<3 acres), medium (3-6 acres) and large (>6 acres).

Farm sizes were measured in acres because this is the unit that is commonly used in the study area. Since the majority of respondents have mall farms the conversion of acres to hectares was thought of not importance because it could have resulted into fractions that are very difficult for some people to grasp the clear picture of farm sizes.

Area under maize:

This refers to the part of the land used to grow maize at the time of the survey. The categorization applied ranged from small (<=1 acre) to medium (1.1-3 acres) to large (>3 acres).

3.5.2 Intervening variables

The intervening variables explored in this study include those which have been found to be important in the prediction of behaviour based on extensive research done in South Africa and Ethiopia by researchers like Düvel, 1975; Louw and Düvel, 1993; Düvel and Scholtz, 1986; Botha, 1986; Düvel and Botha, 1999; Habtemariam, 2004.

These are need related aspects (efficiency misperception, need tension, need compatibility), knowledge (awareness of the solutions) and perception (prominence, advantages and disadvantages).

Efficiency misperception

Closely associated with the perceived current efficiency is the efficiency misperception or the degree to which individuals incorrectly (usually overrate) their efficiency (Düvel, 2004). To establish this, farmers were asked to estimate their own efficiency. The enumerator also did a similar rating based on objective (researched) guidelines or criteria. In both cases a five-point scale was used in order to assist in calculating farmers' degree and percentage of misperception. For this the following formula was used.

Degree of overrating/underrating = Farmers' scale point - Enumerators scale point

Percentage overrating/underrating = (A – B)-1)/4*100 where as,
A = represents farmer's own assessment (scale point)
B = represents enumerator's assessment (scale point) based on research findings
1 is the first figure in the five-point scale, and has to be subtracted in order to make the lowest point on the scale = 0
4 is the difference between the highest and the lowest scale points (5 - 1).

The percentages obtained were then categorized into [2]underrating, slightly underrating, assess correctly, slightly overrating, overrating

[2] Underrating/slightly underrating and overrating/slightly overrating are presented by negative and positive signs respectively while a correct assessment is presented by a zero implying that both farmers and enumerator have the same assessment. In other words the farmer assessed his/her situation of practice adoption correctly.

Need tension:

The NT or problem perception refers to the perceived discrepancy between the present situation and the desired situation or level of aspiration (Düvel, 2004). Based on this definition, farmers were asked to indicate their present and aspired level (or goals) of practice adoption. It is expected that the higher the goal or level of aspiration the higher the need tension. Farmers were then grouped into [3]three categories namely; low, medium, and high need tension.

Need compatibility:

Since 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 the suggested practices

[3] With exception of efficiency misperception and awareness, the categorization of the intervening variables into low, medium and high was based on how one was assessed in a given scale. Low category represented those respondents that were assessed in low scale levels; medium category represented those that were assessed in medium scale levels while high represented those who were in high scale levels. For example, in a 5-point scale, 1-2 level could represent low, 3-4 could represent medium while 5 could represent high.

Awareness

It refers to an awareness of recommended solutions or the optimum that is achievable in terms of efficiency. In this case awareness refers as the knowledge of recommended maize production practices in the study area. Based on this definition awareness was measured by requesting farmers to indicate the recommended maize production practices that they are aware of in their area and making an assessment on the following scale: 1) Not aware 2) Aware

Perceived total attributes of Innovation:

Where needs relate to all positive or driving forces which in total constitute the attractiveness, perceptions are understood to be of a more specific nature and are analyzed on the basis of attributes of innovations (Düvel, 2004). The Perception aspects looked at in this study include prominence, relative advantages and disadvantages of the maize production practices.

Prominence

According to Düvel (2004) prominence is synonymous with Rogers' (1983) concept of relative advantage, which he defines as the degree to which an innovation is perceived as being better than the idea it supersedes. Based on this definition farmers were asked to indicate what they regarded to be the best practice(s) or to compare their own practice with the recommended one. According to the perceived prominence, individuals were categorized into three groups namely, low prominence, medium prominence and high prominence.

Relative advantages/disadvantages of recommended practices

These attributes were captured by requesting the respondents to (a) list the advantages and disadvantages and (b) to assess their importance on a five-point semantic scale. The former was assumed to refer to the number of positive and negative forces, while the latter, namely the weightings, served as an indication of their strength. Both these measures were used in an analysis of the influence of the perceived advantages and disadvantages on adoption behaviour. Due to the time consuming nature and scope of these questions, they were only posed in respect of certain practices, namely maize varieties and fertilization.

It was of interest also to evaluate the role of individual advantages (positive forces) and disadvantages (negative forces) on the adoption behaviour. To achieve this some of the advantages and disadvantages perceived to be more important were considered. It is noteworthy that some of the advantages were regarded as negative forces while some of the disadvantages were considered as positive forces. Due to this the advantages were categorized as 1) Negative force 2) Low positive force 3) Medium positive force 4) High positive force. The disadvantages were categorized as 1) Positive force 2) Low negative force 3) Medium negative force 4) High negative force

3.5.3 Dependent variables:

These include production efficiency and recommended maize production practices, although the latter do assume independent character in Chapter 4 where the focus is on influence of practice adoption on production efficiency.

Production efficiency

Yield in terms of bags per acre for the 2004/2005 season was used to measure the production efficiency. Since the overwhelming majority of the respondents harvested below the optimum or achievable yield of about 40 bags per acre, the following classification was used:

1) <10 bags/acre 2) 10-20 bags/acre 3) >20 bags per acre

Recommended maize production practices

Maize varieties:

This variable was measured by asking the respondents to indicate maize varieties they used for the 2004/2005 season. Most of the respondents grew replanted hybrid, local varieties and recommended hybrids and so the categorization was according to the variety used.

Phosphate fertilization

This practice was measured by requesting respondents to indicate the rate of phosphate fertilization used in the 2004/2005 season. The responses were then categorized into: 1) <30 kg/acre 2) 30-50 kg/acre 3) >50 kg/acre

Nitrogen fertilization

The measurement of nitrogen fertilization was based on the amount of nitrogen applied as well as the time of application. The responses given to the amount of nitrogen applied were categorized into an adoption scale consisting of
1) <25 kg/acre 2) 25-50 kg/acre 3) 50-75 kg/acre 4) 75 kg/acre.

For responses regarding the time of fertilizer application, provision was made for the following categories: 1) At planting only 2) As top dressing only 3) At planting and as top dressing.

The scale for total nitrogen fertilization was a combination of the rate and time of application scales, and resulting in the following adoption scale: 1) low adoption (<5 scores) 2) Medium adoption (5-7scores) 3) High adoption (>7 scores).

Total fertilization package

The recommended fertilization package for the Njombe district involves the use of all the fertilization practices discussed above. The scale used to assess the adoption of fertilization as a whole, consisted of a summation of all the scores and the following categorizations were used: 1) low adoption (<6 scores) 2) Medium adoption (6-10 scores) 3) High adoption (>10 scores).

Seed spacing

The recommended number of maize seed per hill is one or two but in 2004/2005 season the overwhelming majority of the surveyed respondents used one seed per hill. Due to this the analyses and discussion on the factors influencing the adoption of this practice focused on those farmers who used one seed only. Seed spacing was obtained by asking the respondents to indicate which spacing was used in maize production for 2004/2005. The responses were classified into:

1) <20 x <60 2) 20-25 x 60-75 3) 25-30 x 75-90.

Each category of seed spacing was then used to compute the plant population per acre.

Weeding

Weeding is a practice assumed to have a major influence on yield, because weeds compete with the crop for nutrients and moisture. The approach used to differentiate between the effectiveness of weed control and thus its adoption was based on how often they weed their maize fields. It was assumed that this can vary between one and three times, but ultimately the variation allowed for only two scale points: two times (1) and three times (2).

The degree of weed infestation was also thought to have a tremendous influence on the production efficiency. The measurement of weed infestation was based on the occurrence of three most important types of weeds that are most harmful because of their drastic effect of maize yields namely; *tradescantia fluminerisis* (wandering jew), *cynodon dactylon* (cough grass) and nut grass. An occurrence of all three types was assessed as high infestation, while low and medium infestation referred to the occurrence of one and two serious weeds, respectively.

3.6 DATA ANALYSIS

The data collected through means of coded questionnaires was – captured, cleansed and analyzed using the statistical package for social sciences (SPSS). Descriptive statistics such as frequencies, percentages and means were done as a first step towards determining the distribution of the variables (general findings). Graphics like bar charts were used to summarize large amounts of information while correlations, chi-square, and regressions were used to determine the relationship between the independent and the dependent variables.

Chi-square analyses were used in combination with two-dimensional contingency tables to establish whether significant differences occurred between the various categories or groups. This also allowed for the identification of relationship other than linier correlations, which are normally not detected with correlation analyses.

Bivariate correlation analyses were employed to assess the existence, magnitude (strength or degree) and kind (negative or positive) of relationship that exist between the independent and the dependent variables. This was achieved by computing the correlation coefficients and significance or probability. According to De Vos (1998), Morgan and Grego (1998), Mallery & George (2003), the correlation coefficient, *r* range in value from –1 to +1. A correlation coefficient of +1 designates a perfect, positive relationship implying that one variable is precisely predictable from the other variable and as the one increases in value (or decreases) the other similarly increases (or decreases).

A correlation coefficient of 0 indicates no relationship between the two variables whatsoever, while that of –1 represent a perfect, negative correlation. Negative indicate that as one variable increases in value, the other variable decreases in value.

Mallery and George, 2003 assert that perfect correlations (positive or negative) exist only in mathematical formulas and direct physical or numeric relations. The non-perfect positive ($0<r<1$) and non-perfect negative ($-1<r<0$) are common types of correlation or relationship that exist between two variables. In the interpretation of analyses a probability of less than 5 percents ($p<0.05$) was interpreted as statistically significant.

Multiple linear regression analysis were used to investigate the effect of various independent variables (predictors) on the dependent (an outcome) variable. The regression analysis is also an indicator of how well one or more independent variables predict the value of a dependent variable (Lugole, 2005). Due to this fact the model was also used to assess the degree to which the various independent and intervening variables contribute towards explaining the dependent variable variance. According to Tabachnick and Fidell (2001), the regression model is based on the following:

$$Y = A + B_1X_1 + B_2X_2 + \ldots + B_kX_k$$

Where Y is the predicted value on the dependent variable, A is the Y intercept, the Xs represent the various independent variables (of which there are k), and the Bs are the coefficients assigned to each of the independent variables during regression.

CHAPTER 4

PRODUCTION EFFICIENCY AND ADOPTION OF RECOMMENDED MAIZE PRODUCTION PRACTICES

4.1 INTRODUCTION

Although production efficiency is the function of the adoption of recommended practices and the most important goal of developing and promoting the practices, most of the adoption studies (Bwana, 1996; Temu, 1996; Semgalawe, 1998; Kalineza, 2000) do not focus much on the contribution of adoption behaviour to the production efficiency. Instead, they concentrate more on the determining factors and their influence on adoption of recommended practices. Düvel (2004) asserts that the problems normally addressed in agricultural development are concerned with some form of production efficiency. These are normally the result of a certain behaviour (practice adoption) and usually imply the non-adoption or incorrect adoption of certain recommended practices. Düvel's (1991) behaviour analysis model, that this study is based on, accommodates the concept of production efficiency as the consequence of adoption behaviour.

This chapter provides an overview of the status of maize production efficiency in the study area. Also the influence of each practice adoption as well as total adoption of recommended maize production package on production efficiency will be assessed in this chapter.

4.2 PRODUCTION EFFICIENCY

In this study yield in terms of [4]bags per acre is used as a criterion for evaluating the status of production efficiency of maize farming. The motive behind choosing yield as a criterion is due to the fact that it is easy to get reliable information regarding the total yield from which the mean yield per acre can be calculated. Yields for the 2003/2004 season are shown in Table 4.1.

[4] One bag is equivalent to 100 kg

Table 4. 1: Distribution of the respondents according to their production efficiency as reflected in yield (bags per acre)

Yield categories (bags/acre)	Respondents	
	N	%
<5	20	17.7
5-10	19	16.8
10-15	25	22.1
15-20	18	15.9
20-25	17	15.0
25-30	9	8.0
30-35	2	1.8
>35	3	2.7
TOTAL	113	100.0

Seen against the research findings (Liana, 2005) that the optimum maize yield per acre in the study area is judged to be 36-40 bags, it is evident that most (97.3 percent) of the farmer's production efficiency falls well bellow that level. The target of 36-40 bags is not unrealistic as one of the surveyed farmers managed to get a yield of 42 bags per acre.

4.3 ADOPTION OF RECOMMENDED MAIZE PRODUCTION PRACTICES

The recommended maize prodcc varieties, use of fertilizers (phosphate, nitrogen, time of nitrogen fertilizer application), spacing and weed control. Each of these practices will be assessed individually in the following subsections to determine the general level of adoption and its influence on production efficiency.

4.3.1 Seed

The recommended maize varieties in the study area include UH 615, UH 625, H 614, H 628, SC 627, S 627 and P 67. Although different varieties of improved maize seeds have been recommended, most farmers do not buy recommended hybrids but instead they use local varieties or select from previous planted hybrid. The latter is discouraged because it is likely to result in a drastic decrease in yield and uniformity and farmers are thus recommended to obtain fresh supplies of hybrid maize seed every season. Respondents' adoption behaviour regarding the seed used is summarized in Table 4.2.

Table 4. 2: Distribution of respondents according to maize seed adoption and production efficiency as reflected in yield (bags/acre)

Seed adoption	**Yield categories (bags/acre)**							
	1-10		10-20		>20		Total	
	(n)	(%)	(n)	(%)	(n)	(%)	(N)	(%)
Replanted hybrid (1)	20	43.5	18	39.1	8	17.4	46	40.7
Local Varieties (2)	17	36.2	19	40.4	11	23.4	47	41.6
Recommended hybrid (3)	2	10.0	6	30.0	12	60.0	20	17.7
Total	39	34.5	43	38.1	31	27.4	113	100.0

χ^2 = 14.716; df=4; p=0.005

r = 0.392; p=0.000

According to Table 4.2 only 17.7 percent of the interviewed farmers buy the recommended hybrids. Some of the reasons for the non-adoption of recommended hybrids, as reported by the respondents, are fake seeds, poor resistance to diseases, poor milling quality of the grain, high seed costs, low storability and poor taste. These reasons for the non-adoption of recommended maize varieties will be explored in more detail later.

The consequence of non - and or low adoption of recommended hybrid maize is expected to find expression in the level of production efficiency. The results in Table 4.2 reveal a highly significant correlation (r=0.392; p=0.000) between the seed used and the maize yield, implying that the better the seed choice is, the higher the yield tends to be.

For example 60 percent of those respondents using the recommended hybrids had yields of more than 20 bags per acre, while the percentage of those replanting hybrid seed or using local varieties was only 17.4 percent and 23.4 percent, respectively. The results are in line with hypothesis of the study, which states that there is a relationship between adoption of recommended practice and production efficiency.

Data were further analyzed to check whether the local varieties contribute more to the maize yield than replanted hybrids or the *vise versa*. This was achieved by interchanging the scale points of the two seed categories. Local varieties were assigned a score of one instead of two and replanted hybrids were assigned a score of two instead of one as indicated in Table 4.3.

Table 4. 3: Distribution of respondents according to maize seeds adoption and production efficiency as reflected in yield (bags/acre)

Seed adoption	Yield categories (bags/acre)							
	1-10		10-20		>20		Total	
	(n)	(%)	(n)	(%)	(n)	(%)	(N)	(%)
Local Varieties (1)	17	36.2	19	40.4	11	23.4	47	41.6
Replanted hybrid (2)	20	43.5	18	39.1	8	17.4	46	40.7
Recommended hybrid (3)	2	10.0	6	30.0	12	60.0	20	17.7
Total	39	34.5	43	38.1	31	27.4	113	100.0

χ^2 = 14.716; df=4; p=0.005

r = 0.249; p=0.008

Although the results in Table 4.3 reveal a significant correlation (r= 0.249; p=0.008) between the seed use and the maize yield, the correlation is lower than when the scores of seed categories were not interchanged, implying that local varieties contribute more to maize yield than replanted hybrids.

4.3.2 Fertilization

The maize plants have a relatively high demand for nutrients, particularly for nitrogen, phosphorus and potassium for obtaining high yields. These important nutrients can be supplied through application of inorganic fertilizers or farmyard manure (TARO, 1987).

The recommended fertilizers for maize production in the study area are phosphate fertilizers like tri-super phosphate (TSP), di-ammonium phosphate (DAP), Minjingu rock phosphate (MRP) and nitrogen fertilizers like urea, CAN (calcium ammonium nitrate), NPK (nitrogen, phosphate, potassium) and farm yard manure (FYM). Among these, the commonly used fertilizers are TSP, DAP, Urea, CAN and FYM.

The following sections will evaluate individually the influence of adoption of phosphate, nitrogen and time of application of nitrogen fertilizers in production efficiency. Furthermore, the influence of the adoption of the total fertilizer package on production efficiency will be assessed.

4.3.2.1 Phosphate fertilizers

The recommended application of phosphate fertilizer is more than 50kg/acre at planting. In Table 4.4 the respondents' rate of fertilizer application is summarized. Although farmers are advised to apply the recommended rate of phosphate fertilizer, the adoption rate is still low. Most of the respondents (61.1 percent) apply less than 30kg/acre of phosphate fertilizers with only 10.6 percent of respondent farmers applying more than 50 kg/acre.

Table 4. 4: Distribution of respondents according to phosphate fertilizer adoption and production efficiency as reflected in yield (bags/acre)

Phosphate fertilization (kg/acre)	Yield categories (bags/acre)							
	1-10		10-20		>20		Total	
	n	%	n	%	n	%	N	%
<30	34	49.3	26	37.7	9	13.0	69	61.1
30-50	4	12.5	14	43.8	14	43.8	32	28.3
>50	1	8.3	3	25.0	8	66.7	12	10.6
Total	39	34.5	43	38.1	31	27.4	113	100

χ^2 =27.092; df=4; p=0.000

r=0.551; p=0.000

The results reveal a highly significant correlation (r=0.551; p=0.000) between phosphate fertilizer application and the maize yields, implying that the higher the amount of phosphate fertilizers application is, the higher the yield tends to be. For example 66.7 percent of those respondents using more than 50kg/acre of phosphate fertilizers had yields of more than 20 bags per acre, while the percentage of those applying less than 30kg/acre of phosphate fertilizers was only 13 percent.

4.3.2.2 Nitrogen fertilizers

The recommended rate of nitrogen fertilizer is at least 75 kg/acre. As in the case of phosphate fertilizer the adoption rate of the nitrogen fertilizer, summarized in Table 4.5, is still low. For example, about 70 percent of interviewed farmers do not apply the recommended rates of nitrogen fertilizer.

Table 4.5: Distribution of respondents according to nitrogen fertilizer adoption and production efficiency as reflected in yield (bags/acre)

Nitrogen fertilization (kg/acre)	Yield categories (bags/acre)							
	1-10		10-20		>20		Total	
	n	%	n	%	n	%	N	%
<25	19	90.5	2	9.5	0	0.0	21	18.6
25-50	13	37.1	20	57.1	2	5.7	35	31.0
50-75	4	17.4	12	52.2	7	30.4	23	20.4
>75	3	8.8	9	26.5	22	64.7	34	30.1
Total	39	34.5	43	38.1	31	27.4	113	100

r=0.685; p=0.000

The results reveal a highly significant correlation (r=0.685; p=0.000) between nitrogen fertilizer application and the maize yield, implying that the higher the amount of nitrogen fertilizer application is, the higher the yield tends to be. For example 64.7 percent of those respondents using more than 75kg/acre of nitrogen fertilizer had yields of more than 20 bags per acre, while not a single farmer applying less than 25kg/acre of nitrogen fertilizers had a yield of more than 20 bags/acre. The findings are in agreement with hypothesis of the study.

4.3.2.3 Time of nitrogen fertilizer application

In the study area it is recommended that about 33 percent of nitrogen fertilizers should be applied at planting and about 66 percent as topdressing. However according to Table 4.6, which gives an overview of the time (stage) of nitrogen application, the larger majority of the farmers apply all of it as top dressing only. Of the 105 respondents who use nitrogen fertilizer few farmers (25.7 percent) apply nitrogen fertilizer at planting and as topdressing as it is recommended.

Table 4.6: Distribution of respondents according to time of nitrogen fertilizer application and production efficiency as reflected in yield (bags/acre)

Time of Nitrogen fertilizer application	Yield categories (bags/acre)							
	1-10		10-20		>20		Total	
	n	%	n	%	n	%	N	%
All at planting (1)	3	75.0	1	25.0	0	0.0	4	3.8
All as topdressing (2)	27	36.5	33	44.6	14	18.9	74	70.5
At planting and as topdressing (3)	1	3.7	9	33.3	17	63.0	27	25.7
Total	31	29.5	43	41.0	31	29.5	105	100.0

χ^2 =25.211; df=4; p=0.000

r =0.479; p=0.000

The results show a highly significant correlation (r=0.479; p=0.000) between the time of nitrogen fertilizer application and yield. For example 63.0 percent of those respondents using nitrogen fertilizer at plating and as topdressing had yields of more than 20 bags per acre, while not a single farmer applying nitrogen fertilizer at planting only had a yield of more than 20 bags/acre.

The scale used to measure nitrogen application assumes that if only one nitrogen fertilization is applied, it is better to apply all the nitrogen as topdressing than to apply it all at planting. The findings in Table 4.6 seem to justify this, because 75 percent of the respondents who applied all their nitrogen at planting had low yields (less than 10 bags) while among those who apply all nitrogen fertilizer as top-dressing only 36.5 percent fall into the low yield category. This conclusion that, if only one application of nitrogen is made, it is better to apply it all as top-dressing rather than at planting is also supported by a lower correlation (r = 0.401) if these two items on the scale are interchanged. The likely reason for the better effect of nitrogen when applied as topdressing rather than at planting is the high degree of leaching due to the high rainfall that is 1200-1600mm per annum.

4.3.2.4 Fertilizer package

The scores for the adoption of the total fertilization package were obtained by adding the scale points of the individual fertilizer practices[5] already discussed. The scores were then categorized into three groups namely, <6 scale points for low adoption, 6-10 for medium adoption and 11-15 for high adoption. The survey results in respect to the adoption of the total fertilizer package are summarized in Table 4.7.

Table 4.7: Distribution of respondents according to fertilizer package adoption and production efficiency as reflected in yield (bags/acre)

Total fertilization package	**Yield categories (bags/acre)**							
	1-10		10-20		>20		Total	
	n	%	n	%	n	%	N	%
<6	23	82.1	5	17.9	0	0.0	28	24.8
6-10	12	26.1	26	56.5	8	17.4	46	40.7
11-15	4	10.3	12	30.8	23	59.0	39	34.5
Total	39	34.5	43	38.1	31	27.4	113	100

χ^2 =57.183; df=4; p=0.000

r=0.632; p=0.000

According to Table 4.7, the minorities of respondents fall into the low adoption category. For example, 24.8 percent fall under this category while 75.2 percent fall under the medium and high adoption score categories. The results also reveal a highly significant correlation (r=0.632; p=0.000) between fertilizer package adoption and the maize yield, implying that the higher the package adoption score is, the higher the yield tends to be.

[5] The scale points for total fertilization package were obtained before the individual fertilizer practices were re-categorized

For example 59.0 percent of those respondents with high adoption score (11-15 scale points) had yields of more than 20 bags per acre, while not a single farmer with a low adoption score (less than 6) had a yield of more than 20 bags/acre. The results are in agreement with those from maize fertilizer demonstrations conducted by the *Kilimo*/FAO fertilizer program, which proved that poor fertilization generally results in poor yields (United Republic of Tanzania, 1991).

4.3.3 Seed Spacing

The recommended spacing for full season varieties of maize is 25-30 cm by 75-90 cm with one plant per hill. In the Southern Highlands area (where the study area is located) with an altitude of over 1,500 m and reliable rainfall, planting two plants of maize per hill at 50 by 90 cm gives the same yields as a single plant per hill at 25-30 cm by75-90 cm (TARO, 1987). Respondents' adoption behaviour regarding the seed spacing is summarized in Table 4.8 below.

Table 4. 8: Distribution of respondents according to seed spacing adoption and production efficiency as reflected in yield (bags/acre)

Number of seeds	Seed spacing (cm)	Yield categories (bags/acre)							
		1-10		10-20		>20		Total	
		n	%	n	%	n	%	N	%
One	<20 x <60	2	66.7	1	33.3	0	0.0	3	3.2
	20-25 x 60-75	16	32.0	26	52.0	8	16.0	50	52.6
	25-30 x 75-90	14	33.3	12	28.6	16	38.1	42	44.2
	Total	32	33.7	39	41.1	24	25.3	95	100.0
One, two[6]	20-25 x 60-75	2	50.0	1	25.0	1	25.0	4	40.0
	25-30 x 75-90	3	50.0	2	33.3	1	16.7	6	60.0
	Total	5	50.0	3	30.0	2	20.0	10	100.0
Two	<25 x <75	1	100.0	0	0.0	0	0.0	1	12.5
	25-50 x 75-90	1	16.7	1	16.7	4	66.7	6	75.0
	50 x 90	0	0.0	0	0.0	1	100.0	1	12.5
	Total	2	25.0	1	12.5	5	62.5	8	100.0

One seed/hill (r= 0.182; p= 0.078)

One, two seeds/ hill (r= -0.052; p= 0.886)

Two seeds/hill (r= 0.583; p= 0.129)

According to Table 4.8 there is no significant relationship between seed spacing and the maize yield (r = 0.182, p= 0.078; r= -0.052, p= 0.886 and r= 0.583; p= 0.129) indicating that seed spacing has little effect on yield. The results might be inaccurate either because of 1) the wrong estimations of the seed spacing used due to the fact that most of the respondents use step or foot measures estimations instead of the recommended rope or stick. 2) The inappropriateness of the seed spacing recommendations 3) the scale used for its measurement.

[6] In a row for example, if the first hill is planted with one seed then the second hill is planted with two seeds. This is repeated for the whole row

4.3.4 Weeding

Weeds interfere with crop growth through competition for water, light and nutrients. Some weeds may also harbour insect pests and diseases that directly infect the crop plants, consequently causing losses in yield (Temu, 1988). In the Southern Highlands of Tanzania where the study area is located, yield reductions resulting from weeds have been recorded to range from 60-75 percent of the potential yield (Croon *et al.,* 1984).

As said earlier, the most important types of weeds that are believed to contribute to a drastic decrease in the maize yield in the study area are *tradescantia fluminerisis* (wandering jew), *cynodon dactylon* (cough grass) and nut grass. The prevalence of these weeds was used as a criterion for weed infestation. These were categorized into four categories namely, "no weed infestation" for farmers who had none of the mentioned types of weeds; "low weed infestation" for farmers who had one type of weed; "medium weed infestation" for farmers who had two types of weeds and "high weed infestation" for farmers who had all three types of weeds. Table 4.9 shows the distribution of respondents according to the weed infestation and maize yield.

Table 4.9: Distribution of respondents according to weed infestation and production efficiency as reflected in yield (bags/acre)

Weed infestation	**Yield categories (bags/acre)**							
	1-10		10-20		>20		Total	
	n	%	n	%	n	%	N	%
None	0	0.0	5	38.5	8	61.5	13	11.5
Low	7	18.9	14	37.8	16	43.2	37	32.7
Medium	10	25.6	23	59.0	6	15.4	39	34.5
High	22	91.7	1	4.2	1	4.2	24	21.2
Total	39	34.5	43	38.1	31	27.4	113	100.0

χ^2 =58.110; df=6; p=0.000

r= -0.587; p=0.000

Although the prevalence of weed infestation is believed to have a significant decrease in yield, Table 4.9 shows that only few respondents have no weed infestation. Most of the respondents (91.7 percent) with the high weed infestation had a low maize yield of 1-10 bags per acre. The results reveal a highly significant negative correlation (r= -0.587; p=0.000) between the degree of weed infestation and the maize yield, which implies that the lower the degree of weed infestation, the higher the maize yield tends to be. For example 61.5 percent of those respondents without a single type of weed infestation had yields of more than 20 bags per acre, while the percentage of those with high weed infestation was only 4.2 percent.

To overcome weed infestation, the recommended weeding frequency in the study area is three times or more but, according to Table 4.10, which gives an overview of the weeding frequency, the majority of the respondents weed three times. No single respondent weeds more than three times.

Table 4.10: Distribution of respondents according to weeding frequency and production efficiency as reflected in yield (bags/acre)

Weeding frequency	Yield categories (bags/acre)							
	1-10		10-20		>20		Total	
	n	%	n	%	n	%	N	%
Twice	22	40.0	18	32.7	15	27.3	55	48.7
Thrice	17	29.3	25	43.1	16	27.6	58	51.3
Total	39	34.5	43	38.1	31	27.4	113	100.0

$\chi^2 = 1.734$; df = 2; p = 0.420

r = 0.82, p =0.386

According to the distributions there is a slight tendency for an increased frequency of weeding to increase yields, but this only applies below the 20 bags/acre threshold, but is not statistically significant ($\chi^2 = 1.734$; df = 2; p = 0.420; r = 0.82, p =0.386). A possible reason for the low relationship between the weeding frequency and yield is that the weeding frequency is a function of weed infestation, which as has been shown in Table 4.9, is negatively related to yield.

A further analysis of the relationship between weeding frequency, degree of weed infestation and the yield is shown in Table 4.11. According to the results there is a highly significant relationship (r= -0.593; p= 0.000 and r= -0.574; p= 0.000) between degree of weed infestation and the maize yield within the weeding frequency categories.

Table 4. 11: Distribution of respondents according to weeding frequency, weed infestation and production efficiency as reflected in yield (bags/acre)

Weeding Frequency	Weed infestation	Yield categories (bags/acre)							
		<10		10-20		>20		Total	
		n	%	n	%	n	%	N	%
Twice									
	None	0	0.0	2	33.3	4	66.7	6	10.9
	Low	2	14.3	6	42.9	6	42.9	14	25.5
	Medium	7	35.0	9	45.0	4	20.0	20	36.4
	High	13	86.7	1	6.7	1	6.7	15	27.3
	Total	22	40.0	18	32.7	15	27.3	55	100.0
Three times	None	0	0.0	3	42.9	4	57.1	7	12.1
	Low	5	21.7	8	34.8	10	43.5	23	39.7
	Medium	3	15.8	14	73.7	2	10.5	19	32.8
	High	9	100.0	0	0.0	0	0.0	9	15.5
	Total	17	29.3	25	43.1	16	27.6	58	100.0

Twice: r= -0.593; p= 0.000

Three times: r= -0.574; p= 0.000

For example, 66.7 percent of those without any weed infestation and weed two times had yields of more than 20 bags per acre, while the percentage of those with high weed infestation was only 6.7 percent. The trend is the same in the case of those who weed three times. For example, 57.1 percent of those without any weed infestation had yields of more than 20 bags per acre, while not a single farmer with high weed infestation had yields of more than 20 bags/ acre.

However there is a little support for the assumption that farmers who weed less are the ones with lower weed infestations. The fact that 63.7 percent of the respondents weeding twice had a medium or high infestation of weeds as opposed to 48.3 percent of those weeding three times, rejects the view that weeding is a function of the degree of infestation in the survey area. This might be attributed to the fact that the measures that are used in this study to measure the influence of weeding on production efficiency are not very realistic or fail to differentiate between different levels of weeding effectiveness. A more refined measure of weeding is therefore required to shed more light on the causality relationship between weed control and production efficiency.

4.4 MAIZE PRODUCTION PACKAGE

The previous section assessed the influence of individual maize production practice on production efficiency. This section will go further to evaluate the influence of maize production package in totality on production efficiency. The linear regression model was used to assess the relationship. The model results are summarized in Table 4.12.

Table 4.12: Relationship between maize production packages and production efficiency as reflected in yield (bags/acre)

Variable	Beta	t	p
(Constant)		0.003	0.998
Maize variety	0.073	1.071	0.287
Phosphate fertilizers	0.189	2.137	0.035
Nitrogen fertilizers	0.295	3.354	0.001
Time of Nitrogen fertilization	0.126	1.944	0.055
Fertilizer Package	-0.025	-0.210	0.834
Seed spacing	0.095	1.637	0.105
Degree of weed infestation[7]	-0.476	-7.609	0.000
Weeding frequency	-0.032	-0.580	0.563
Number of seeds per hill	0.110	1.918	0.058

R^2 = 0.720, p = 0.000

The total contribution of all included practices toward the explanation of yield variation is only about 55 percent. It is meaningful that the mere inclusion of weed infestation as an independent variable increases the regression (R^2) or explanation of variation from 55 to 72 percent (Table 4.12).

The degree of weed infestation explains more than any of the practices studied followed by the use of nitrogen and then the use of phosphate fertilizers. The degree of weed infestation is however, not a practice, but the findings regarding its importance do suggest that with better and more appropriate measures and indicators, degree of weed infestation would have emerged as a much more important yield or efficiency determining factor.

[7] The degree of weed infestation is not a practice but it has been included in the model because it has an influence on yield and it was expected to have an influence on weeding frequency and consequently on the yield. Also, there is no other measure in this study found to measure the influence of weeding on production efficiency.

The fact that weed control, measured as weeding frequency, did not significantly contribute towards the regression, clearly shows that the measure used is inappropriate and that much work needs to be done in order to come up with appropriate and practical measures for assessing the level of weed control for baseline or for extension output purposes.

These findings represent convincing evidence in support of the widely accepted causal relationship between practice adoption and production efficiency. More importantly, the evidence provides the basis for the behaviour analysis model, which focuses on the adoption of recommended practices as the means of increasing efficiency, in this case the yields.

CHAPTER 5

THE INFLUENCE OF INDEPENDENT AND INTERVENING VARIABLES ON ADOPTION OF RECOMMENDED MAIZE VARIETIES

5.1 INTRODUCTION

Over a number of years, the independent variables like socio-economic, environmental and institutional have been widely accepted and considered as the determinants of the adoption behaviour. However, as it is explained in chapter 2 various adoption studies have revealed an inconsistency on relationship between independent variables and adoption behaviour (Rogers, 1983; Adesina and Baidu-Forson, 1995; CIMMYT, 1993; Amir and Pannel, 1999; John, 1995; Temu, 1996; Kalineza, 2000). Due to unclear relationship between the independent variables and adoption behaviour, various studies (Düvel, 1975; Louw and Düvel, 1993; Düvel and Scholtz, 1986; Botha, 1986; Düvel and Botha, 1999; Habtemariam, 2004) were conducted to determine other variables that have a better prediction value of adoption behaviour, and came up with the following intervening variables namely, need, knowledge and perception.

According to Düvel (1991), any adoption behaviour model, in order to be acceptable, must make provision for influence of an extensive number of dynamically interdependent personal and environmental factors, which depending on the situation can potentially become functional in various combinations and directions. In his model, Düvel (1991) makes provision for both the independent variables (personal and environmental factors) and intervening variables. Among the intervening variables he has identified needs, knowledge and perception and argues that the influence of independent variables become manifested in decision - making (adoption behaviour) via the intervening variables. The intervening variables are thus considered to be the most immanent and direct forerunners of the behaviour.

This chapter presents the results of the influence of independent and intervening variables on adoption of recommended maize varieties. Thereafter analyses are carried out to determine the comparative contribution of the independent and intervening variables to the adoption behaviour.

5.2 INDEPENDENT VARIABLES

The independent variables discussed in this study include sex, age, formal education, farm size and area under maize. In this section each individual variable is examined separately to determine its influence on adoption of recommended maize varieties and thereafter the linear regression model is used to evaluate the influence of all independent variable on adoption behaviour. The model will also identify the independent variables that contribute most to the adoption behaviour.

5.2.1 Age

An overview of the age of respondents in the study area is summarized in Table 5.1 below.

Table 5. 1: Distribution of the respondents according to their age

Age category	Respondents	
	N	%
<36	31	27.4
36-56	59	52.2
>56	23	20.4
TOTAL	113	100.0

Mean =45.4; Minimum=20; Maximum=80

In the study area most of the farmers are reasonably young as is the case else where in Tanzania (Bwana, 1996; Temu, 1996; Lohay, 1998; Kalineza, 2000). According to Table 5.1, the large majority of the respondents (80 percent) are under 56 years of age and therefore can be expected to still perform all farming activities. The mean age is 45.4 but there are big variations, the youngest respondent being 20 years and the oldest 80 years old.

Young and energetic people have been found to be more venturesome, active and ready to try innovations (Rogers, 1983; Polson and Spencer, 1991; Nanai, 1993; John, 1995; CIMMYT, 1993; Van den Ban and Hawkins, 1996). This implies a negative relationship between age and adoption, and it is consequently assumed that age of the respondents is also likely to be negatively related to the adoption of recommended maize varieties. The results are summarized in Table 5.2 below.

Table 5. 2: Distribution of respondents according to their age and the adoption of maize varieties

Age (years)	Adoption							
	Replanted hybrid		Local varieties		Recommended hybrid		Total	
	n	%	n	%	n	%	N	%
>36	11	35.5	12	38.7	8	25.8	31	27.4
36-56	27	45.8	20	33.9	12	20.3	59	52.2
>56	8	34.8	15	65.2	0	0.00	23	20.4
Mean ages	44.8		49.2		37.7		45.4	

χ^2 = 10.219; df=4; p=0.037

r = -0.113; p=0.235

The results show significant differences between the age groups in terms of adoption of maize varieties (χ^2 = 10.219; df=4; p=0.037). However, the correlation is not significant (r = -0.113, p= 0.235) and can be attributed to the fact that the relationship is not quite linear.

Evidence of the non-linear relationship is the mean ages of the different adoption categories. Also the biggest percentage of the oldest farmers (65.2 percent) plant local varieties while the biggest percentage of the middle - age group (36-56 years) use replanted hybrid, which is probably the worst practice. Another possible reason for the insignificant relationship or for the non-linear relationship could be the unequal intervals between the scale items.

5.2.2 Sex

Women are estimated to be the heads of one third of households worldwide (Gass and Bigs, 1993). In Africa, women have always been actively involved in agriculture. For example, in Tanzania 88 percent of women are engaged, directly or indirectly, in agricultural production (Lugembe, 1991). Although women are considered to be key performers in agriculture their adoption of recommended practices tends to be lower than that of the men (Shayo, 1991; Jefremovas, 1991; Stephens, 1992; Bwana, 1996). In view of this it was hypothesized that the adoption of recommended maize varieties is higher among men than among women respondents. The findings regarding the relationship between gender and adoption are summarized in Table 5.3.

Table 5. 3: Distribution of respondents according to their sex and the adoption of maize varieties.

Sex	Adoption							
	Replanted hybrid		**Local varieties**		**Recommended hybrid**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**	**N**	**%**
Male	25	35.7	29	41.4	16	22.9	70	61.9
Female	21	48.8	18	41.9	4	9.3	43	38.1
Total	46	40.7	47	41.6	20	17.7	113	100.0

χ^2 =3.893; df=2; p=0.143

r= -0.178; p=0.060

Although the differences between the gender categories are not significant, there are clear indications of a correlation, albeit only at a 6 percent probability (p=0.06). The negative correlation (r=-0.178) implies that female farmers are less inclined than the male farmers to adopt the recommended hybrids. For example 22.9 percent of male farmers planted the recommended hybrid, while the percentage among women is only 9.3. This relationship does not necessarily imply that gender has a direct influence on adoption behaviour, but could imply that the influence is because of gender related factors like contact with extension or other sources of technology.

5.2.3 Formal education

Better-educated farmers are assumed to have enhanced information processing abilities allowing them to make better decisions. The more complex the recommended practice is, the more likely it is that education will play a role in its adoption. Reviewed literature (Levinger and Drahman, 1980; Rogers, 1983; Anosike and Coughenour, 1990; CIMMYT, 1993; Lugeye, 1994) indicate the existence of a positive relationship between formal education and adoption leading to the assumption that the farmers qualification has a positive influence on adoption. An overview of the respondent's education with respect to adoption is presented in Table 5.4 below.

Table 5. 4: Distribution of respondents according to their formal education and the adoption of maize varieties

Formal education (years)	Adoption							
	Replanted hybrid		Local varieties		Recommended hybrid		Total	
	n	%	n	%	n	%	N	%
0	10	50.0	9	45.0	1	5.0	20	17.7
1-7	32	50.0	28	43.8	4	6.3	64	56.6
>7	4	13.8	10	34.5	15	51.7	29	25.7
Total	46	40.7	47	41.6	20	17.7	113	100.0

χ^2 =32.953; df=4; p=0.000

r= 0.410; p=0.000

As far as education is concerned, very few interviewed respondents have not had any formal education (17.7 percent), and larger majority (56.6 percent) have seven years of formal education (primary education), which is common in Tanzania. The correlation analysis reveal a highly significant positive correlation between formal education and adoption implying that the higher the formal education is, the higher the adoption of recommended maize varieties tends to be.

This evidence is clearly seen in Table 5.4 where 51.7 percent of those respondents with formal education of more than seven years of schooling had adopted the recommended maize varieties while only 5 percent of those who did not have formal education did so. The results are supportive of the hypothesis that there is a significant positive relationship between formal education and adoption.

5.2.4 Farm size

Farm size is an independent variable of assumed importance that was also looked at in this survey. It is widely accepted that the farmer's farm size tends to influence his/her decision regarding the adoption of recommended practices. Evidence of this relationship has been provided by amongst others, Rogers, 1983; Jamison and Laurance, 1982; Wambura, 1988; Hussain *et al.,* 1994; Senkondo *et al.,* 1998 and Kalineza, 2000).

In Tanzania most of the farmers are subsistence farmers with small farms. The distribution of the respondents' farm sizes in relation to their adoption of maize varieties is presented in Table 5.5

Table 5. 5: Distribution of respondents according to their farm size and the adoption of maize varieties

Farm size (acres)	Adoption							
	Replanted hybrid		Local varieties		Recommended hybrid		Total	
	n	%	n	%	n	%	N	%
<3	18	46.2	16	41.0	5	12.8	39	34.5
3-6	20	44.4	19	42.2	6	13.3	45	39.8
>6	8	27.6	12	41.2	9	31.0	29	25.7
Total	46	40.7	47	41.6	20	17.7	113	100.0

χ^2 =5.596; df=4; p=0.231

r= 0.184; p=0.051

As elsewhere in Tanzania most of the respondents in the study area have very small farms with the majority (39.8 percent) of them owning 3 to 6 acres (Table 5.5). Maize farms occupy about 57 percent of the total land owned. Although the differences between the farm size categories are not significant, there are indications of a correlation, albeit only at a 6 percent probability (p=0.06) implying that the larger the farm size is, the higher the adoption tends to be. This is manifested in the fact that 31 percent of the respondents who own more than 6 acres have adopted recommended maize varieties while only 12.8 percent of those who own less than 3 acres did so.

5.2.5 Area under maize

The survey went further to assess the influence of area under maize on the adoption of recommended maize varieties. The results are presented in Table 5.6

Table 5. 6: Distribution of respondents according to their area under maize and the adoption of maize varieties

Area under maize (acre)	Adoption							
	Replanted hybrid		Local varieties		Recommended hybrid		Total	
	n	%	n	%	n	%	N	%
<=1	14	53.8	8	30.8	4	15.4	26	23.0
1.1-3	26	43.3	27	45.0	7	11.7	60	53.1
>3	6	22.2	12	44.4	9	33.3	27	23.9
Total	46	40.7	47	41.6	20	17.7	113	100.0

χ^2 =9.464; df=4; p=0.050

r= 0.235; p=0.012

The distribution of farmers according to farm size follow a normal distribution with the majority of the respondents (76.1 percent) growing between one and three acres of maize. As confirmed by the correlation (r= 0.235; p=0.012) there is a significant relationship between the area under maize and the adoption of recommended maize varieties implying that the bigger the area under maize, the higher the adoption tends to be. For instance, 33.3 percent of those respondents with farm size of more than three acres had adopted recommended maize seeds, while the percentage of those with equal or less than one acre is only 15.4 percent. These findings although they do not rule out the influence of farm size (p=0.051), seem to indicate that the size of the enterprise rather than the size of the farm has an influence on adoption behaviour.

5.2.6 Total influence of independent variables

This section investigates the total influence of independent variables discussed above on the adoption of recommended maize varieties. To achieve this, the linear regression model was used. The independent variables entered into the model include age, sex, formal education, farm size, and the area under maize. Table 5.7 summarizes the model results.

Table 5. 7: Total influences of independent variables

Variable	Beta	t	p
(Constant)		1.404	0.163
Sex	-0.039	-0.399	0.691
Age	-0.001	-0.013	0.990
Formal education	0.364	3.350	0.001
Farm size	-0.015	-0.131	0.896
Area under maize	0.144	1.416	0.160

$R^2 = 0.187$, $p = 0.000$

According to Table 5.7 formal education and area under maize are confirmed to be the variables contributing most significantly to the adoption of maize varieties. However the total contribution towards explaining the variance in adoption is only 18.7 percent. This is reflected in the significant R^2 of 0.187. In accordance with the research hypothesis, the findings provide clear evidence of the influence of some independent variables on decision making or adoption behaviour, but the total influence is somewhat limited and, according to literature (Rogers, 1983) not always consistent.

5.3 INTERVENING VARIABLES

The following section will evaluate the influence of intervening variables on adoption behaviour to assess and to ultimately compare their influence with that of the independent personal and environmental variables. The intervening variables considered in this study include various aspects of needs, perception, and knowledge. Each intervening variable's relationship with the adoption of recommended maize varieties will be analyzed separately in this section.

5.3.1 Efficiency misperception (EM)

Efficiency misperception is one of the intervening variables that Düvel (1991) identified to be one of the major behaviour determinants. There is a tendency of individuals to overrate their own production and or practice adoption efficiency. This is bound to have a significant effect on adoption behaviour due to the fact that the more the efficiency is overrated, the smaller the problem scope or need tension becomes and thus the smaller the incentive to adopt the recommended innovations.

This assumed influence is based on various research findings (Koch, 1987; Düvel, 1991; Düvel, 2004;) and has led o the hypothesis that there is a significant negative relationship between the EM and adoption of recommended maize seeds. Table 5.8 summarizes the relationship between EM and adoption of recommended maize varieties.

Table 5. 8: Relationship between EM and adoption of recommended maize varieties

Efficiency perception Assessment	Adoption: Local varieties n	%	Replanted hybrid n	%	Recommended hybrid n	%	Total N	%
Underrate	16	42.1	16	42.1	13	81.3	16	14.2
Slightly underrate	0	0.0	2	22.2	7	77.8	9	8.0
Assess correctly	4	18.2	18	81.8	0	0.0	22	19.5
Slightly overrate	5	17.2	24	82.8	0	0.0	29	25.7
Overrate	37	100.0	0	0.0	0	0.0	37	32.7
Total	46	40.7	47	41.6	20	17.7	113	100.0

χ^2 =157.817; df = 8; p=0.000

r= -0.860; p=0.000

The majority of the respondents namely 58.4 percent overrate their efficiency of maize variety choice when compared to a more "objective" measure or assessment by the enumerator. All of these respondents do not adopt the recommended hybrid cultivars, and the likely reason for this is their high assessment (overrating), and consequent they are satisfied with their current choice and thus the little or no need tension to change. The almost opposite applies to the 22.2 percent respondents, that underrate their efficiency. This underrating indicates a scope for improvement and probably leads towards an attitude of continuously wanting to improve. This very close and significant relationship between EM and adoption of recommended varieties is reflected in the highly significant negative correlation (r=-0.860, p=0.000), which implies that the adoption rate decreases with increasing misperception (overrating) of the current adoption efficiency.

The more farmers misperceive or overrate their efficiency of practice adoption to be better than it really is, the lower the incentive to change their behaviour towards what is recommended. Clear evidence of this is that, for example, 81.3 percent of the respondents who underrate their current efficiency of maize variety adoption had adopted, while not a single respondent who perceived his/her current efficiency better than "objectively" assessed, had adopted.

5.3.2 Need tension (NT)

Need tension (NT) is another key intervening variable that is expected to have an influence on adoption behaviour. Düvel (1991) defines need tension as the problem scope or perceived discrepancy between the current and the desired or potential situation. NT was assumed to be also positively related with adoption of recommended maize varieties. Evidence of this relationship has previously been found by Düvel (1975); Düvel and Botha (1999); Düvel (1991); Düvel and Scholtz (1986); Düvel (2004). Table 5.9 summarizes the survey results.

Table 5. 9: Relationship between Need Tension (NT) and adoption of recommended maize varieties

Need Tension (NT)	Adoption							
	Replanted hybrid		Local varieties		Recommended hybrid		Total	
	n	%	n	%	n	%	N	%
Low	44	100.0	0	0.0	0	0.0	44	38.9
Medium	0	0.0	44	100.0	0	0.0	44	38.9
High	2	8.0	3	12.0	20	80.0	25	22.1
Total	46	40.7	47	41.6	20	17.7	113	100.0

χ^2 =192.533; df = 4; p=0.000
r= 0.916, p= 0.000

All the respondents (44) with a low need tension, replanted hybrids, which is judged to be the poorest or least recommended practice and clearly shows the influence of this lacking need. On the other hand, 80 percent of those with a high need tension adopted the recommended hybrids. This is indicative of a very close relationship, as shown by the highly significant correlation coefficient (r=0.916, p=0.000) and clearly reflects that the adoption of recommended maize varieties in the study area increases with the increase in need tension.

5.3.3 Need compatibility

Düvel (2004) contends that Need incompatibility is another need related cause of non adoption in the sense that the suggested solution, in terms of increased efficiency or a specific innovation or practice, is not compatible with the individual's needs, aspirations, goals or problems. This means that it does not fit into the psychological field or need situation, in so far as that it is not perceived as either a need related goal, or as a means of achieving such a poor. Need compatibility is therefore confirmed to have a positive influence on the adoption behaviour (Louw and Düvel, 1993; Düvel and Botha, 1999; Habtemariam, 2004). The survey results on the relationship between need compatibility and the adoption of maize varieties are presented in Table 5.10

Table 5. 10: Relationship between Need compatibility (NC) and the adoption of maize varieties

Need compatibility	Maize varieties							
	Replanted hybrid		Local varieties		Recomm. hybrid		Total	
	n	%	n	%	n	%	N	%
Low need compatibility	39	47.0	44	53.0	0	0.0	83	75.5
Medium need compatibility	3	30.0	2	20.0	5	50.0	10	9.1
High need compatibility	2	11.8	0	0.0	15	88.2	17	15.5
Total	44	40.0	46	41.8	20	18.2	110	100.0

χ^2 = 81.930; df = 4; p=0.000

r= 0.631, p= 0.000

The majority of the respondent farmers (75.5 percent) have low need compatibility or perceive that the suggested maize varieties do not fit into the psychological field or need situation, hence poor adoption. None of these respondents planted hybrid varieties while 88.2 percent of those with high need compatibility had adopted. There is a highly positive significant correlation (r = 0.631, p = 0.000) between need compatibility and adoption behaviour (Table 5.10). The positive correlation implies that the more hybrid varieties are perceived to be compatible with the farmers needs, aspirations, goals or problems the higher the adoption tends to be. In other words the more hybrid maize varieties seem to improve maize yield the higher the adoption. The low yield observed in the study area might be therefore attributed by the fact that the recommended varieties are perceived to be incompatible with most of the farmers need.

5.3.4 Awareness

Awareness is another intervening variable that has been found to have an influence on adoption behaviour (Düvel, 2001; Düvel, 2004). It refers to an awareness of recommended solutions or the optimum that is achievable in terms of efficiency.

In this case awareness refers as the knowledge of recommended maize varieties in the study area, and farmers were asked to indicate which maize varieties are recommended in their area. The findings relating to the relationship between awareness and adoption are represented in Table 5.11

Table 5. 11: Relationship between awareness and adoption of recommended maize varieties

Awareness	Adoption							
	Replanted hybrid		Local varieties		Recommended hybrid		Total	
	n	%	n	%	n	%	N	%
Not aware	39	52.7	35	47.3	0	0.0	74	65.5
Aware	7	17.9	12	30.8	20	51.3	39	34.5
Total	46	40.7	47	41.6	20	17.7	113	100.0

χ^2 =47.204; df = 2; p=0.000

r= 0.513, p= 0.000

According to Table 5.11, the majority of the respondents lack knowledge of the recommended maize varieties in their area. Only 34.5 percent of the respondents seem to be aware of the recommended varieties. The results show that there is a highly significant positive correlation (r=0.513, p=0.000) between awareness of recommended maize varieties and their adoption, implying that awareness of recommended maize varieties tends to lead to a higher adoption rate. For example 51.3 percent of the respondents that are aware of recommended maize varieties in their area adopted it while not a single respondent who had no knowledge of recommended maize varieties did so.

5.3.5 Prominence

Prominence, which is defined as the degree to which an innovation is perceived as being better than the idea it supersedes, is another intervening variable evaluated in this study. It is contended that the more an innovation or a practice is perceived to be relatively better than the traditional practices, the higher the adoption is likely to be (Düvel, 1991; Düvel, 2004). Table 5.12 summarizes the survey results.

Table 5. 12: Relationship between prominence and adoption of recommended maize varieties

Prominence	Adoption							
	Replanted hybrid		Local varieties		Recommended hybrid		Total	
	n	%	n	%	n	%	N	%
Low prominence	4	66.7	2	33.3	0	0.0	6	5.3
Medium prominence	39	52.0	36	48.0	0	0.0	75	66.4
High prominence	3	9.4	9	28.1	20	62.5	32	28.3
Total	46	40.7	47	41.6	20	17.7	113	100.0

χ^2 =63.919; df = 4; p=0.000

r= 0.637, p= 0.000

The perceived prominence clearly seems to have an influence on the adoption of recommended maize varieties in the study area. As indicated in Table 5.12, the majority of the respondents (71.4 percent) perceived the recommended varieties to have a low or medium prominence relative to their own varieties and none of these respondents adopted. This clear relationship between perceived prominence and adoption is also reflected in the highly significant correlation coefficient (r=0.637, p=0.000).

5.3.6 Perceived advantages and disadvantages of recommended maize varieties

The perceived advantages and disadvantages of recommended maize varieties are further aspects of perception that can have an influence on adoption. The perceived advantages of recommended maize varieties will be discussed first followed by the perceived disadvantages.

5.3.6.1 Perceived advantages

This is based on the assumption that the adoption of recommended maize varieties is attributed to the favourable perception concerning the advantages of the recommended maize varieties.

Farmers were therefore asked to list the advantages of recommended maize varieties that they regarded to be important in their adoption decision. The most important advantages mentioned are high yield, early maturity, good taste and good grain quality (Table 5.13).

Table 5. 13: Relationship between perceived advantages and adoption of recommended maize varieties

Attributes forces (strength)	Adoption							
	Replanted hybrid		Local varieties		Recommended hybrid		Total	
	n	%	n	%	n	%	N	%
High yield								
Negative	14	50.0	14	38.9	0	0.0	28	33.3
Low positive	13	46.4	14	38.9	0	0.0	27	32.1
Medium positive	0	0.0	1	2.8	0	0.0	1	1.2
High positive	1	3.6	7	19.4	20	100.0	28	33.3
Total	28	33.3	36	42.9	20	23.8	84	100.0
χ^2 =55.573; df = 6; p=0.000; r= 0.696, p= 0.000								
Early maturity								
Negative	4	57.1	2	18.2	1	6.3	7	20.6
Low positive	3	42.9	4	36.4	0	0.0	7	20.6
High positive	0	0.0	5	45.5	15	93.8	20	58.8
Total	7	20.6	11	32.4	16	47.1	34	100.0
χ^2 =20.252; df = 4; p=0.000; r= 0.721, p= 0.000								
Good taste								
Negative	6	40.0	3	15.0	0	0.0	9	18.4
Low positive	8	53.3	13	65.0	5	35.7	26	53.1
Medium positive	1	6.7	1	5.0	1	7.1	3	6.1
High positive	0	0.0	3	15.0	8	57.1	11	22.4
Total	15	30.6	20	40.8	14	28.6	49	100.0
χ^2 =19.288; df = 6; p=0.004; r= 0.582, p= 0.000								
Good grain quality								
Negative	1	33.3	1	25.0	0	0.0	2	13.3
Low positive	2	66.7	2	50.0	0	0.0	4	26.7
High positive	0	0.0	1	25.0	8	100.0	9	60.0
Total	3	20.0	4	26.7	8	53.3	15	100.0
χ^2 =11.875; df =4; p=0.018; r= 0.835, p= 0.000								

Some of the respondents listed the advantages as the negative forces that influenced their adoption behaviour. For example all the respondents who adopted the recommended maize varieties regarded high yield as a high positive force that enhanced their adoption decision. On the other hand, there was no adoption among the respondents who considered high yield as a negative force. This is indicative of a highly significant correlation (r= 0.696, p= 0.000).

In all cases there is a highly significant correlation between advantages and adoption of recommended varieties, with the influence of good grain quality (r= 0.835, p= 0.000) and early maturity (r= 0.721, p= 0.000) probably contributing most towards adoption. This implies that the adoption of recommended maize varieties tends to be associated with the awareness of the advantages pertaining to high yield, early maturity, good taste and good grain quality.

5.3.6.2 Perceived disadvantages

As far as the perceived disadvantages of recommended maize varieties are concerned, it is assumed that an awareness of them will hinder the adoption of recommended maize varieties. Farmers were therefore asked to list the disadvantages of recommended maize varieties that were important in their decision-making. The most important disadvantages mentioned include poor milling quality of grain, low storability, high implementation costs, and poor resistance to drought (Table 5.14).

Table 5. 14: Relationship between perceived disadvantages and adoption of recommended maize varieties

Attributes forces (strength)	Adoption							
	Replanted hybrid		Local varieties		Recommended hybrid		Total	
	n	%	n	%	n	%	N	%
Poor milling quality								
Positive	1	5.3	4	18.2	8	88.9	13	26.0
Low negative	5	26.3	5	22.7	1	11.1	11	22.0
Medium negative	0	0.0	1	4.5	0	0.0	1	2.0
High negative	13	68.4	12	54.5	0	0.0	25	50.0
Total	19	38.0	22	44.0	9	18.0	50	100.0
χ^2 =25.154; df = 6; p=0.000; r= -0.540, p= 0.000								
High implementation costs								
Positive	0	0.0	1	5.9	2	22.2	3	6.0
Low negative	3	12.5	2	11.8	6	66.7	11	22.0
High negative	21	87.5	14	82.4	1	11.1	36	72.0
Total	24	48.0	17	34.0	9	18.0	50	100.0
χ^2 =21.032; df = 4; p=0.000; r= -0.554, p= 0.000								
Low storability								
Positive	0	0.0	0	0.0	3	30.0	3	7.3
Low negative	5	29.4	3	21.4	7	70.0	15	36.6
High negative	12	70.6	11	78.6	0	0.0	23	56.1
Total	17	41.5	14	34.1	10	24.4	41	100.0
χ^2 =20.977; df = 4; p=0.000; r= -0.548, p= 0.000								
Poor drought resistance								
Low negative	0	0.0			1	100.0	1	20.0
High negative	4	100.0			0	0.0	4	80.0
Total	4	80.0			1	20.0	5	100.0
χ^2 =5.000; df =1; p=0.025; r= -1.000, p= 0.000								

According to Table 5.14 some of the respondents listed the disadvantages as the positive forces that influenced their adoption behaviour. For example 88.9 percent of the respondents who regarded poor milling quality of grain as a strong positive force adopted the recommended maize varieties, while there was no adoption among the respondents who perceived this as a disadvantage or medium or high negative force. This is proved by a highly negative significant correlation (r= -0.540, p= 0.000).

In accord with expectations, Table 5.14 depicts the existence of a highly negative significant correlation between the perceived disadvantages and the adoption of recommended maize varieties. The influence of poor resistance to drought (r= -1.000, p= 0.000) appears to be the biggest constraint, but the rejection of recommended maize varieties tends to be affected by the poor milling quality of grain, low storability and high implementation costs.

A further analysis was carried out to determine the influence of the total attributes of recommended maize varieties in terms of their total numbers and total weightings on adoption behaviour. The attributes considered include total number of advantages, total number of disadvantages, the difference between total number advantages and total number disadvantages, total number positive forces, total number negative forces, the difference between total number positive and total number negative forces (Table 5.15).

Table 5. 15: Relationship between different categories of adoption and the total numbers and weightings of advantages and disadvantages of recommended maize varieties

Total attributes	Perceived total numbers of advantages/disadvantages			Perceived total weightings of advantages/disadvantages		
	Replant hybrid	Local variet.	Recom. hybrid	Replant. hybrid	Local variet	Recom. hybrid
Total advantages	37	79	102	-15	143	341
	r = 0.648; p=0.000			r = -0.193; p=0.000		
Total disadvantage	185	214	64	686	748	143
	r = -0.061; p=0.518			r = -0.061; p=0.040		
Total advt.- disadvt.	-148	-131	38	-701	-605	198
	r = 0.456; p=0.000			r = 0.491; p=0.000		
Total positive forces	36	78	102	-94	31	363
	r = 0.649; p=0.000			r = 0.634; p=0.000		
Total negative forces	189	210	65	598	651	22
	r = -0.072 ; p=0.451			r = -0.310; p=0.001		
Total(+)-(-) forces	-153	-132	37	-692	-620	341
	r = 0.459; p=0.000			r = 0.527; p=0.000		

The findings in Table 5.15 indicate a highly significant correlation (r= 0.648, p=0.000) between the adoption and the total numbers and weightings of advantages depicting that the adoption increases with the increase in numbers and weightings of the advantages. More specifically, the more farmers are aware and even perceive the advantages of the innovation (technology) as important in their adoption decision-making, the higher its adoption tends to be.

In the case of the disadvantages expressed as the total numbers there is no correlation (r = -0.061; p=0.518), which implies that there is no difference between adopters and non - adopters in terms of awareness of numbers of disadvantages. This is due to the fact that the adopters have gone through the adoption processes that made them to be aware of the disadvantages of the recommended maize varieties. More evidence of the relationship between the adoption of recommended maize varieties and total advantages / total disadvantages is clearly seen in the calculated means (Fig. 5.1).

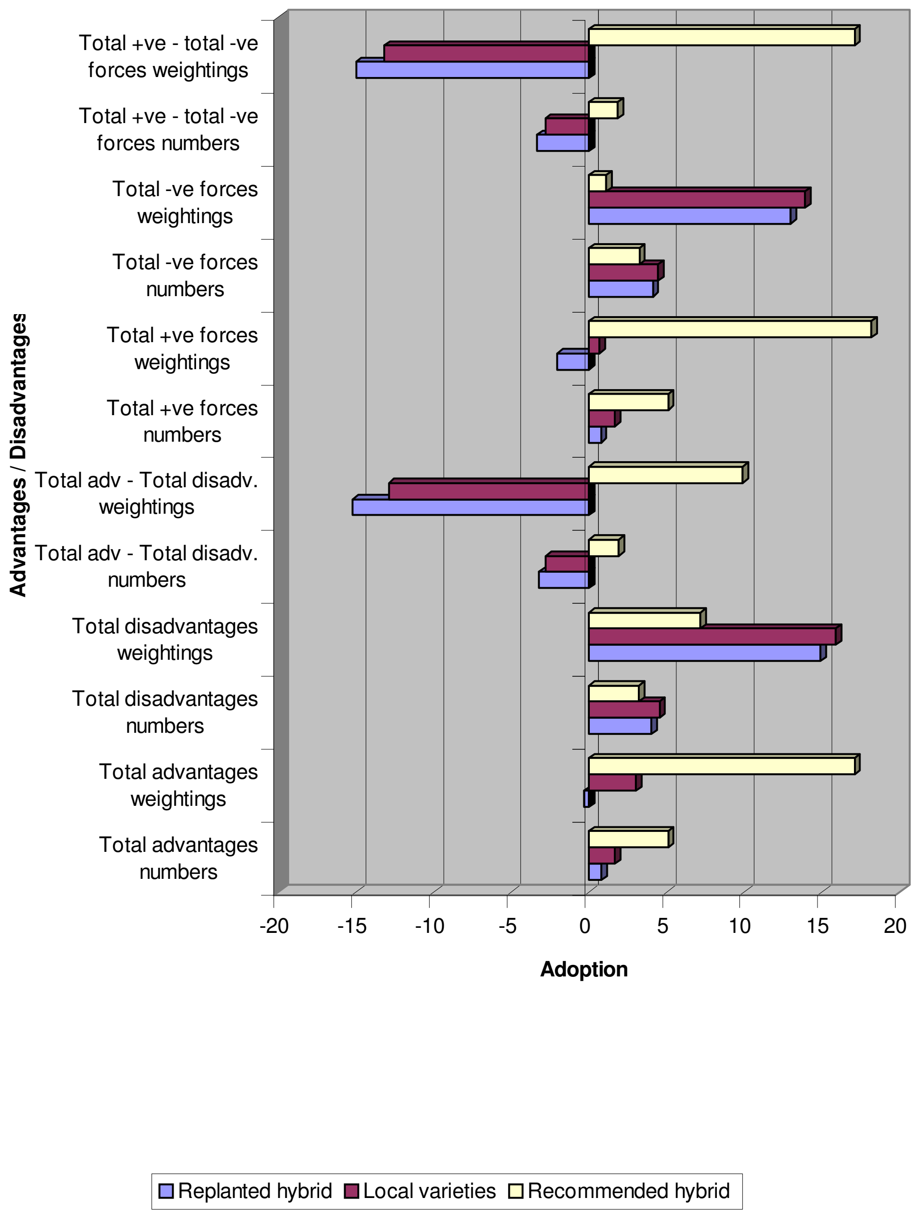

Figure 5. 1: The mean numbers and weightings of advantages and disadvantages of recommended maize varieties as perceived by respondents in different categories of adoption

As far as the advantages are concerned, the mean total numbers and total weightings of the different adoption categories increase in a linear fashion from the poor adoption to the higher adoption levels implying that the higher the numbers and weightings of the total advantages is, the higher the adoption tends to be. In the case of the total disadvantages there is no tendency.

5.3.7 Total influence of intervening variables

In the previous section the influence of each intervening variable on the adoption of recommended maize varieties was discussed individually, and the correlation analysis was used to indicate relationships. In this section the total influence of all tested intervening variables is analyzed and in Table 5.16 the influence of the different individual intervening variables is shown, as well as their combined contribution towards the explanation of total variance in adoption.

Table 5. 16: Linear regression analysis showing the relationship between intervening variables and adoption

Variable	Beta	t	p
Constant		5.423	0.000
Efficiency misperception (EM)	-.232	-2.729	0.008
Need tension (NT)	.659	7.049	0.000
Need compatibility	.023	0.349	0.728
Awareness	-.092	-1.640	0.104
Prominence	.090	1.760	0.082
High yield	-.079	-1.295	0.198
Early maturity	.087	1.749	0.083
Good taste	.003	0.072	0.943
Good grain quality	.072	1.621	0.108
Poor hauling quality of grain	-.020	-0.397	0.692
High implementation costs	-.026	-0.576	0.566
Low storability	.046	1.003	0.318
Poor resistance to drought	-.005	-0.131	0.896

R^2 =0.866, p=0.000

The intervening variables entered into the model contribute very significantly to the adoption of recommended maize varieties. According to Table 5.16 they explain 86.6 percent of the variation in adoption (R^2 =0.866, p=0.000). As far as the individual intervening variables are concerned it is especially the NT (Beta = 0.659, p=0.000) and the efficiency misperception (Beta = -0.232, p=0.008) that make the biggest contribution.

5.4 COMPARISONS BETWEEN INDEPENDENT AND INTERVENING VARIABLES

When comparing the influences of the individual independent and intervening variables on adoption, it appears that the later indicates existence of a highly significant correlation with adoption at 1 percent probability level in each investigated variable, while not a single independent variable appear to have influence on adoption at this probability level. Further more, some of the independent variables like age (p = 0.235), sex (p = 0.060) and farm size (0.051) of the respondents showed lack of the relationship with adoption behaviour as it is hypothesized. As far as the total influence of the two variables on adoption behaviour is concerned, the total influence of intervening variables explains up to 86.6 percent while independent variables contributes only at 18.7 percent (Fig 5.2).

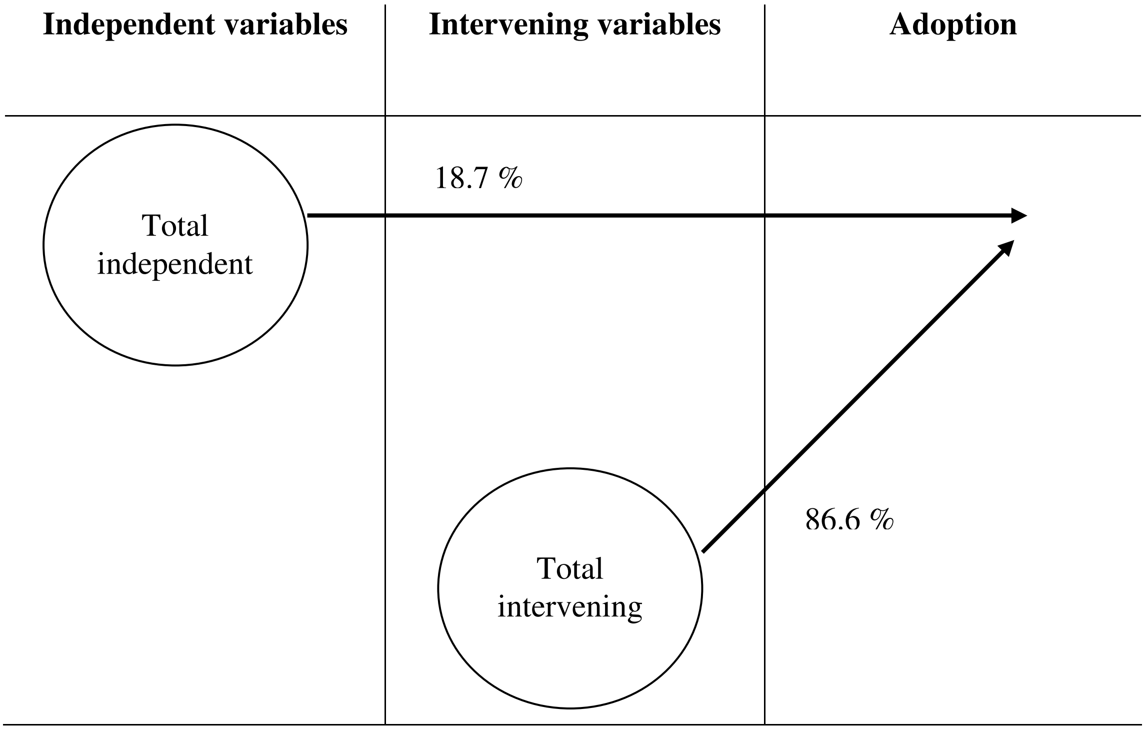

Figure 5. 2: Comparative contribution of independent and intervening variables on adoption behaviour

C H A P T E R 6

THE INFLUENCE OF INDEPENDENT AND INTERVENING VARIABLES ON THE ADOPTION OF PHOSPHATE FERTILIZATION

6.1 INTRODUCTION

Although phosphate fertilization seem to have a tremendous influence on the production efficiency or maize yield, some of the maize growers do not apply the recommended amount or do not apply at all in the maize fields. These lead into the speculation of variables or factors that lead to such non-or poor adoption of this practice. This chapter presents the results of the influence of independent and intervening variables on the adoption of phosphate fertilization, and more specifically the level of adoption. The influences of the independent and the intervening variables are analyzed separately and then total contribution is compared to allow for a comparative influence of the two sets of variables.

6.2 INDEPENDENT VARIABLES

In this section each individual variable namely, sex, age, formal education, farm size and area under maize is assessed separately to explore its influence on adoption of the recommended rate of phosphate fertilization. Thereafter the linear regression model is used to determine the influence of all independent variables on adoption with the ultimate objective of assessing their relative importance in adoption behaviour.

6.2.1 Age

It is assumed that age of the respondents has an influence on the adoption of the recommended rate of phosphate fertilization in the sense that the adoption amongst younger farmers is assumed to be relatively higher than that of the older ones. The survey results with respect to the relationship between age and adoption of recommended rate of phosphate fertilization are summarized in Table 6.1.

Table 6. 1: Distribution of respondents according to their age and phosphate fertilization

Age (years)	Phosphate fertilization (kg/acre)							
	<30		30-50		>50		Total	
	n	%	n	%	n	%	N	%
>36	13	41.9	14	45.2	4	12.9	31	27.4
36-56	36	61.0	17	28.8	6	10.2	59	52.2
>56	20	87.0	1	4.3	2	8.7	23	20.4
Total	69	61.1	32	28.3	12	10.6	113	100.0

χ^2 = 12.404; df=4; p=0.015

r = -0.232; p=0.013

The differences between the age categories are significant at 5 percent probability (χ^2 = 12.404; df=4; p=0.015). The frequency distribution and negative correlation (r = -0.232) indicate not only that old farmers are less receptive than the young farmers to adopt the recommended phosphate fertilization but also, based on the linear relationship that the tendency to adopt decreases with increasing age. For example, the percentage farmers not adopting or applying no or only a minimum of phosphates increase from 41.9 in the case of young farmers, to 61 percent in the case of the middle-age group and to 87 percent in the case of the oldest category of farmers. In other words, there is a clear negative relationship between the age and the adoption behaviour.

6.2.2 Sex

Sex of the respondents was another independent variable that was dealt with to examine its influence on the adoption of recommended phosphate fertilization. Table 6.2 summarizes the results.

Table 6. 2: Distribution of respondents according to their sex and phosphate fertilization

	Phosphate fertilization (kg/acre)							
	<30		30-50		>50		Total	
Sex	**n**	**%**	**n**	**%**	**n**	**%**	**N**	**%**
Male	40	57.1	21	30.0	9	12.9	70	61.9
Female	29	67.4	11	25.6	3	7.0	43	38.1
Total	69	61.1	32	28.3	12	10.6	113	100.0

χ^2 = 1.514; df=2; p=0.469

r = -0.116; p=0.223

There are no significant differences between the sex categories (χ^2 =1.514; df=2; p=0.469) and the correlation analyses also confirms the non-existence of a relationship between sex and the adoption decision (r = -0.116). The negative correlation coefficient implies that, if anything; the adoption rate amongst female farmers is lower than in the case of male farmers.

These findings resemble those relating to the adoption of recommended maize varieties where the sex of the respondents was found to have no significant influence on the adoption behaviour and contributed only at a beta value of -0.039 (p = 0.691) to the adoption variance. This suggests that it is probably not the sex as such, but factors related with sex, like contact with extension, that determine the adoption behaviour.

6.2.3 Formal education

It is expected that the extent to which farmers are educated will have an influence on their adoption behaviour and thus also on the adoption of phosphate fertilization in the Njombe district. An overview of the respondent's education and adoption of phosphate fertilization is presented in Table 6.3 below.

Table 6.3: Distribution of respondents according to their formal education and phosphate fertilization

Formal education (years)	Phosphate fertilization (kg/acre) <30		30-50		>50		Total	
	n	%	n	%	n	%	N	%
0	20	100.0	0	0.0	0	0.0	20	17.7
1-7	40	62.5	19	29.7	5	7.8	64	56.6
>7	9	31.0	13	44.8	7	24.1	29	25.7
Total	69	61.1	32	28.3	12	10.6	113	100.0

χ^2 =25.356; df=4; p=0.000

r= 0.401; p=0.000

According to the findings (Table 6.3) education has a very significant influence on the adoption of phosphate ferilization. Not a single respondent without formal education adopted the recommended rate of phosphate fertilization while about 31.9 percent of those with formal education applied the recommended amount of phosphate fertilizer. The relationship between the two variables is further confirmed by a highly significant correlation (r= 0.401; p=0.000), which implies that the more years of formal education farmers have, the more they tend to adopt the recommended rate of phosphate fertilization.

6.2.4 Farm size

The distribution of the respondents' farm sizes in relation to their adoption of phosphate fertilization is presented in Table 6.4

Table 6. 4: Distribution of respondents according their farm size and the adoption of recommended rate of phosphate fertilization

Farm size (acres)	Phosphate fertilization (kg/acre)							
	<30		30-50		>50		Total	
	n	%	n	%	n	%	N	%
<3	27	69.2	11	28.2	1	2.6	39	34.5
3-6	29	64.4	11	24.4	5	11.1	45	39.8
>6	13	44.8	10	34.5	6	20.7	29	25.7
Total	69	61.1	32	28.3	12	10.6	113	100.0

χ^2 =7.553; df=4; p=0.109

r= 0.236; p=0.012

Although the differences between the farm size categories are not significant (χ^2 =7.553; df=4; p=0.109), the correlation analyses shows a significant positive correlation (r = 0.236; p=0.012) between farm size and the adoption of recommended phosphate fertilization. This signifies that the bigger the farm size is, the higher the adoption. This evidence is clearly seen in Table 6.4 where 20.7 percent of those respondents with farm size of more than six acres adopted the recommended rate of phosphate fertilization, while only 2.6 percent of those with less than three acres did so.

6.2.5 Area under maize

Results of analyses carried out to evaluate the influence of area under maize on the adoption are summarized in Table 6.5.

Table 6. 5: Distribution of respondents according to their area under maize and phosphate fertilization.

Area under maize (acre)	Phosphate fertilization (kg/acre)							
	<30		30-50		>50		Total	
	n	%	n	%	n	%	N	%
<=1	15	57.7	9	34.6	2	7.7	26	23.0
1.1-3	47	78.3	11	18.3	2	3.3	60	53.1
>3	7	25.9	12	44.4	8	29.6	27	23.9
Total	69	61.1	32	28.3	12	10.6	113	100.0

χ^2 =25.792; df=4; p=0.000

r= 0.276; p=0.003

Only 7.7 percent of the respondents owning one acre or less of maize fields applied the recommended rate of phosphate fertilizer while as many as 57.7 percent of them applied less than thirty kilograms per acre, which is regarded as the worst level of fertilization. As confirmed by the correlation (r= 0.276;) this relationship between the area under maize and the level of phosphate application is significant (p=0.003) implying that the bigger the area under maize, the higher the level of adoption.

6.2.6 Total influence of independent variables

In trying to assess the total influence of all the independent variables on the adoption of phosphate fertilization a regression analysis was used. The results are summarized in Table 6.6.

Table 6. 6: Total influences of independent variables

Variable	Beta	t	p
(Constant)		1.220	0.225
Sex	0.020	0.215	0.830
Age	-0.149	-1.492	0.139
Formal education	0.345	3.299	0.001
Farm size	0.100	0.930	0.355
Area under maize	0.129	1.322	0.189

$R^2 = 0.248$, p = 0.000

The overall contribution of independent variables to the explanation of variance is significant (p = 0.000) but amounts to only 24.8 percent ($R^2 = 0.248$). This relatively low contribution can be attributed to the fact that only education contributes very significantly to the explanation of variation regarding the adoption of phosphate fertilization. The fact that age, farm size and area under maize correlated significantly with adoption, but lost significance in the regression analysis indicates a multicollinearity, suggesting that it is not these variables as such, but rather factors associated with them, that have the influence on decision making and adoption behaviour.

6.3 INTERVENING VARIABLES

The other category of variables assumed to be important or more important than the personal and environmental variables (in this study referred to as independent variables) are the intervening variables. Here their influence is analyzed specifically in relation to the adoption of phosphate fertilization. The variables under consideration include the efficiency misperception (EM), need tension (NT), awareness and perception.

6.3.1 Efficiency misperception (EM)

As shown in Table 6.7 the majority of the respondents (84 percent) did not perceive their practice adoption efficiency (in this case the adoption of recommended rate of phosphate fertilization) correctly in the sense that they either overrated or underrated it.

Table 6.7: Distribution of the respondents according to their efficiency misperception (EM) and phosphate fertilization

Efficiency perception (EP)	Phosphate fertilization (kg/acre) <30 n	<30 %	30-50 n	30-50 %	>50 n	>50 %	Total N	Total %
Underrate	16	42.1	16	42.1	6	15.8	38	33.6
Slightly underrate	10	41.7	8	33.3	6	25.0	24	21.2
Assess correctly	14	77.8	4	22.2	0	0.0	18	15.9
Slightly overrate	11	78.6	3	21.4	0	0.0	14	12.4
Overrate	18	94.7	1	5.3	0	0.0	19	16.8
Total	69	61.1	32	28.3	12	10.6	113	100.0

χ^2 =26.617; df = 8; p=0.001

r= -0.417; p=0.000

The findings show that the majority (54.8 percent) of respondents underrate the efficiency of their own phosphate fertilization, which has the effect of increasing their need tension and thus the assumed tendency to change their current fertilization. It is significant that about 41 percent of the respondents who underrated their current adoption efficiency had adopted the recommended rate of phosphate fertilization while not a single respondent who overrated or misperceived his/her current fertilization efficiency, did in fact adopt the recommended rate of fertilization.

This relationship between EM and adoption of the recommended rate of phosphate fertilization is highly significant (r= -0.417; p=0.000), which implies that the adoption rate decreases with an increasing overrating of the current adoption efficiency. The more respondents overrate or misperceive their current adoption situation to be better than it is, the lower the need to change their behaviour towards what is recommended.

6.3.2 Need tension (NT)

Need tension (NT) has been associated with forces that incite the individual to action or that sustain or give direction to motion (Düvel, 2004). It is therefore regarded as the force that energizes behaviour and gives it direction. According to him (Düvel, 2004) there appears to exist a field polarity consisting of a need (usually some form of deprivation resulting in disequilibrium or system in tension) located within the individual, and a goal-object situated in the environment. The goal-object will assume a positive character (positive incentive) if it is perceived by the individual as having a potential need-satisfying capacity, and a negative valence in the case of a threatening further deprivation (negative incentive). This implies that an object can only become a goal or assume a positive valence if there is a corresponding need tension. An indication of the NT regarding the adoption of the recommended rate of phosphate fertilization in the study area is provided in Table 6.8

Table 6.8: Distribution of the respondents according to their need tension (NT) and phosphate fertilization

Need Tension (NT)	Phosphate fertilization (kg/acre)							
	<30		30-50		>50		Total	
	n	%	n	%	n	%	N	%
Low	62	100.0	0	0.0	0	0.0	62	54.9
Medium	3	42.9	2	28.6	2	28.6	7	6.2
High	4	9.1	30	68.2	10	22.7	44	38.9
Total	69	61.1	32	28.3	12	10.6	113	100.0

χ^2 =92.268; df = 4; p=0.000

r = 0.803, p= 0.000

The need tension or need potential of farmers in the study area regarding the application of recommended rate of phosphate fertilization is somewhat low in that about 55 percent of the respondents were found to have a low need tension. All the respondents (62) in this category fall into the lowest adoption category (applying no or less than 30 kg of phosphate fertilizer).

On the other hand 28.6 percent and 22.7 percent of those with medium and high need tension respectively, adopted the recommended rate of phosphate fertilization. As confirmed by the correlation (r = 0.803, p= 0.000) there is a highly significant relationship between the NT and the adoption depicting that the higher the NT is, the higher the adoption rate. In other words, the higher need tension acts as the force that energizes and drives a farmer in a direction towards adopting the recommended rate of phosphate fertilization.

6.3.3 Awareness of solution

The study model assumes that unawareness or lacking knowledge of the recommended practices as solution can contribute to the non-adoption of recommended maize production practices. Respondents were asked to indicate the recommended rate of phosphate fertilization in their area and were consequently judged as being aware or unaware of the recommended fertilization. An overview of the relationship between awareness and adoption is presented in Table 6.9.

Table 6.9: Distribution of the respondents according to their awareness and phosphate fertilization

	Phosphate fertilization (kg/acre)							
Awareness of solution	**<30**		**30-50**		**>50**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**	**N**	**%**
Not aware	43	79.6	10	18.5	1	1.9	74	47.8
Aware	26	44.1	22	37.3	11	18.6	59	52.2
Total	69	61.1	32	28.3	12	10.6	113	100.0

χ^2 =16.833; df = 2; p=0.000

r= 0.385, p= 0.000

According to Table 6.9 the majority (52.2 percent) of the respondents seem to be aware of the recommended rate of phosphate fertilization. The knowledgeable and the non-knowledgeable farmers are significantly different (χ^2 =16.833; df = 2; p=0.000) in terms of adoption.

The difference lies mainly in the phenomenon that farmers who are aware of the recommended level of phosphate fertilization tend to adopt it more than those having no knowledge of it.

This relationship between awareness and adoption is highly significant (r= 0.385, p= 0.000). From the distribution in Table 6.9 it can be concluded (with the exception of one individual who was supposedly unaware of the recommendation but nevertheless adopted it) that awareness is a precondition but not a guarantee for adoption.

6.3.4 Prominence

Insufficient prominence – implying that the recommended practice is seen as less prominent or less advantageous than the current one or than other alternatives - is another intervening variable or factor hypothesized to cause unwillingness to adopt (Düvel, 1998). Table 6.10 shows the relationship between prominence and phosphate fertilization.

Table 6 10: Distribution of the respondents according to their prominence and phosphate fertilization

	Adoption							
Prominence	**<30**		**30-50**		**>50**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**	**N**	**%**
Low prominence	53	94.6	3	5.4	0	0.0	56	49.6
Medium prominence	5	71.4	1	14.3	1	14.3	7	6.2
High prominence	11	22.0	28	56.0	11	22.0	50	44.2
Total	69	61.1	32	28.3	12	10.6	113	100.0

χ^2 =59.535; df = 4; p=0.000

r = 0.673, p= 0.000

As indicated in Table 6.10, the majority of the respondents (55.8 percent) perceived the recommended rate of phosphate fertilization to have a low or medium prominence.

Poor or low prominence clearly seems to have an influence on the adoption behaviour since not a single respondent who perceived the recommended rate of phosphate fertilization to have a low prominence adopted it. This clear positive and highly significant relationship between perceived prominence and adoption is also reflected in the correlation coefficient of 0.673 and the probability (p= 0.000) implying that the more the recommended rate is perceived to have a high prominence or higher prominence than the current one or than other alternatives, the higher the adoption tends to be.

6.3.5 Total influence of intervening variables

To assess the total influence of all discussed intervening variables (efficiency misperception, need tension, awareness and prominence) a regression analysis was conducted. Table 6.11 presents the findings regarding the influence of the different individual intervening variables as well as their combined contribution towards the total variance in adoption behaviour.

Table 6. 11: Linear regression analysis showing the relationship between intervening variables and adoption of phosphate fertilization

Variable	Beta	t	p
Constant		16.685	0.000
Efficiency misperception	0.030	0.514	0.608
Need tension	0.708	9.093	0.000
Awareness	0.053	0.933	0.353
Prominence	0.172	2.144	0.034

R^2 =0.732, p=0.000

According to Table 6.11 the intervening variables contribute highly significantly (R^2 =0.732, p=0.000) to the adoption of phosphate fertilization. They explain 73.2 percent of the variation in the adoption behaviour. The NT makes the biggest contribution towards explaining the adoption behaviour, which further support other researchers (Koch, 1986; Düvel and Botha, 1999; Düvel and Scholtz, 1986;) who identified the NT to be a key dimension in adoption behaviour.

6.4 COMPARISONS BETWEEN INDEPENDENT AND INTERVENING VARIABLES

When comparing the influence of the independent and intervening variables, it is clear that the intervening variables have a significantly bigger influence on adoption behaviour. Not only do a greater percentage of the intervening variables have an influence, but the influence as reflected in correlation coefficients is also much more significant. Particularly conspicuous is the comparison of the total influence of these categories of variables. As shown in Fig 6.1, the influence of intervening variables far outweighs that of the independent variables in terms of the percentage variation explained. The intervening variables explain 73.2 percent of the variation in phosphate fertilizer adoption as opposed to the 24.8 percent contributed by the independent variables.

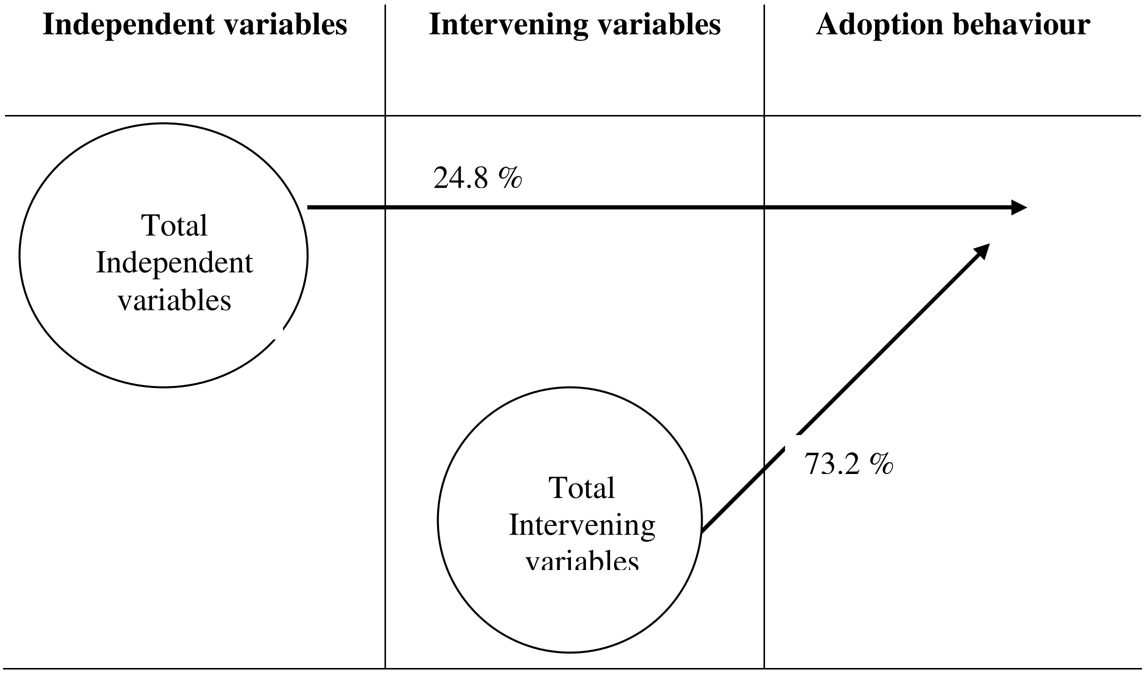

Figure 6.1: Comparative contribution of independent and intervening variables on adoption behaviour

CHAPTER 7

THE INFLUENCE OF INDEPENDENT AND INTERVENING VARIABLES ON THE ADOPTION OF NITROGEN FERTILIZATION

7.1 INTRODUCTION

Nitrogen fertilization is one of the practices recommended in the Njombe district in order to improve maize production. The practice consists of two aspects namely, the rate and time of nitrogen fertilization. In order to have an adoption score for total nitrogen fertilization, the scale points of the individual practices (nitrogen and time of nitrogen fertilization) were added before being re-categorized into three groups namely, <5 scale points for low adoption, 5-7 for medium adoption and >7 for high adoption or the recommended adoption.

Despite all efforts to promote these practices in the area, the adoption is still low. As already pointed out earlier only 30.1 and 25.7 percent of the respondents had adopted the recommended rate and time of nitrogen fertilization respectively. This chapter explores the factors that contribute to the non-or poor adoption. The independent factors or variables are examined first followed by the intervening ones.

7.2 INDEPENDENT VARIABLES

This part discusses the results of chi-square and correlation tests carried out to determine how the individual socio-economic and personal characteristics of farmers like sex, farm size and formal education influence the adoption of nitrogen fertilization in the Njombe district.

7.2.1 Age

Age of the farmers is one of the independent variables of assumed importance in affecting the adoption of nitrogen fertilization in the study area. It is hypothesized that the adoption is higher among young farmers than in older ones. The findings of the relationship between age and adoption are presented in Table 7.1 below.

Table 7.1: Distribution of respondents according to their age and nitrogen fertilization

Nitrogen fertilization	Age (years)							
	<36		36-56		>56		Total	
	n	%	n	%	n	%	n	%
1. Rate (kg/acre)								
<25	4	12.9	9	15.3	8	34.8	21	18.6
25-50	6	19.4	20	33.9	9	39.1	35	31.0
50-75	8	25.8	14	23.7	1	4.3	23	20.4
>75	13	41.9	16	27.1	5	21.7	34	30.1
Total	31	27.4	59	52.2	23	20.4	113	100.0
χ^2 = 11.976; df=6; p=0.063; r = -0.303; p=0.001								
2. Time of fertilization								
All at planting	1	3.2	2	3.6	1	5.3	4	3.8
All as top dressing	19	61.3	43	78.2	12	63.2	74	70.5
At planting & as top dressing	11	35.5	10	18.2	6	31.6	27	25.7
Total	31	29.5	55	52.4	19	18.1	105	100.0
χ^2 = 3.735; df=4; p=0.443; r = -0.085; p=0.388								
3. Total N-fertilizaton								
<5	4	12.9	9	15.3	8	34.8	21	18.6
5-7	10	32.3	29	49.2	9	39.1	48	42.5
>7	17	54.8	21	35.6	6	26.1	44	38.9
Total	31	27.4	59	52.2	23	20.4	113	100.0
χ^2 = 8.737; df=4; p=0.068; r = -0.236; p=0.012								

Although there are no significant differences between the age groups in terms of adoption of rate, time and total nitrogen fertilization the percentages and the negative correlation coefficients (r = -0.303; r = - 0.085; r = - 0.236) show that the adoption seems to be higher in the category of young farmers than in the older ones. This proof is shown in a statistically significant negative correlation (r = -0.236; p=0.012) between farmers age and the adoption of total nitrogen fertilization. For example only 26.1 percent of the oldest category farmers applied the recommended level represented by a scale point of more than 7, while the percentage of young farmers who did so is as high as 54.8 percent.

The opposite tendency is evident where the percentage of the oldest farmers who scored less than 5 points is 34.8 percent, while the percentage young farmers in the lowest adoption category is only 12.9 percent. The findings are in correspondence with the other findings that younger farmers are more likely to adopt a new technology than the older ones (CIMMYT, 1993; Van den Ban and Hawkins, 1996). The results are not supportive of many other findings (Habtemariam, 2004; Kalineza, 2000; Temu, 1996) that reflect a non-linear or parabolic correlation between adoption and age, implying that frequently the middle-age group tend to be the ones with the highest adoption rate. In this case the middle group shows even bigger resemblance with the oldest group as far as poor adoption is concerned.

7.2.2 Sex

An overview of the influence of sex as a behaviour determinant is given in Table 7.2

Table 7.2: Distribution of respondents according to their sex and nitrogen fertilization

Nitrogen fertilization	Sex					
	Male		Female		Total	
	n	%	n	%	n	%
1. Rate (kg/acre)						
<25	10	14.3	11	25.6	21	18.6
25-50	20	28.6	15	34.9	35	31.0
50-75	16	22.9	7	16.3	23	20.4
>75	24	34.3	10	23.3	34	30.1
Total	70	61.9	43	38.1	113	100.0
χ^2 = 3.815; df=3; p=0.282; r = -0.176; p=0.062						
2. Time of N-fertilization						
All at planting	2	3.0	2	5.3	4	3.8
All as top dressing	47	70.1	27	71.1	74	70.5
At planting & as top dressing	18	26.9	9	23.7	27	25.7
Total	67	63.8	38	36.2	105	100.0
χ^2 = 0.429; df=2; p=0.807; r = -0.053; p=0.593						
3. Total N-fertilizaton						
<5	10	14.3	11	25.6	21	18.6
5-7	29	41.4	19	44.2	48	42.5
>7	31	44.3	13	30.2	44	38.9
Total	70	61.9	43	38.1	113	100.0
χ^2 = 3.228; df=2; p=0.199; r = -0.168; p=0.075						

The distributions in Table 7.2 indicate some relationship, but according to the χ^2 analyses the difference between the gender groups is not significant. (χ^2 = 3.815, df=3, p=0.282; χ^2 = 0.429; df=2; p=0.807; χ^2 = 3.228; df=2; p=0.199). However, the negative correlation coefficients, especially in the case of the rate of nitrogen fertilization and the total adoption score where the values approach the five percent probability, do suggest that male farmers are more inclined to adopt the recommended nitrogen fertilization. Again the suspicion is that this behaviour is indirectly rather than directly related to sex, and can be attributed to factors such as less access to resources and to extension information (Jefremovas, 1991; Stephens, 1992; Gass and Bigs, 1993).

7.2.3 Formal education

Formal education has already emerged as an important behaviour determinant in the practices already discussed and is also assumed to be an important factor in the adoption of nitrogen fertilization. Its influence is shown in Table 7.3.

Table 7.3: Distribution of respondents according to their formal education and nitrogen fertilization

Nitrogen fertilization	Formal education (years)							
	None		1-7 yrs		>7 yrs		Total	
	n	%	n	%	n	%	N	%
1. Rate (kg/acre)								
<25	11	55.0	9	14.1	1	3.4	21	18.6
25-50	7	35.0	23	35.9	5	17.2	35	31.0
50-75	2	10.0	14	21.9	7	24.1	23	20.4
>75	0	0.0	18	28.1	16	55.2	34	30.1
Total	20	17.7	64	56.6	29	25.7	113	100.0
χ^2 = 34.424 df=6; p=0.000; r = 0.510; p=0.000								
2. Time of N-fertilization								
All at planting	2	14.3	2	3.2	0	0.0	4	3.8
All as top dressing	12	85.7	40	63.5	22	78.6	74	70.5
At planting & as top dressing	0	0.0	21	33.3	6	21.4	27	25.7
Total	14	13.3	63	60.0	28	26.7	105	100.0
χ^2 = 11.547; df=4; p=0.021; r = 0.153; p=0.120								
3. Total N-fertilizaton								
<5	11	55.0	9	14.1	1	3.4	21	18.6
5-7	9	45.0	29	45.3	10	34.5	48	42.5
>7	0	0.0	26	40.6	18	62.1	44	38.9
Total	20	17.7	64	56.6	29	25.7	113	100.0
χ^2 = 30.957; df=4; p=0.000; r = 0.485; p=0.000								

The formal education categories differ significantly with respect to the adoption of the recommended rate, time and total nitrogen fertilization. With exception to the time of nitrogen fertilization the nature of the percentage distribution clearly indicates that the application tends to increase with an increased level of formal education. This is clearly seen in Table 7.3 where 62.1 percent of those respondents with formal education of more than seven years of schooling had adopted the recommended total nitrogen fertilization but not a single respondent of those who did not have formal education did so. The later could even be an indication that some form of formal training is essential for nitrogen fertilization to be adopted. This relationship also finds its expression in a highly significant positive correlation coefficient of 0.485 (p = 0.000), indicating that the higher the formal education is, the higher the adoption tends to be.

7.2.4 Farm size

With respect to the adoption of new ideas or technologies, indications have been that large farm operators have higher rates of adoption than small farmers (Rogers, 1983; Thakre & Bansode, 1990; Polson & Spencer, 1991; Kalineza, 2000; Kipaka, 2000). The findings regarding the influence of farm size on nitrogen fertilization are presented in Table 7.4

Table 7.4 Distribution of respondents according to their farm size and Nitrogen fertilization

Nitrogen fertilization	Farm size (Acres)							
	<3		3-6		>6		Total	
	n	%	n	%	n	%	N	%
1. Rate (kg/acre)								
<25	12	30.8	8	17.8	1	3.4	21	18.6
25-50	13	33.3	14	31.1	8	27.6	35	31.0
50-75	5	12.8	10	22.2	8	27.6	23	20.4
>75	9	23.1	13	28.9	12	41.4	34	30.1
Total	39	34.5	45	39.8	29	25.7	113	100.0
χ^2 = 10.682; df=6; p=0.099; r = 0.274; p=0.003								
2. Time of N-fertilization								
All at planting	1	2.9	3	7.0	0	0.0	4	3.8
All as top dressing	29	85.3	29	67.4	16	57.1	74	70.5
At planting & as top dressing	4	11.8	11	25.6	12	42.9	27	25.7
Total	34	32.4	43	41.0	28	26.7	105	100.0
χ^2 = 9.861; df=4; p=0.043; r = 0.258; p=0.008								
3. Total N-fertilizaton								
<5	12	30.8	8	17.8	1	3.4	21	18.6
5-7	17	43.6	19	42.2	12	41.4	48	42.5
>7	10	25.6	18	40.0	16	55.2	44	38.9
Total	39	34.5	45	39.8	29	25.7	113	100.0
χ^2 = 10.474; df=4; p=0.033; r = 0.299; p=0.001								

There are clear indications of a correlation at $p < 0.05$ between farm size and adoption. The positive correlations (r = 0.274; r = 0.258; r = 0.299) imply that the individuals with large farm sizes are more likely to adhere to the required nitrogen fertilization than small farm holders.

As far as the rate of fertilization is concerned this relationship is clearly shown in Table 7.4 where 41.4 percent of those with farm sizes of more than six acres had the highest adoption rate while only 23.1 percent of those on smaller farms (less than six acres) accomplished the same level of adoption. It appears that farm size more than any of the other factors influences this practice, which might imply that practical considerations are a factor when it comes to farm size.

7.2.5 Area under maize

If size of farm acts as a behaviour determinant, a similar influence could be expected from the size of the enterprise, in this case the total area under maize production. The survey results with respect to the relationship between the area under maize and nitrogen fertilization are summarized in Table 7.5

As confirmed by both chi-square (χ^2 = 14.258; df = 4; p=0.007) and the correlation (r = 0.297; p=0.001) there is a significant relationship between the area under maize and the adoption of nitrogen fertilization (measured both in terms of the time and rate of application), implying that the bigger the area under maize, the higher the adoption tends to be.
For instance, 55.6 percent of those respondents with more than three acres had applied the recommended nitrogen fertilization, but the percentage of those with equal or less than one acre is only 30.8 percent.

Table 7. 5: Distribution of respondents according to their area under maize and nitrogen fertilization

Nitrogen fertilization	Area under maize (Acres)							
	<=1		1.1-3		>3		Total	
	n	%	n	%	n	%	n	%
1. Rate (kg/acre)								
<25	10	38.5	11	18.3	0	0.0	21	18.
25-50	7	26.9	20	33.3	8	29.6	35	31.0
50-75	4	15.4	12	20.0	7	25.9	23	20.4
>75	5	19.2	17	28.3	12	44.4	34	30.1
Total	26	23.0	60	53.1	27	23.9	113	100.0
χ^2 = 14.469; df=6; p=0.025; r = 0.310; p=0.001								
2. Time of fertilization								
All at planting	1	4.5	3	5.4	0	0.00	4	3.8
All as top dressing	16	72.7	41	73.2	17	63.0	74	70.5
At planting & as top dressing	5	22.7	12	21.4	10	37.0	27	25.7
Total	22	21.0	56	53.3	27	25.7	105	100.0
χ^2 = 3.526; df=4; p=0.474; r = 0.138; p=0.161								
3. Total N-fertilizaton								
<5	10	38.5	11	18.3	0	0.0	21	18.6
5-7	8	30.8	28	46.7	12	44.4	48	42.5
>7	8	30.8	21	35.0	15	55.6	44	38.9
Total	26	23.0	60	53.1	27	23.9	113	100.0
χ^2 = 14.258; df=4; p=0.007; r = 0.297; p=0.001								

7.6 TOTAL INFLUENCE OF INDEPENDENT VARIABLES

All the independent variables discussed above were entered into the linear regression model to evaluate their total contribution to the variance regarding the adoption of nitrogen fertilization. The model results are presented in Table 7.6.

Table 7.6: Regression analysis of the influences of independent variables on adoption of nitrogen fertilization

Variable	Beta	t	p
(Constant)		2.458	0.016
Sex	-0.061	-0.666	0.507
Age	-0.234	-2.425	0.017
Formal education	0.269	2.656	0.009
Farm size	0.214	2.059	0.042
Area under maize	0.102	1.081	0.282

$R^2 = 0.295$, $p = 0.000$

The regression analysis confirms the significant influence of most of the tested independent variables. Only the area under maize and sex do not contribute significantly to the total variance regarding adoption of nitrogen fertilization. However, the overall contribution towards explaining the variance in adoption is only 29.5 percent, which is reflected in R^2 value ($R^2 = 0.295$; $p = 0.000$). As shown in Table 7.6 formal education seems to be the only variable contributing very significantly to the adoption behaviour.

7.3 INTERVENING VARIABLES

To establish the relative influence of intervening variables compared to the independent personal and environmental factors on nitrogen fertilization, the former are analyzed in a similar fashion. The following section deals with this. First the influences of the individual intervening variables are analysed, and then the overall influence is analysed and compared.

7.3.1 Efficiency misperception (EM)

The efficiency misperception of nitrogen fertilization is assumed to have an influence on the adoption behaviour. Table 7.7 shows the relationship between EM and adoption of recommended rate of nitrogen fertilization.

Table 7.7: Distribution of respondents according to their efficiency misperception (EM) and nitrogen fertilization

Nitrogen fertilization	Perceived current efficiency (PCE)											
	Underrate		Slightly underrate		Assess correctly		Slightly overrate		Overrate		Total	
	n	%	n	%	n	%	n	%	n	%	N	%
1. Rate (kg/acre)												
<25	0	0.0	0	0.00	0	0.0	2	10.5	19	59.4	21	18.6
25-50	4	12.9	7	36.8	0	0.0	11	57.9	13	40.6	35	31.0
50-75	12	38.7	5	26.3	0	0.0	6	31.6	0	0.0	23	20.4
>75	15	48.4	7	36.8	12	100.0	0	0.0	0	0.0	34	30.1
Total	31	27.4	19	16.8	12	10.6	19	16.8	32	28.3	113	100.0
	χ^2 = 107.612; df=12; p=0.000; r = -0.695; p=0.000											
2. Time of N-fertilization												
Planting	0	0.0	0	0.0	0	0.0	0	0.0	4	9.3	4	3.8
Top dressing	0	0.0	7	87.5	0	0.0	30	85.7	37	86.0	74	70.5
Both	11	100.0	1	12.5	8	100.0	5	14.3	2	4.7	27	25.7
Total	11	10.5	8	7.6	8	7.6	35	33.3	43	41.0	105	100.0
	χ^2 = 72.634; df=8; p=0.000; r = -0.613; p=0.000											
3. Total N-fertilizaton												
<5	0	0.0	0	0.0	1	3.7	9	24.3	11	100.0	21	18.6
5-7	4	36.4	8	29.6	14	51.9	22	59.5	0	0.0	48	42.5
>7	7	63.6	19	70.4	12	44.4	6	16.2	0	0.0	44	38.9
Total	11	9.7	27	23.9	27	23.9	37	32.9	11	7.9	113	100.0
	χ^2 = 77.032; df=8; p=0.000; r =- 0.629; p=0.000											

The minority of respondents (7.6 percent) assess their current efficiency of total nitrogen fertilizer application correctly in the sense that their assessments are inline with the assessment by the enumerator and assuming that the more objective scale used by the enumerator is the objectively correct one. All of these respondents adopted the recommended rate of nitrogen fertilization. The findings further show that not a single respondent who overrated or assessed his/her nitrogen fertilization efficiency to be higher than it really is, adopted the recommended rate, which would imply that they are satisfied with their current rate of nitrogen fertilization and thus have no need (low need tension) to go for the recommended rate. The opposite tendency applies on all individuals that underrate their efficiency.

This close relationship between efficiency misperception and adoption of recommended rate of nitrogen fertilization finds its expression in the highly significant negative correlation (r=-0.695, p=0.000). The same tendency and highly significant negative correlation is observed in time and total nitrogen fertilization, which implies that the adoption rate decreases with an increasing overrating of the current adoption efficiency. The more farmers misperceive or overrate their efficiency of nitrogen adoption, or the more they perceive their own efficiency of nitrogen application to be better than it really is, the lower the incentive to change their behaviour towards what is recommended.

7.3.2 NEED TENSION (NT)

The influence of NT on the adoption of nitrogen fertilization is indicated in Table 7.8

Table 7 8: Distribution of respondents according to their perceived need tension (NT) and Nitrogen fertilization

Nitrogen fertilization	Need tension (NT)							
	Low		Medium		High		Total	
	n	%	n	%	n	%	N	%
1. Rate (kg/acre)								
<25	17	77.3	4	11.4	0	0.0	21	18.6
25-50	4	18.2	24	68.6	7	12.5	35	31.0
50-75	1	4.5	2	5.7	20	35.7	23	20.4
>75	0	0.0	5	14.3	29	51.8	34	30.1
Total	22	19.5	35	31.0	56	49.6	113	100.0
χ^2 = 106.616; df=6; p=0.000; r = 0.758; p=0.000								
2. Time of N-fertilization								
All at planting	4	6.1	0	0.0	0	0.0	4	3.8
All as top dressing	61	92.4	3	23.1	10	38.5	74	70.5
At planting & as top dressing	1	1.5	10	76.9	16	61.5	27	25.7
Total	66	62.9	13	12.4	26	24.8	105	100.0
χ^2 = 56.064; df=4; p=0.000; r = 0.622; p=0.000								
3. Total N-fertilizaton								
<5	17	77.3	4	6.5	0	0.0	21	18.6
5-7	5	22.7	39	62.9	4	13.8	48	42.5
>7	0	0.0	19	30.6	25	86.2	44	38.9
Total	22	19.5	62	54.9	29	25.7	113	100.0
χ^2 = 91.104; df = 4; p=0.000; r = 0.735; p=0.000								

The biggest group of respondents, about 50 percent, seem to have high need tensions with regard to nitrogen fertilization and not a single individual from this group applied the lowest rate of no or less than 25 kg per acre of nitrogen. On the other hand, no one with low need tension applied the recommended rate. This low need tension can be attributed to the fact that (a) they either perceive their current adoption as more efficient than it really is and/or they are unaware of what the recommended application rate is. Evidence of this very close relationship between need tension and adoption of nitrogen fertilisation is provided by the extremely high correlation coefficient (r = 0.758; p=0.000). The positive coefficients in all three cases (r = 0.758; r = 0.622; r = 0.735) signifies that the higher the need tension is, the higher the adoption of nitrogen fertilization tends to be.

7.3.3 Awareness of solution

Table 7.9 below presents the findings of the relationship between knowledge or awareness of the recommended practice, in this case the recommended nitrogen fertilization and its adoption.

According to Table 7.9 the general awareness is low, with only 49.6, 30.5, 51.3 percent respondents being aware of the recommended rate, time and total nitrogen fertilization respectively. This is an indication of the work still to be done by extension agents as far as creating an awareness of the recommended nitrogen fertilization is concerned. The consequence of unawareness is expected to be reflected in the adoption rate attained. This is in fact the case. In all aspects there is a highly significant correlation at 1 percent level of probability with between awareness of the recommended nitrogen fertilisation.

Table 7 9: Distribution of respondents according to their awareness and Nitrogen fertilizer recommendations

	Awareness					
	Not aware		Aware		Total	
Nitrogen fertilization	**n**	**%**	**n**	**%**	**n**	**%**
1. Rate (kg/acre)						
<25	15	26.3	6	10.7	21	18.6
25-50	25	43.9	10	17.9	35	31.0
50-75	8	14.0	15	26.8	23	20.4
>75	9	15.8	25	44.6	34	30.1
Total	57	50.4	56	49.6	113	100.0
χ^2 = 19.938; df=3; p=0.000; r = 0.391; p=0.000						
2. Time of fertilization						
All at planting	3	4.1	1	3.1	4	3.8
All as top dressing	61	83.6	13	40.6	74	70.5
At planting & as top dressing	9	12.3	18	56.3	27	25.7
Total	73	69.5	32	30.5	105	100.0
χ^2 = 22.566; df=2; p=0.000; r = 0.416; p=0.000						
3. Total N-fertilizaton						
<5	14	25.5	7	12.1	21	18.6
5-7	30	54.5	18	31.0	48	42.5
>7	11	20.0	33	56.9	44	38.9
Total	55	48.7	58	51.3	113	100.0
χ^2 = 16.265; df=2; p=0.000; r =0.344; p = 0.000						

7.3.4 Prominence

The degree to which one alternative is perceived to be better than another, in other words the more one alternative is perceived to be more prominent than another, the more likely it will be adopted.

It is consequently expected that the more prominent the recommended nitrogen fertilization is perceived to be relative to other alternatives, the more likely it will be adopted. Findings relating to this assumption are summarised in Table 7.10.

Table 7.10: Distribution of respondents according to their perceived prominence of the recommended nitrogen fertilization and its adoption.

Nitrogen fertilization	Prominence							
	Low		Medium		High		Total	
	n	%	n	%	n	%	n	%
1. Rate (kg/acre)								
<25	13	76.5	5	17.9	3	4.4	21	18.6
25-50	4	23.5	22	78.6	9	13.2	35	31.0
50-75	0	0.0	0	0.0	23	33.8	23	20.4
>75	0	0.0	1	3.6	33	48.5	34	30.1
Total	17	15.0	28	24.8	68	60.2	113	100.0
χ^2 = 100.265; df=6; p=0.000; r = 0.732; p = 0.000								
2. Time of fertilization								
All at planting	4	6.3	0	0.0	0	0.0	4	3.8
All as top dressing	58	92.1	4	30.8	12	41.4	74	70.5
At planting & as top dressing	1	1.6	9	69.2	17	58.6	27	25.7
Total	63	60.0	13	12.4	29	27.6	105	100.0
χ^2 = 49.272; df=4; p=0.000; r = 0.599; p=0.000								
3. Total N-fertilizaton								
<5	13	76.5	7	11.1	1	3.0	21	18.6
5-7	4	23.5	38	60.3	6	18.2	48	42.5
>7	0	0.0	18	28.6	26	78.8	44	38.9
Total	17	15.0	63	55.8	33	29.2	113	100.0
χ^2 = 69.401; df=4; p=0.000; r =0.647; p = 0.000								

Again in all nitrogen fertilization practices there is a very close relationship between the perceived prominence and adoption. The importance of this intervening variable is further emphasised by the indications that it is almost a precondition of adoption, although its prevalence does not necessarily guarantee it.

It is noteworthy, for example that not a single individual with a low prominence perception (and only one with a medium perception) adopted the recommended level of nitrogen fertilisation.

7.3.5 Total influence of intervening variables

For purposes of a more accurate analysis of the various intervening variables, as well as for a holistic overview of their total influence on practice adoption, a linear regression analysis was conducted and the results presented in Table 7.11.

Table 7.11: Influence of intervening variables on adoption of nitrogen fertilization

Variable	Beta	t	p
(Constant)		3.314	0.001
Efficiency misperception (EM)	-0.281	-3.874	0.000
Need tension	0.411	5.582	0.000
Awareness	0.085	1.584	0.116
Prominence	0.250	3.730	0.000

R^2 = 0.74.8, p = 0.000

The need aspects namely, need tension and the efficiency misperception seem to have the biggest influence on the adoption of the recommended rate of nitrogen fertilization. They are followed by prominence, which similarly contributes in a highly significant degree to the variance in adoption. Awareness is the only intervening variable, which does not contribute in a significant way to the variation in adoption, and this can probably be attributed to its inaccurate measurement. The total influence of all intervening variables on adoption behaviour is highly significant. As indicated in Table 7.11 they explain 74.8 percent of the adoption variance, which is reflected in R square of 0.748.

7.4 COMPARISON B ETWEEN INDEPENDENT AND INTERVENING VARIABLES

Having assessed the influence of independent and intervening variables in the previous sections, this part provides a brief summary of the comparison between the two with the view of shedding light on which variables are more important in predicting the adoption decision or adoption behaviour of maize growers as far as nitrogen fertilizer application in the study area is concerned. Figure 7.1 summarizes the results

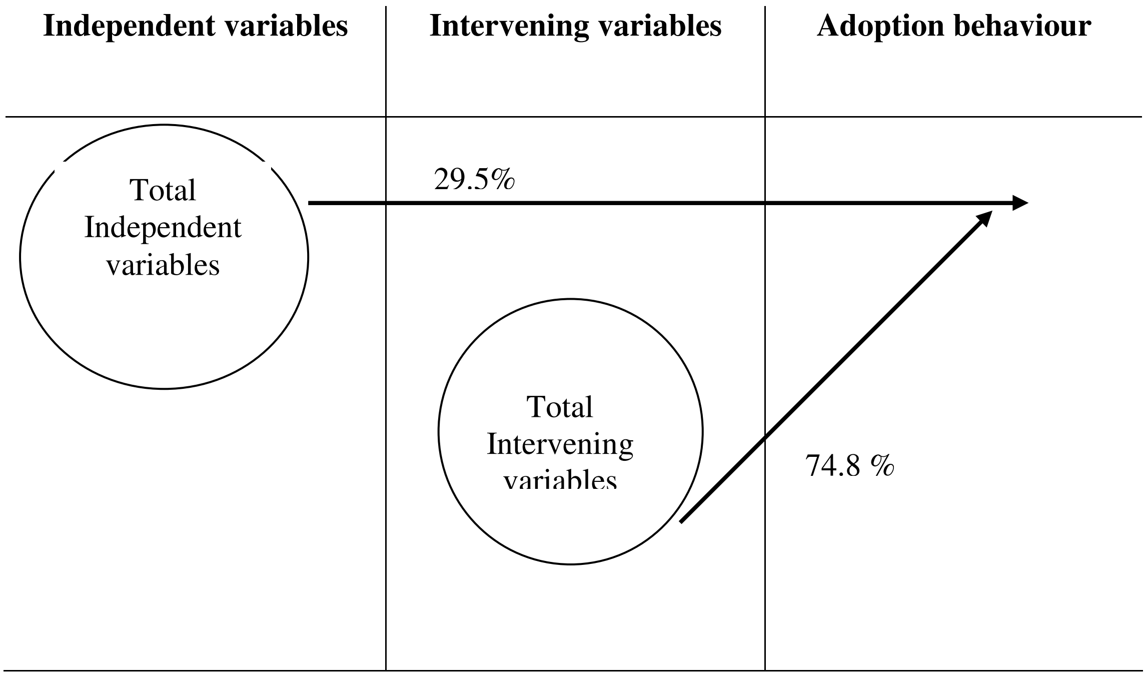

Figure 7.1: Comparative contribution of independent and intervening variables on adoption behaviour

As presented in Fig 7.1 the total influences of the two variables on adoption behaviour are quite different as can clearly seen in their percentage contributions. The total influence of intervening variables explains up to 74.8 percent while independent variables contribute only at 29.5 percent. The findings are in support of the hypothesis of the study, which states that the influence of intervening variables on adoption decision is higher than that of the independent variables.

CHAPTER 8

THE ROLE OF INDEPENDENT AND INTERVENING VARIABLES ON THE ADOPTION OF THE TOTAL FERTILIZER PACKAGE

8.1 INTRODUCTION

Various independent and intervening factors have been found to be reasonably important in influencing the adoption of fertilization practices. The influence of these factors seems to be bigger with the practices that contribute more significantly to yield improvement and less evident in the practices less associated with increased production efficiency, like the time of nitrogen fertilization. In this chapter these variables are further evaluated to determine their influence on the adoption of the total fertilization package in order to make a comparison with the individual fertilization practices already discussed.

8.2 INDEPENDENT VARIABLES

8.2.1 Age

The influence of age on decision-making regarding the total fertilizer package is shown in Table 8.1. As indicated in chapter four, the scores for the adoption of total fertilization package were obtained by adding the scale points of the individual fertilizer practices[8] (phosphate, nitrogen and time of nitrogen fertilization) already discussed. The scores were then categorized into three groups namely, <6 scale points for low adoption, 6-10 for medium adoption and 11-15 for high adoption.

[8] The scale points for total fertilization package were obtained before the individual fertilizer practices were re-categorized

Table 8.1: Distribution of the respondents according to their age and the adoption of fertilization (total fertilizer package)

	Fertilization Categories							
	<6		6-10		>10		Total	
Age	n	%	n	%	n	%	N	%
<36	4	12.9	12	38.7	15	48.4	31	27.4
36-56	13	22.0	26	44.1	20	33.9	59	52.2
>56	11	47.8	8	34.8	4	17.4	23	20.4
Mean ages	53.0		44.1		41.3		45.4	

χ^2 =10.956; df=4; p=0.027

r= -0.310; p=0.001

Although the results show that there are no significant differences between the age groups in terms of adoption of fertilizer package (χ^2 =10.956; df=4; p=0.027), the correlation is significant (r= -0.310; p=0.001) and can be attributed to the fact, although the differences between the groups is not very big, the relationship is of a clear linear nature. Evidence of the negative linear relationship are the mean ages of the different adoption categories. As the mean age decreases, the fertilization improves. In the highest adoption category close to 50 percent (48.4) of the respondents are younger than 36 years of age, while in the lowest adoption category this group of young farmers comprises only 12.9 percent. The negative relationship is also found in other fertilization practices namely phosphate, nitrogen and time of nitrogen fertilization but the influence of age on the total fertilization package seems to be higher than that of individual fertilization practices.

8.2.2 Sex

Table 8.2 provides a summary of the influence of the respondents' sex on the adoption of the total fertilizer package.

Table 8.2: Distribution of respondents according to their sex and the adoption of fertilization (total fertilizer package)

Sex	Fertilization categories							
	<6		6-10		>10		Total	
	n	%	n	%	n	%	N	%
Male	14	20.0	28	40.0	28	40.0	70	61.9
Female	14	32.6	18	41.9	11	25.6	43	38.1
Total	28	24.8	46	40.7	39	34.5	113	100.0

χ^2 =3.323; df=2; p=0.190

r= -0.171; p=0.069

The weak but negative correlation (r= -0.171; p=0.069) between the sex and the adoption of total fertilizer package suggests that the adoption of the recommended fertilizer package is higher among male farmers than among female farmers. This proof is clearly presented by frequencies and percentages of the respondents in Table 8.2 above. As in the case of other fertilization practices this relationship does not necessarily imply that gender has a direct influence on adoption behaviour, but may be could imply that the influence is because of gender related factors like contact with extension or other sources of technology. The influence of sex on the total fertilization package is almost similar to that of nitrogen fertilization but more than that of phosphate (r = -0.116, p= 0.223) and time of nitrogen fertilization (r = -0.053, 0.593).

8.2.3 Formal education

In the analyses carried out to examine the influence of formal education on the adoption of total fertilizer package, the following results obtained (Table 8.3).

Table 8.3: Distribution of the respondents according to their formal education and the adoption of fertilization (total fertilizer package)

Formal education	Fertilization categories							
	<6		6-10		>10		Total	
	n	%	n	%	n	%	N	%
None	12	60.0	8	40.0	0	0.0	20	17.7
1-7	14	21.9	30	46.9	20	31.3	64	56.6
>7	2	6.9	8	27.6	19	65.5	29	25.7
Total	28	24.8	46	40.7	39	34.5	113	100.0

χ^2 =30.977; df=4; p=0.000

r= 0.498; p=0.000

Based on the correlation test carried to test a kind of relationship that exist between formal education and adoption, the results suggest that the tendency to adopt increase in a linear fashion with increasing number of years of schooling. For example, not a single respondent without formal education scored more than ten scale points of total fertilizer package. The percentages increase to 31.3 in the case of farmers with one up to seven years of schooling, to 65.5 percent to in the case of those with more than seven years of schooling. This proof is reflected in a highly correlation coefficient of r = 0.498 at 1 percent level of probability. The correlation between formal education and total fertilization package is more than that of phosphate fertilization and time of nitrogen fertilization and more or less of the same order of nitrogen fertilization (r = 0.510; p = 0.000).

8.2.4 Farm size

An overview of the relationship between farm size and the adoption of total fertilizer package is indicated in Table 8.4.

Table 8.4: Distribution of respondents according to their farm size and the adoption of fertilization (total fertilizer package)

Farm size	Fertilization categories							
	<6		6-10		>10		Total	
	n	%	n	%	n	%	N	%
<3	17	43.6	12	30.8	10	25.6	39	34.5
3-6	8	17.8	24	53.3	13	28.9	45	39.8
>6	3	10.3	10	34.5	16	55.2	29	25.7
Total	28	24.8	46	40.7	39	34.5	113	100.0

χ^2 =16.770; df=4; p=0.002

r= 0.315; p=0.001

As indicated earlier that the farmer's farm size tends to influence his/her decision regarding the adoption of recommended practices, Table 8.4 also provides evidence of this relationship. According to the Table results, the adoption of total fertilizer package seems to be higher among the large farms owners than in the case of those owning small pieces of land. This evidence is clearly reflected in statistically significant relationships (χ^2 =16.770; df=4; p=0.002; r= 0.315; p=0.001) that exist between farm size and the adoption of total fertilizer package. The findings further tell us that only 34.5 percent of the respondents indicated to have high fertilizer package adoption, represented by more than ten points score. This lead into the speculation that poor adoption of the package might be one of the most important cause of low yields observed to the majority of farmers in the Njombe district.

The influence of education is evident in all fertilization practices discussed in chapter six and seven except in the case of time of nitrogen fertilization that proved to have no correlation with this variable. Although farm size seems to have a significant influence on all fertilization practices, the influence seems to be much more with total package (r= 0.315; p=0.001) than other fertilization practices.

8.2.5 Area under maize

The influence of the area under maize on the adoption of total fertilizer package is presented in Table 8.5 below.

Table 8.5: Distribution of respondents according to their area under maize and the adoption of fertilization (total fertilizer package)

Area under maize	Fertilization categories							
	<6		6-10		>10		Total	
	n	%	n	%	n	%	N	%
<=1	11	42.3	6	23.1	9	34.6	26	23.0
1.1-3	17	28.3	29	48.3	14	23.3	60	53.1
>3	0	0.0	11	40.7	16	59.3	27	23.9
Total	28	24.8	46	40.7	39	34.5	113	100.0

χ^2 =20.026; df=4; p=0.000

r= 0.303; p=0.001

As in the case of farm size, the area under maize also found to have a significant influence on the adoption of fertilizer package. This is clearly indicated by the chi-square and correlation analyses results (χ^2=20.026; df=4; p=0.000; r= 0.303; p=0.001) presented in Table 8.6.

The proof of this is reflected in the percentages of farmers not adopting or who had a score of less than 6 scale points of total fertilizer package application. For example none of those owning a farm size of more than three acres scored less than six scale points while the percentage of the respondents with less than 1.1 acres is 42.3 percent.

8.2.6 Total influence of independent variables

The linear regression model was used to determine the total influence of all independent variables discussed above on the adoption behaviour regarding fertilization. In addition, the model was used to assess the contribution of each variable in the adoption of fertilizer package variance. The model results are summarized in Table 8.6

Table 8 6: Regression analysis of the influence of independent variables on the adoption of fertilization (total fertilizer package)

Variable	Beta	t	p
(Constant)		2.578	0.011
Sex	-0.032	-0.357	0.722
Age	-0.235	-2.488	0.014
Formal education	0.324	3.278	0.001
Farm size	0.205	2.019	0.046
Area under maize	0.098	1.064	0.290

$R^2 = 0.329$, p = 0.000

Formal education has the biggest and most significant contribution (beta = 0.324, p = 0.001) on the adoption of fertilizer package. This is followed by other independent variables like age of the respondents and farm size, which also have significant effects on the adoption behaviour. Area under maize and sex of the respondents have the least influence on the adoption of fertilizer package adoption. Their contributions are still significant at 3 percent and 8 percent levels of probability, respectively.

Despite that the contribution of all independent variables on adoption behaviour is highly significant, the regression coefficient represented by $R^2 = 0.329$, p = 0.000 is very low. This implies that the independent variables entered into the model account for only 32.9 percent of the adoption behaviour variance. However, this contribution is a little higher compared to that observed in individual practice like phosphate (24.8 percent) and nitrogen fertilization (29.5 percent).

8.1 INTERVENING VARIABLES

8.3.1 Efficiency misperception (EM)

How a farmer perceives the efficiency of fertilizer package adoption is expected to have influence on his/her adoption behaviour in several ways namely; non-or low adoption, medium or full adoption of this practice. The relationship between EM and adoption is summarized in Table 8.7

Table 8.7: Distribution of the respondents according to the efficiency misperception (EM) and the adoption of fertilization (total fertilizer package)

Efficiency perception Assessment	Fertilization categories <6		6-10		>10		Total	
	n	%	n	%	n	%	N	%
Underrate	0	0.0	0	0.0	8	100.0	8	7.1
Slightly underrate	0	0.0	7	35.0	13	65.0	20	17.7
Assess correctly	0	0.0	10	45.5	12	54.5	22	19.5
Slightly overrate	15	33.3	24	53.3	6	13.3	45	39.8
Overrate	13	72.2	5	27.8	0	0.0	18	15.9
Total	28	24.8	46	40.7	39	34.5	113	100.0

χ^2 =66.055; df = 8; p=0.000

r= -0.685; p=0.000

Very few respondents (19.5 percent) assessed their current efficiency of total fertilizer package adoption correctly. The large majority, 55.7 percent overrate or perceive their current situation of phosphate, nitrogen and time of nitrogen fertilizer application to be higher than it really is. This probably contributes to their poor adoption of the package. For example not a single respondent who overrated his/ her adoption efficiency applied the recommended fertilization.

On the other hand, all the respondents who underrated their fertilizer application were among the adopters. This might be due to the fact that they were not satisfied with their fertilizer programmes and perceived them to be inferior to the recommended one. These findings are supported by a highly significant negative correlation (r = -0.685; p = 0.000) between the efficiency misperception and the adoption behaviour. The negative correlation coefficient observed here and in other fertilization practices indicates that the more farmers misperceive or overrate their practice adoption efficiency, i.e. perceive it to be better than it really is, the lower the adoption tends to be. The influence of efficiency misperception is highly significant in all fertilization practices but is more evident in total fertilization package (r= - 0.685, p=0.000) and nitrogen fertilization (r= 0.695, p= 0.000) than in other fertilization practices.

8.3.2 Need tension (NT)

Need tension (NT) is another key intervening variable that has been found to have significant influences on the adoption of the various individual fertilization practices and is expected to have a similar influence on the total fertilization package. Table 8.8 summarizes the results in this regard.

Table 8. 8: Relationship between Need Tension (NT) and the adoption of fertilization (total fertilizer package)

Need tension	Fertilization categories							
	<6		6-10		>10		Total	
	n	%	n	%	n	%	N	%
Low Need tension	27	64.3	15	35.7	0	0.0	42	37.2
Medium Need tension	1	4.5	19	86.4	2	9.1	22	19.5
High Need tension	0	0.0	12	24.5	37	75.5	49	43.4
Total	28	24.8	46	40.7	39	34.5	113	100.0

χ^2 =99.398; df = 4; p=0.000

r= 0.819, p= 0.000

All the respondents (42) with a low need tension, did not adopt the fertilizer package. On the other hand, not a single respondent among the 49 respondents with a high need tension was among the worst adopters (scale point of <6). This is indicative of a very close relationship, as is further supported by the highly significant chi-square and correlation coefficient of χ^2 =99.398; and r=0.819, respectively. This reflects that the adoption of fertilizer package consisting of phosphate, nitrogen and time of nitrogen application in the study area increases with the increase in need tension. In this case the NT seems to contribute more significantly to the adoption behaviour of maize growers as far as the total package is concerned than the individual fertilization practices.

8.3.3 Need compatibility

Table 8. 9: Relationship between need compatibility (NC) and the adoption of fertilization (total fertilizer package)

Need compatibility	Fertilization categories							
	<6		6-10		>10		Total	
	n	%	n	%	n	%	N	%
Low need compatibility	20	35.7	33	58.9	3	5.4	56	49.6
Medium need compatibility	1	3.8	8	30.8	17	65.4	26	23.0
High need compatibility	7	22.6	5	16.1	19	61.3	31	27.4
Total	28	24.8	46	40.7	39	34.5	113	100.0

χ^2 =44.572; df = 4; p=0.000

r= 0.429, p= 0.000

The majority of the respondent farmers (49.6 percent) perceive a low need compatibility between the suggested fertilization package and their need situation and hence have a low level of adoption. Only 5.4 percent of these respondents applied the recommended fertilizer package while 61.3 percent of those with high need compatibility had adopted.

This is indicative of a highly significant positive correlation (r = 0.429, p = 0.000) between need compatibility and adoption behaviour (Table 9.9), implying that the more fertilizer package is perceived to be compatible with the farmers needs the higher the adoption tends to be. The low adoption observed in the study could largely be attributed to the fact that the package is not perceived as a means of improving maize yield.

8.3.4 Awareness

According to Table 8.10 below, awareness is another intervening variable that seems to have influence on adoption of total fertilizer package in the Njombe district.

Table 8. 10: Relationship between awareness and the adoption of fertilization (total fertilizer package)

Awareness	Fertilization categories							
	<6		6-10		>10		Total	
	n	%	n	%	n	%	N	%
Not aware	23	41.8	25	45.5	7	12.7	55	48.7
Aware	5	8.6	21	36.2	32	55.2	58	51.3
Total	28	24.8	46	40.7	39	34.5	113	100.0

χ^2 =27.885; df = 2; p=0.000

r= 0.495, p= 0.000

Almost half of the respondents (48.7 percent) lack knowledge of the recommended fertilizer package in their area, signifying that only 51.3 percent of the respondents seem to be aware of the recommended package. The results show that there is a highly significant positive correlation (r=0.495, p=0.000) between awareness of the recommended fertilization package and its adoption, implying that awareness of required fertilizer package in maize production tends to lead to a higher adoption.

For example 55.2 percent of the respondents that are aware of the fertilization package needed to fertilize maize fields in their area had adopted but only 12.7 percent of those who had no knowledge did so. As in the case of NT the awareness of solutions seem to be more important in determining the adoption of total fertilization package than in the case of individual fertilization practices.

8.3.5 Prominence

The study model contends that the more the total fertilizer package is perceived to be relatively better than the traditional practices the higher its adoption is likely to be. The findings relating to the relationship between awareness and farmers adoption behaviour are represented in Table 8.11

Table 8. 11: Relationship between prominence and the adoption of fertilization (total fertilizer package)

Prominence	Fertilization categories							
	<6		6-10		>10		Total	
	n	%	n	%	n	%	N	%
Low prominence	22	71.0	9	29.0	0	0.0	31	27.4
Medium prominence	3	11.1	23	85.2	1	3.7	27	23.9
High prominence	3	5.5	14	25.5	38	69.1	55	48.7
Total	28	24.8	46	40.7	39	34.5	113	100.0

χ^2 =91.495; df = 4; p=0.000

r= 0.748, p= 0.000

As shown in Table 8.11, the majority of the respondents (72.6 percent) perceived the recommended fertilizer package to have a medium or high prominence relative to their own practices. None of the 27.4 percent respondents regarding the package to have low prominence (in other words not perceiving the recommended package to be better than the own or traditional fertilization), adopted it.

This clear relationship between perceived prominence and adoption is also reflected in the highly significant correlation coefficient (r=0.637, p=0.000), signifying that the perceived prominence clearly seems to have an influence on the adoption of recommended fertilizer package in the study area.

8.3.6 Perceived advantages and disadvantages of fertilization

The perceived advantages and disadvantages of the recommended fertilizer package are assumed to have a significant influence on farmer's adoption decision or behaviour. The perceived advantages are discussed first followed by the perceived disadvantages.

8.3.6.1 Perceived advantages

Farmers were asked to list the advantages of the recommended fertilizer application in their maize fields. The most important advantages mentioned are high yield, growth facilitation, good grain quality and high yield of maize plant residues (Table 8.12).

The perception of the various attributes vary form strongly positive to negative, meaning that certain attributes are seen as highly positive by some respondents while others perceive the same as negative. In both cases this perception influences the adoption behaviour. For example, the negative interpretations of attributes are only found among the non-adopters or those at a low level of adoption. This applies to high or increased yield, growth facilitation and good grain quality. The opposite also applies, namely that none of the low adopters perceived any of the mentioned attributes as highly positive.

From the distributions in Table 8.12 is can further be concluded that the more positive the attributes are assessed, the higher is the level of adoption. This applies more specifically to the major advantages of higher yield and growth facilitation, but is a little less conspicuous in the case of grain quality and high yield of maize plant residues. These clear relationships also find manifestation in the correlation coefficients, which are all highly significant.

Table 8. 12: Relationship between perceived advantages and the adoption of fertilization (total fertilizer package)

Attributes forces (strength)	Fertilization categories <6		6-10		>10		Total	
	n	%	n	%	n	%	N	%
High yield								
Negative	11	39.3	3	6.5	0	0.0	14	12.4
Low positive	16	57.1	24	52.2	0	0.0	40	35.4
Med positive	1	3.6	7	15.2	2	5.1	10	8.8
High positive	0	0.0	12	26.1	37	94.9	49	43.4
Total	28	24.8	46	40.7	39	34.5	113	100.0
χ^2 =86.431; df = 6; p=0.000; r= 0.795, p= 0.000								
Growth facilitation								
Negative	3	10.7	1	2.2	0	0.0	4	3.5
Low positive	21	75.0	28	60.9	2	5.1	51	45.1
Med positive	4	14.3	4	8.7	1	2.6	9	9.0
High positive	0	0.0	13	28.3	36	92.3	49	43.4
Total	28	24.8	46	40.7	39	34.5	113	100.0
χ^2 =66.552; df = 6; p=0.000; r= 0.711, p= 0.000								
Good grain quality								
Negative	2	7.1	0	0.0	0	0.0	2	1.8
Low positive	21	75.0	35	76.1	8	20.5	64	56.6
Med positive	5	17.9	9	19.6	7	17.9	21	18.6
High positive	0	0.0	2	4.3	24	61.5	26	23.0
Total	28	24.8	46	40.7	39	34.5	113	100.0
χ^2 =58.404; df = 6; p=0.000; r= 0.612, p= 0.000								
High yield of maize plant residues								
Low positive	28	100.0	46	100.0	33	84.6	107	94.7
Med positive	0	0.0	0	0.0	4	10.3	4	3.5
High positive	0	0.0	0	0.0	2	5.1	2	1.8
Total	28	24.8	46	40.7	39	34.5	113	100.0
χ^2 =12.023; df =4; p=0.017; r= 0.263, p= 0.005								

8.3.6.2 Perceived disadvantages

It is expected that the perceived disadvantages associated with the implementation of the fertilizer package will hinder its adoption. Farmers were therefore asked to list the disadvantages of applying phosphate, nitrogen and time of nitrogen fertilization in the maize fields. The most important disadvantages mentioned are poor grounding quality of grain, high labour requirements, pest attack and wastage of money (Table 8.13).

Table 8. 13: Relationship between perceived disadvantages and the adoption of fertilization (total fertilizer package)

	Fertilization categories							
	<6		6-10		>10		Total	
Attributes forces (strength)	**n**	**%**	**n**	**%**	**n**	**%**	**N**	**%**
Poor grounding quality								
Low negative	26	92.9	46	100.0	39	100.0	111	98.2
High negative	2	7.1	0	0.0	0	0.0	2	1.8
Total	28	24.8	46	40.7	39	34.5	113	100.0
χ^2 =6.181; df = 2; p=0.045; r= -0.193, p= 0.041								
High labour requirement								
Low negative	25	89.3	42	91.3	39	100.0	106	93.8
High negative	3	10.7	4	8.7	0	0.0	7	6.2
Total	28	24.8	46	40.7	39	34.5	113	100.0
χ^2 =4.055; df = 2; p=0.132; r= -0.177, p= 0.061								
Pest attack								
Low negative	25	89.3	42	91.3	38	97.4	105	92.9
High negative	3	10.7	4	8.7	1	2.6	8	7.8
Total	28	24.8	46	40.7	39	34.5	113	100.0
χ^2 =1.954; df = 2; p=0.376; r= -0.126, p= 0.185								
Wastage of money								
Low negative	21	75.0	34	73.9	36	92.3	91	80.5
High negative	7	25.0	12	26.1	3	7.7	22	19.5
Total	28	24.8	46	40.7	39	34.5	113	100.0
χ^2 =5.281; df =2; p=0.071; r= -0.180, p= 0.057								

Except poor grounding quality that signifies that adopters and non-adopters perceive this attribute completely differently, other disadvantages like high labour requirement and pests attack perceived by both groups of farmers as important factors that influence adoption. The difference lies in the fact that the adopters are more inclined to rate the negative attributes as low negative, whilst the non-adopters or low adopters are more inclined to perceive certain disadvantage as highly negative. This seems to indicate that the adopters are equally aware of disadvantages but they have overcome them, and although they may have been critical in terms of adoption behaviour, they no longer play a critical role. It would appear that those respondents who assess an attribute as highly negative, that perception is likely to be critical as far as their decision-making or adoption is concerned.

A further analysis was carried out to determine the influence of the total attributes of recommended maize varieties in terms of their total numbers and total weightings on adoption behaviour. The attributes considered include total number of advantages, total number of disadvantages, the difference between total number advantages and total number disadvantages, total number positive forces, total number negative forces, the difference between total number positive and total number negative forces (Table 8.14).

The findings in Table 8.14 indicate a highly significant correlation (r= 0.648, p=0.000) between the adoption and the total numbers and weightings of advantages represented by the correlation coefficient of r = 524 and r = 577, respectively. This clearly shows that the awareness of advantages is closely related to adoption. In other words, the more farmers are aware and even perceive the advantages of the fertilizer package as important in their adoption decision- making, the higher its adoption tends to be.

As far as the disadvantages expressed as the total numbers and total fertilizer package adoption are concerned, there is no correlation (r = 0.028; p=0.770) between the two variables. The reason for this non-significant correlation is a non-linear distribution with the middle adoption group being aware of the most disadvantages, followed by the group with the highest level of adoption. When expressed as total forces, this correlation even becomes negative (r = -0.006; p=0.951), which is indicative of the

Table 8. 14: Relationship between different categories of adoption and the total numbers and weightings of advantages and disadvantages of the fertilizer package

Total attributes	Perceived total numbers of advantages/disadvantages			Perceived total weightings of advantages/disadvantages		
	<6	**6-10**	**>10**	**<6**	**6-10**	**>10**
Total advantages	50	119	133	102	427	557
	r = 0.524 ; p=0.000			r = 0.577; p=0.000		
Total disadvantages	102	175	147	384	747	612
	r = 0.028; p=0.770			r = 0.104; p=0.271		
Total advt.- disadvt.	-52	-56	-14	-282	-320	-55
	r = -0.291; p=0.002			r = -0.353; p=0.000		
Total positive forces	47	119	132	8	275	539
	r = 0.532; p=0.000			r = 0.764; p=0.000		
Total negative forces	104	171	144	351	581	344
	r = -0.006 ; p=0.951			r = -0.259; p=0.006		
Total(+)-(-) forces	-57	-52	-12	-343	-306	195
	r = 0.322; p=0.001			r = 0.647; p=0.000		

phenomenon that adopters are as aware, if not more aware of the disadvantages than the non-adopters, probably because they have gone through the adoption process and are still fully aware of the constraints, but have probably overcome them. This could imply that to them these disadvantages are mere disadvantages and no longer represent forces of change.

Ultimately the combination of positive and negative forces should determine whether or not change (adoption) will take place. Where these are combined, the correlations are highly significant, both as far as the number of advantages/disadvantages (r = 0.322; p=0.001) and weighted values (r = 0.647; p=0.000) are concerned, which further confirms the relationship between the perceived advantages and disadvantages and the adoption behaviour. For full adoption there needs to be a positive imbalance of positive over negative forces and this in fact the case with weighted forces. Only the full adopters have a positive imbalance of positive over negative forces, namely 195, while all the other categories have a very strong negative imbalance. This does indicate that the non-adopters still need much persuasion before deciding to fully adopt.

8.3.7 Total influence of intervening variables

The total influence of all tested intervening variables is assessed here by means of showing not only the influence of the individual intervening variable, but also their total or aggregate influence on the adoption behaviour. The results of the linear regression model used for this purpose are presented in Table 8.15 below.

Table 8. 15: Linear regression analysis showing the relationship between intervening variables and adoption

Variable	Beta	t	p
Constant		0.474	0.637
Efficiency misperception	-0.148	-2.294	0.024
Need tension	0.348	4.370	0.000
Need compatibility	-0.123	-2.314	0.023
Awareness	0.075	1.444	0.152
Prominence	0.155	2.135	0.035
High yield	0.210	2.273	0.025
Facilitate growth	0.149	2.127	0.036
High stover yield	0.073	1.621	0.108
Good grain quality	0.065	1.110	0.270
Poor hauling quality of grain	-0.037	-0.818	0.415
High labor requirement	0.002	0.040	0.968
Pests attack	0.120	2.496	0.014
Wastage of money	-0.055	-1.139	0.257

R^2 =0.82, p=0.000

The intervening variables entered into the model contribute very significantly to the adoption of total fertilizer package. According to Table 8.15 they explain 82 percent of the variation in adoption (R^2 =0.82, p=0.000). As far as the individual intervening variables are concerned, most of them as clearly seen in Table 8.15 contribute significantly to the adoption behaviour but the need tension (Beta 0.348, p=0.000) makes the biggest contribution. Although the intervening variables demonstrate high contribution to the adoption of each fertilization practice, the contribution is even more in the case of the total fertilization package.

8.4 COMPARISONS BETWEEN INDEPENDENT AND INTERVENING VARIABLES

Compared to individual independent variables each intervening variable has a significantly bigger influence on adoption behaviour if the correlation coefficients are used as criterion. In addition, the total influence of intervening variables on the adoption behaviour far outweighs that of the independent variables in terms of the percentage variation explained. The intervening variables explain 82 percent of the variation in total fertilizer package adoption as opposed to the 32.9 percent contributed by the independent variables (Fig 8.2).

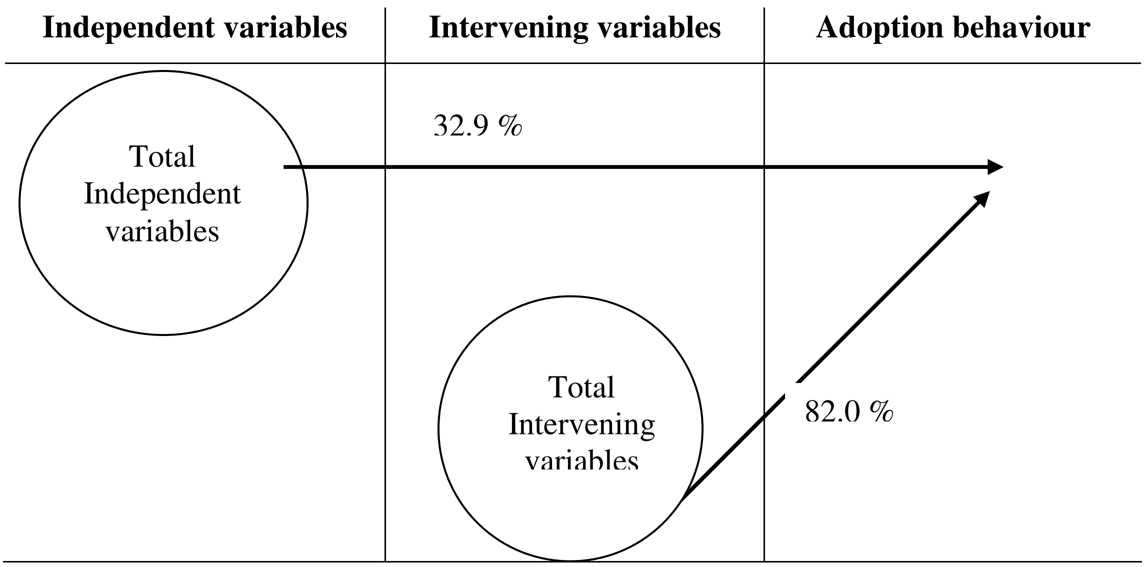

Figure 8. 1: Comparative contribution of independent and intervening variables on adoption behaviour in respect of fertilization

CHAPTER 9

THE ROLE OF INDEPENDENT AND INTERVENING VARIABLES ON THE ADOPTION OF SEED SPACING

9.1 INTRODUCTION

The seed spacing as measured in this study does not significantly influence the production efficiency or yield (see Chapter 4). As said earlier, the results might be inaccurate either because of 1) the wrong estimations of the seed spacing used due to the fact that most of the respondents use step or foot measures estimations instead of the recommended rope or stick. 2) the inappropriateness of the seed spacing recommendations 3) the scale used for its measurement.

The recommended spacing for full season varieties of maize is 25-30 cm by 75-90 cm with one plant per hill or 25-30 cm by 75-90 cm planting two plants of maize per hill but most of the surveyed respondents used one seed. Due to this the analyses and discussion focus on the independent and intervening factors or variables that influence the adoption of seed spacing among this group of farmers only.

9.2 INDEPENDENT FACTORS

9.2.1 Age

Table 9.1 shows the survey results of the relationship between age of the respondents and their adoption of seed spacing.

Although the results show significant differences between the age groups in terms of adoption of seed spacing (χ^2 = 9.750; df=4; p=0.045), the correlation is not significant at ($p > 0.05$), and can be attributed to the fact that the relationship is not quite linear as seen in Table 9.1. It is only among the youngest group of farmers where there is an increased tendency towards a higher plant population or seeding rate, while there is no difference between the groups above the age of 36 years.

For example, 12 percent of the youngest group of farmers opted for the highest plant population, while none of the older farmers made this choice.

Table 9. 1: Distribution of respondents according to their age and their adoption of seed spacing

Seed spacing (cm)	Population/ acre (x 1000)	Age (years) <36		36-56		>56		Total	
		n	%	n	%	n	%	N	%
<20 x <60	40-45	3	12.5	0	0.0	0	0.0	3	3.2
20-25 x 60-75	30-35	13	54.2	26	52.0	11	52.4	50	52.6
25-30 x 75-90	20-25	8	33.3	24	48.0	10	47.6	42	44.2
Total		24	25.3	50	52.6	21	22.1	95	100.0

χ^2 = 9.750; df=4; p=0.045

r = 0.173; p=0.094

9.2.2 Sex

An analysis of the relationship between sex and the adoption of seed spacing is provided in Table 9.2.

Table 9. 2: Distribution of respondents according to their sex and the adoption of seed spacing

Seed spacing (cm)	Population/acre (x 1000)	Sex Male		Female		Total	
		n	%	n	%	N	%
<20 x <60	40-45	0	0.0	3	8.1	3	3.2
20-25 x 60-75	30-35	29	50.0	21	56.8	50	52.6
25-30 x 75-90	20-25	29	50.0	13	35.1	42	44.2
Total		58	61.1	37	38.9	95	100.0

χ^2 = 6.028; df=2; p=0.049

r = -0.203; p=0.049

According to Table 9.2 there is a negative correlation (r=-0.203; p=0.049) between sex of the respondents and adoption. The negative correlation suggests that male farmers tend to have higher adoption rates as far as seed spacing or plant population is concerned. For example 50.0 percent male farmers used the required spacing with 20 000 - 25 000 plants population per acre compared to only 35.1 percent female farmers. Similarly amongst the lowest adopters is not a single male farmer but 8.1 percent female farmers.

9.2.3 Formal education

Table 9.3 summarizes the distribution of the respondent farmers according to their formal education and maize seed spacing.

Table 9. 3: Distribution of respondents according to their formal education and seed spacing

Seed spacing (cm)	Population/ acre (x 1000)	Formal education							
		None		1-7		>7		Total	
		n	%	n	%	n	%	N	%
<20 x <60	40-45	0	0.0	1	1.8	2	9.1	3	3.2
20-25 x 60-75	30-35	9	52.9	35	62.5	6	27.3	50	52.6
25-30 x 75-90	20-25	8	47.1	20	35.7	14	63.6	42	44.2
Total		17	17.9	56	58.9	22	23.2	95	100.0

χ^2 = 9.871; df=4; p=0.043

r = 0.058; p=0.576

Although the chi-square test on this variable is statistically significant at five percent probability level, the correlation is not significant (r= 0.058; p=0.576) meaning that there is no relationship between formal education and the adoption behaviour. This can be attributed to the fact that the relationship is not linear.

This non-linear relationship is evident in the fact that both the lowest and highest qualification groups have higher adoption rates than the middle group. Evidence of the non-linear relationship is the percentages of the different age groups who used the proper seed spacing and number of plant population (Table 9.3).

This is in support of inconsequent influence of education referred to by CIMMYT (1993), namely that "the adoption of an innovation or technology among farmers may not depend at all on their education level, while the adoption of a chemical input (if it needs computations) may be rapid among farmers who have a certain minimum level of education." However, if there are question marks regarding the appropriateness of the seed spacing recommendations, it cannot be expected that education will correlate significantly with seeding rate.

9.2.4 Farm size

Table 9.4 summarizes the survey results regarding the relationship between farm size and the adoption of seed spacing.

Table 9. 4 Distribution of respondents according to their farm size and the adoption of seed spacing

Seed spacing (cm)	Population/ acre (x 1000)	Farm size							
		<3		3-6		>6		Total	
		n	%	n	%	n	%	N	%
<20 x <60	40-45	2	6.7	1	2.4	0	0.0	3	3.2
20-25 x 60-75	30-35	14	46.7	26	63.4	10	41.7	50	52.6
25-30 x 75-90	20-25	14	46.7	14	34.1	14	58.3	42	44.2
Total		30	31.6	41	43.2	24	25.3	95	100.0

χ^2 = 5.714; df=4; p=0.222

r = 0.113; p=0.275

Also in the case of farm size there is no significant relationship with seed spacing. It is perhaps worth noting not a single farmer in the biggest farm size category applied the high seeding rate, which is the least recommended one.

9.2.5 Area under maize

The area under maize is closely correlated with farm size (r = 0.471, p = 0.000) and consequently similar results are expected. These results are summarised in Table 9.5 and show the relationship between the area under maize production and seed spacing.

Table 9.5: Distribution of respondents according to their area under maize and the adoption of seed spacing

Seed spacing (cm)	Population/ acre (x 1000)	Area under maize 0.1-1		1.1-3		>3		Total	
		n	%	n	%	n	%	N	%
<20 x <60	40-45	0	0.0	3	5.5	0	0.0	3	3.2
20-25 x 60-75	30-35	7	38.9	34	61.8	9	40.9	50	52.6
25-30 x 75-90	20-25	11	61.1	18	32.7	13	59.1	42	44.2
Total		18	18.9	55	57.9	22	23.2	95	100.0

χ^2 = 8.189; df=4; p=0.085
r = 0.011; p=0.919

These findings (Table 9.5) resemble those of farm size (Table 9.4) in that area under maize also reveals no linear relationship with seed spacing, when using the correlation coefficient as criterion (r = 0.011; p=0.919). In this case the non-linear distribution is even more pronounced, which becomes evident if the significantly poorer adoption of the middle group (with 1 to 1.3 acres under maize) is compared with the groups with less and more maize. An alternative explanation for the absence of a relationship is the possible inappropriateness of seed spacing recommendations as manifested in the scale used to assess the efficiency of seed spacing as a production practice in maize production.

9.2.6 Total influence of all independent variables

The comparative and total influence of the different independent variables on seed spacing are reflected in Table 9.6.

Table 9.6: Total influence of all independent variables on adoption of seed spacing

Variable	Beta	t	p
(Constant)		6.465	0.000
Sex	-0.138	-1.164	0.247
Age	0.148	1.165	0.247
Formal education	0.066	0.525	0.601
Farm size	0.028	0.223	0.824
Area under maize	-0.014	-0.121	0.904

R^2 = 0.060, p = 0.343

The total contribution of the tested independent variables on the adoption behaviour variance is only 6.0 percent and also not significant (p = 0.343). This seems to imply that the independent variables investigated are not very much important in determining the adoption behaviour as far as seed spacing is concerned.

9.3 INTERVENING VARIABLES

9.3.1 Efficiency misperception (EM)

In order to have a better understanding of farmers' perception of their current efficiency of practice adoption in this case the proper seed spacing, farmers were asked to indicate their current efficiency regarding this practice. This assessment was then compared with the adoption score in order to establish whether or not and to what degree they tend to overrate their current seed spacing efficiency. The assumption here is that the efficiency misperception (EM) could lead to non-adoption or irrational decision making. Table 9.7 summarizes the findings.

About 44 percent of the respondents perceived their current situation of practice adoption correctly, meaning that their responses agreed with the assumed "objective" assessment based on the adoption scale, while 41.1 percent tend to overrate their efficiency. What is conspicuous is that none of the respondents overrating their efficiency, adopted the recommended seeding rate, while 75 percent of those

Table 9.7: Distribution of respondents according to their efficiency misperception (EM) and the adoption of seed spacing

Seed spacing (cm)	Population/ acre (x 1000)	Efficiency perception assessment											
		Underrate		Slightly underrate		Assess correctly		Slightly overrate		Overrate		Total	
		n	%	n	%	n	%	n	%	n	%	N	%
<20x<60	40-45	0	0.0	0	0.0	0	0.0	2	5.3	1	100.0	3	3.2
20-25x 60-75	30-35	1	25.0	4	40.0	9	21.4	36	94.7	0	0.0	50	52.6
25-30x 75-90	20-25	3	75.0	6	60.0	33	78.6	0	0.0	0	0.0	42	44.2
Total		4	4.2	10	10.5	42	44.2	38	40.0	1	1.1	95	100.0

χ^2 = 83.859; df=8; p=0.000

r = -0.586; p=0.000

underrating their own seeding rate efficiency, adopted the recommended seeding rate. This is an indication of a significant relationship between the EM and adoption and is supported by the highly significant correlation coefficient (r = -0.586; p=0.000). The more farmers misperceive or overrate their efficiency of practice adoption to be better than it really is, the lower the incentive to change their behaviour towards what is recommended.

9.3.2 Need tension (NT)

Need tension is not independent of the perceived current efficiency (PCE) in that it refers to the total discrepancy or difference between the potential and the current efficiency or PCE. It is therefore expected that the more farmers overrate their current situation of seed spacing to be better than the factual the more the need tension is reduced and consequently the lower the adoption, and *visa versa*. The results of the relationship between need tension and seed spacing are presented in Table 9.8.

Table 9 8: Distribution of respondents according to their Need tension (NT) and the adoption of seed spacing

Seed spacing (cm)	Population/ acre (x 1000)	Need tension (NT) categories							
		Low NT		Medium NT		High NT		Total	
		n	%	n	%	n	%	N	%
<20 x <60	40-45	3	100.0	0	0.0	0	0.0	3	3.2
20-25 x 60-75	30-35	0	0.0	49	98.0	1	2.4	50	52.6
25-30 x 75-90	20-25	0	0.0	1	2.0	41	97.6	42	44.2
Total		3	3.2	50	52.6	42	44.2	95	100.0

χ^2 =181.859; df=4; p=0.000

r = 0.966; p=0.000

As shown in Table 9.8 the need tension or problem scope, as far as seed spacing is concerned, is reasonably high in that about 52.6 percent and 44.2 percent of the respondents seem to have medium and high need tensions respectively. Both the chi-square and correlation analyses indicate that there is a highly significant association between NT and adoption of the recommended seed spacing.

This almost perfect linear relationship is reflected in the correlation of 0.966, signifying that the higher the need tension the higher the adoption rates tend to be. This close relationship is further supported by the fact that 97.6 percent of the respondent with high NT had adopted while the percentage of those with medium and low NT is 0.0 percent and 2.0 percent respectively. On the other hand, all the respondents with a low NT seem to have a poor seeding rate adoption, namely a high plant population of more than 40 000 plants per acre.

9.3.3 Awareness

The surveys went further to investigate whether farmers had knowledge or were aware of the recommendation regarding the plant population per acre. The responses are summarized in Table 8.9 below.

Table 9.9: Distribution of respondents according to their awareness of the recommendation and their adoption of seed spacing

Seed spacing (cm)	Population/acre (x 1000)	Awareness					
		Not aware		Aware		Total	
		n	%	n	%	N	%
<20 x <60	40-45	3	4.9	0	0.0	3	3.2
20-25 x 60-75	30-35	41	67.2	9	26.5	50	52.6
25-30 x 75-90	20-25	17	27.9	25	73.5	42	44.2
Total		61	64.2	34	35.8	95	100.0

χ^2 = 18.853; df = 2; p=0.000

r = 0.439; p=0.000

According to Table 9.9 the overwhelming majority (64.2 percent) of maize growers in the Njombe district are not aware of the number of maize plants per acre recommended for that area and thus can hardly be expected to implement it. This unawareness finds its expression in a highly significant correlation of r = 0.439 (p = 0.000) showing that there is a positive relationship between awareness and adoption decision or behaviour. For example 73.5 percent of the respondents that were aware of recommended seed spacing had adopted while only 27.9 percent who had no knowledge of it did so.

9.3.4 Prominence

An overview of how prominent or how relatively more advantageous farmers perceive the recommended seed spacing to be in comparison with their own practice is summarized in Table 9.10.

Table 9.10: Distribution of respondents according to their perceived prominence of the recommended seed spacing and their adoption of it.

		Prominence							
Seed spacing (cm)	**Population/ acre (x 1000)**	**Low prominence**		**Medium prominence**		**High prominence**		**Total**	
		n	**%**	**n**	**%**	**n**	**%**	**N**	**%**
<20 x <60	40-45	2	28.6	1	2.2	0	0.0	3	3.2
20-25 x 60-75	30-35	4	57.1	43	93.5	3	7.1	50	52.6
25-30 x 75-90	20-25	1	14.3	2	4.3	39	92.9	42	44.2
Total		7	7.4	46	48.4	42	44.2	95	100.0

χ^2 = 87.338; df=4; p=0.000

r = 0.792; p=0.000

The large percentage (44.2) regard low plant populations (20 000 to 25 000 plants per acre) as more prominent and thus better than high plant populations for improving maize yields. 92.9 percent of them are implementing these low plant populations, which indicate at the close relationship between the perceived prominence and adoption. Furthermore, not a single respondent with a high prominence, had a high plant population. This close relationship is further supported by the highly significant correlation coefficient of 0.792 (p = 0.00) between the perceived prominence and adoption.

9.3.5 Total influence of intervening variables

The results of all the intervening variables entered into the regression model are presented in Table 9.11 below.

Table 9.11: Influence of intervening variables on adoption of seed spacing

Variable	Beta	t	p
(Constant)		9.896	0.000
Efficiency misperception	-0.067	-2.047	0.044
Need tension	0.923	17.261	0.000
Awareness	-0.038	-1.181	0.241
Prominence	0.028	0.557	0.579

$R^2 = 0.936$; p = 0.000

According to Table 9.11 the greatest contribution to the adoption behaviour (beta = 0.923; p = 0.000) comes from the NT. In totality, all the intervening variables contribute highly significantly and explain as high as up to 93.6 percent of the variation in the adoption behaviour. Based in these findings, the following part provides a brief summary of the relative importance of the independent and intervening variables in explaining the adoption behaviour of the respondent farmers as far as seed spacing is concerned.

9.4 COMPARISONS BETWEEN INDEPENDENT AND INTERVENING VARIABLES

Figure 9.1 demonstrates the overall contributions of independent and intervening variables on the adoption behaviour of maize growers.

It is apparent that the contribution from the independent variables is not significant and yet very small (6.0 percent) when compared to the close and highly significant contribution of the intervening variables (93.6 percent). This implies that the intervening variables seem to have a very high influence on the adoption of seed spacing in the study area.

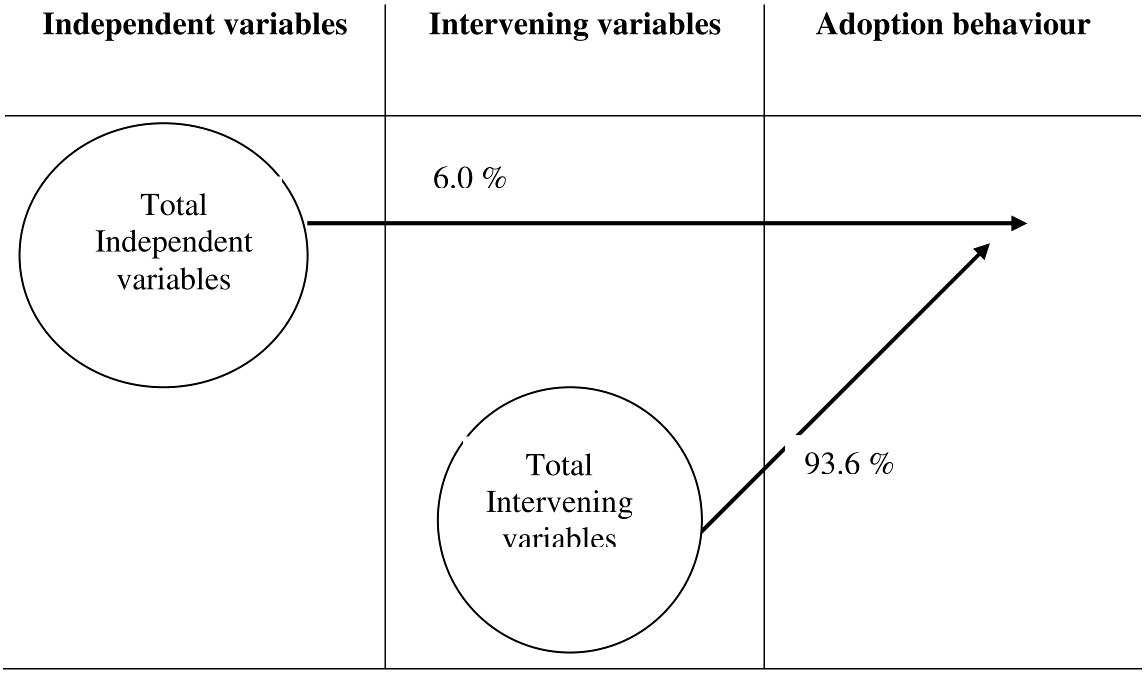

Figure 9.1: Comparative contribution of independent and intervening variables on adoption behaviour

CHAPTER 10

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

10.1 SUMMARY AND CONCLUSIONS

The ongoing quest for a better understanding of adoption behaviour, and more specifically the search for relevant, and meaningful behaviour determinants that can be useful in the understanding, analysis and change of adoption behaviour, has prompted this study. Over the years much attention has been given to independent variables like socio-economic and environmental factors, but with limited success in view of their rather limited and often inconsistent influence. More recent claims that intervening variables like; needs, knowledge and perception, have a potentially better prediction value, gave direction to the objective of this study namely to compare independent and intervening variables with regard to their influence on the adoption behaviour of recommended maize production practices by maize growers in the Njombe district.

A structured questionnaire was used to collect data from 113 farmers randomly selected to represent five percent samples of four villages selected to represent the biggest variation in terms of climatic conditions within the Njombe district of Tanzania. The data collected were analyzed using the statistical package for social sciences (SPSS). Correlations, chi-square, and regressions were used to determine the relationship between the independent and the dependent variables

The following hypotheses guided the study and provide an appropriate framework for a brief overview regarding the main findings and conclusions:

Hypothesis 1: The production efficiency is influenced by the adoption of recommended maize production practices

The results show that most of the farmers' (97.3 percent) production efficiency falls well below the optimum maize yield of about 40 bags per acre. The overall low level of adoption of the recommended and investigated practices as well as their highly significant correlation with yield goes a long way in explaining the low production efficiency. However, the total contribution of all included practices toward the explanation of yield variation is only about 55 percent. It is meaningful that the mere inclusion of weed infestation as an independent variable increases the regression (R^2) or explanation of variation from 55 to 72 percent and contributes more than any of the practices studied.

The fact that weed control, measured as weeding frequency, did not significantly contribute towards the regression, clearly shows that the measure used is inappropriate and that much work needs to be done in order to come up with appropriate and practical measures for assessing the level of weed control for baseline or for extension output purposes. The same applies, albeit to a lesser degree, to other recommended practices and it would appear that this is an area frequently overlooked by research, thereby largely failing in its knowledge support function.

Hypothesis 2: The adoption of recommended maize production practices is influenced by the independent variables like farmer's age, sex, formal education and farm size

As far as age is concerned large majority of the respondents (80 percent) are under 56 years of age and therefore can be expected to still perform all farming activities. The mean age is 45.4 but there are big variations, the youngest respondent being 20 years and the oldest 80 years old. It had been expected that the adoption of recommended maize production practices is higher among young **farmers** than among older ones, but the findings were rather inconsistent. Younger farmers appear to be more efficient than older ones regarding phosphate, nitrogen and total fertilizer package application. However, significant relationships are not found between age and the adoption of maize varieties, time of nitrogen fertilization and seed spacing.

The majority of the respondents (61.9 percent) were males but, in contradiction with many other studies, there is insufficient evidence to support this assumption in most of the investigated practices. Only seed spacing adoption seems to suggest that males are more efficient than female farmers in adopting this practice.

Amongst the independent variables education appeared to be one of the most influential. The correlation analysis revealed a significant positive correlation between formal education and adoption implying that the higher the formal education is, the higher the adoption of practices. However, formal education seems to have no relationship with some of the practices like time of nitrogen fertilization and seed spacing. This again shows the inconsequence of influence, even amongst the most influential independent variables, and questions their usefulness in behaviour prediction.

The influences of farm size and area under maize are very similar, and must be attributed to the close relationship between the two independent variables ($r = 0.471$, $p = 0.000$) In both cases there are significant correlations with the majority of practices, with the exception of seed spacing and maize varieties in the case of farm size and nitrogen application in the case of area under maize. The reasonably strong influence of these variables relative to other research findings (Bwana, 1996; Temu, 1996) can be attributed to the range of farm sizes found in the Njombe District (typical of many parts of Africa), which somewhere between the range of one and six acres can be more critical than is the case where farms are much bigger or well above the threshold of what can be regarded as economical units.

Hypothesis 3: The adoption of recommended maize production practices is influenced by the intervening variables like need related aspects, knowledge and perception

When investigating the role of intervening variables, they were all found to be very influential as determinants of adoption behaviour.

Efficiency misperception or the tendency to overrate one's own efficiency was a common phenomenon. For example in the case of nitrogen fertilization, 74.3 percent of the respondents overrated their efficiency while 58.4 percent and 55.7 percent overrated the efficiency of their maize varieties and total fertilization respectively. This perception was, according to the findings, very significantly related to the adoption of all the practices, implying that the more the own efficiency is overrated, the lower the level of adoption can be expected to be.

The need tension, which refers to the difference between the perceived current and desired level of adoption or production efficiency, was also found to be a very important behaviour determinant. The findings reveal a highly significant positive relationship between need tension and adoption behaviour. In respect of all the practices investigated, it was found that the higher the need tension, the higher the level or degree to which the practices are adopted.

When discerning about the role of the perceived need compatibility, its critical role becomes very obvious and was very clearly supported by the findings. This leads to the conclusion that the higher the perceived need compatibility, that is the degree to which the recommended practices are perceived to contribute towards the accomplishment of the individual's needs, the higher the level of adoption. The relatively low adoption of recommended maize varieties and fertilizer package, can largely be attributed to the fact that they are not perceived as very appropriate means in helping the respondents achieve their goals or satisfying their needs.

In general most farmers are not aware of what the optimum recommended level is regarding the adoption of the various practices in the study area. This perception or lack thereof was also found to be correlated with the degree of adoption. The perceived awareness of the solution or the optimum level has a direct bearing on the total need tension and can be regarded as a precondition, but not necessarily as a guarantee of adoption and as such can be one of a series of factors or forces preventing change.

Another intervening variable found to be related to adoption behaviour is the perceived degree of prominence of the recommended practice. The more prominent, or the more advantageous a recommended practice is perceived relative to other alternatives (especially the own) the more likely it is to be adopted. For example in the case of nitrogen fertilization, 60 percent of the respondents assessed it as having a low prominence and were correspondingly poor adopters.

The most important advantages of recommended maize varieties mentioned are high yield, early maturity, good taste and good grain quality; while poor grounding quality of grain, low storability, high implementation costs and poor resistance to draught were mentioned as the disadvantages. As far as the fertilization package is concerned the following advantages were mentioned: high yield, growth facilitation, good grain quality and high yield of maize plant residues. The disadvantages of the fertilization package identified include poor grounding quality of grains, high labour requirement, pests attach and wastage of money.

The study revealed that the number of perceived advantages of recommended maize production practices is positive and highly significantly related to adoption behaviour. This means that adopters are more aware of advantages than non-or poor adopters. However, as far as the number of perceived disadvantages of recommended maize production practices is concerned, there is no clear relationship with adoption behaviour. This could be attributed to the fact that adopters are as aware of the disadvantages as the non-adopters, but having gone through the adoption process, many of the disadvantages may have been overcome by them and no longer present negative forces preventing change.

A further analysis focused on the strength rather than the number of forces (advantages and disadvantages) revealed similar results, namely strong relationships between the total positive forces and imbalance of positive over negative forces with adoption behaviour.

The negative correlation regarding the total negative forces and adoption behaviour confirm the above suspicion that disadvantages can be mere disadvantages without representing negative forces acting as restraining forces to change. The challenge, from a behaviour analysis point of view, lies in differentiating between what are mere cognitions or disadvantages and what are actual negative forces

In general the intervening variables show very strong relationships with adoption behaviour and, unlike what is a common phenomenon among independent variables, these relationship show great consistency, which is in support of the research hypothesis.

Hypothesis 3: The influence of intervening variables on adoption behaviour is bigger than that of independent variables

A regression analysis, of which the results are summarized in Table 10.1, shows the much bigger influence of intervening variables compared to independent variables.

Table 10.1: Comparative role of total independent and intervening variables in explaining the percentage variation in adoption behaviour

Recommended practices	Independent variables (%)	Intervening variables (%)
Maize varieties	18.7	86.7
Phosphate fertilization	24.8	73.2
Nitrogen fertilization	29.5	74.8
Total fertilizer package application	32.9	82.0
Seed spacing	6	93.6

In regard to all practices investigated, the influence of intervening variables very clearly overshadows that of independent variables. The tremendous difference emphasizes the importance of the former variables.

The logical explanation for this highly significant difference is that the intervening variables are probably the immediate and direct determinants of adoption behaviour and that the influence of independent variables only becomes manifested in adoption behaviour *via* the intervening variables. This means that the obvious variables on which attention need to be focused in behaviour analysis are the intervening variables; like needs, perceptions and knowledge.

According to the findings of this study, focus of extension can be narrowed down to that of the intervening variables, which are relatively low in number and very relevant as opposed to independent variables that involve collection of bulk data from the great number of variables that are not always consistence in behaviour determination. Concentration in intervening variables will also assist in saving time, energy and financial resources.

10.2 RECOMMENDATIONS

Based on the findings of the study the following recommendations emerge:

1. Refinement of adoption criteria and scales.

Extension often lacks appropriate criteria, scales and absolute standards of adoption behaviour analysis. This problem manifests itself in the poor contribution of the various maize production practices on production efficiency. This leads to the conclusion that extension and research haven't got all the answers, either in terms of the nature and completeness of recommended practices or in terms of the appropriate criteria for their measurement. This calls for closer collaboration between extension and research in the area of message development, refinement and outcome evaluation.

2. Focusing on intervening variables

In all the practices investigated the contributions of intervening variables on the adoption behaviour far outweigh those of independent variables (Table 10.1). Since the results provide sufficient evidence in supporting the relevance of intervening variables in adoption behaviour, the study recommends that emphasis be put on these variables in extension programs.

More specifically, the focus in all strategies should be focused on

- adding or strengthening the positive or driving forces,
- elimination or reduction of negative or restraining forces, and
- changing the direction of negative to positive forces.

Strictly speaking, it is very important to concentrate more on removing the constraining forces that hinder the adoption behaviour to take place. If the existing situation for example efficiency of practice adoption is overrated due to misperception the solution from an extension point of view is to establish a form of tactful disillusionment i.e avoiding public exposure. In the case of need incompatibility the innovation or practice should, if possible, be compatible with or lead to a solution of the perceived major needs or problems. For example, if the problem is limited knowledge concerning the optimum that is achievable, it is important for the extension staffs to provide convincing evidence about the optimum and that its achievement is worthwhile.

3. Further research

Although the intervening variables seem to be critical and very crucial in behaviour determination, there are still some outstanding challenges. For example, in the case of disadvantages, the study model (Fig. 2.7) indicates that one cause of non - adoption is awareness of disadvantages but the findings show that both adopters and non-adopters are almost equally aware of these disadvantages. The challenge here lies in differentiating between what are mere disadvantages and what are actual negative forces.

It is also important to continue the search for possible other intervening variable and to try and merge the variables encompassed in the models of Ajzen and Düvel. Furthermore, studies should be replicated in different parts of the world and different cultures for the purpose of further verification and introduction of these variables to other people who are not yet familiar with them and Düvel's (1991) behaviour analysis model in general. It can form the basis for the development of an epistemology of extension for which there is still a dire need.

APPENDIX 1

FARMER'S QUESTIONNAIRE

TITTLE: THE COMPARATIVE ROLE OF INTERVENING AND INDEPENDENT VARIABLES IN THE ADOPTION BEHAVIOUR OF MAIZE GROWERS IN NJOMBE DISTRICT, TANZANIA

A. INTRODUCTION

In this interview schedule there is no wrong or correct answer. What is required is just your opinion on practices you use in maize production. This will assist in formulation of policies, research and extension programs that are appropriate to your area. Your cooperation will be therefore highly appreciated.

B. GENERAL INFORMATION

Date---------------------------

Name of the respondent………………………………… Resp.No ☐ V1

Name of the enumerator-……………………………………….

Number of Ward: 1. ☐ V2

2.

3.

Name of the village: ……………………….. ☐ V3

C. FARMER'S CHARACTERISTICS

1. Sex of the respondent [ ] V4
   1. Male
   2. Female

2. How old are you? (In years)
   1. <30
   2. 30-40
   3. 40-50 .. Actual [ ] V5
   4. 50-60
   5. >60………………………………………………………… Code [ ] V6

3. What is your highest level of formal education? *In each category also indicate the total number of years attained.*
   (a) Formal — Total No. of years [ ] V7
   1. No education
   2. Primary education — Category [ ] V8
   3. Secondary education
   4. Certificate
   5. Diploma

   [ ] V9

   (b) Non-formal (Adult education)
   Number of weeks

4. What is your literacy level? [ ] V10
   1. Innumeracy
   2. Illiterate
   3. Partially literate
   4. Literate

5. What is your farm size? (In acres)

1. < 3 Actual no. of acres ☐ V11
2. 3-6
3. 6-9
4. 9-12 Code ☐ V12
5. >12

6. What area of your farm (in acres) did you use to grow maize last season?

1. < 2
2. 2-4 Actual no. of acres ☐ V13
3. 4-6
4. 6-8 Code ☐ V14
5. 8-10
6. >10

D. PRODUCTION EFFICIENCY

7. What was your maize yield (in bags) in the last season)?

Total number of bags ☐ V15

b. Size of bags used: ☐ V16

100kg bags (5tins)	(1)
120 kg bags (6 tins)	(2)
140 kg bags (7 tins)	(3)

d. Adjusted yield (adjusted to 100 kg bags) V17

8. Was there any natural hazard(s) (eg drought) that affected your yield level in the last season?

1. No ☐ V18
2. Yes

9. If yes, what was that? --

10. If last season's yield was affected by natural hazards, what yield (in bags) do you normally get?

Total number of bags V19

Total number of bags when adjusted to 100kg bags V20

[11. The total and average maize yield of this farmer (bags/acre) is]

1. <10 Total No. of bags (for calculation) (V17 or V20) V21
2. 10-20
3. 20-30
4. 30-40 Average No. of bags/acre V22
5. >40

(This will also be used as an objective scale) Code V23

Percentage efficiency[9] V24

Need Related Aspects

Perceived Current Efficiency

12. You told me your yield (Q7=V15) or normal yield (Q10=V19) is ------------ bags. How do you rate this yield on the following scale?

Very Low ↓ Very High ↓ V25

1	2	3	4	5

[9] V21/(V13*40)*100

Degree of overrating (V25-V23) V26

Percentage overrating[10] V27

13. How many bags is "5" on the scale or what is the best yield one could get (bags) on your farm when using all the best maize production practices in a normal rainfall year?

    1. <10
    2. 10-20
    3. 20-30
    4. 30-40
    5. >40

Actual no. of bags V28

Av. No. per acre V29

Code V30

14 How many bags is "1" on the scale or what is the yield the worst farmer (not using any recommended practices) would get on your farm?

    1. <10
    2. 10-20
    3. 20-30
    4. 30-40
    5. >40

Actual no. of bags V31

Av. No. per acre V32

Code V33

Production efficiency

15. On a five point scale below how do you rate your efficiency as a maize farmer compared to other farmers in this area?

Worst or least efficient farmer ↓		Average farmer ↓		Best or most efficient farmer ↓
1	2	3	4	5

V34

---

[10] ((V25-V23)-1)*100/4

Need Tension

16. Your yield last year was (your normal yield is) …..bags. What <u>were</u> you striving for this year? V35

    1. <10 Actual yield (bags)
    2. 10-20
    3. 20-30 Av. Yield (bags/acre) V36
    4. 30-40
    5. >40 Code V37

17. To what yield level were you striving for last season?

    1. <10 Actual yield (bags) V38
    2. 10-20
    3. 20-30 Av. Yield (bags/acre) V39
    4. 30-40
    5. >40 Code V40

18. What are your plans for the future in terms of yield that you want to achieve?

    1. <10 Actual yield (bags) V41
    2. 10-20
    3. 20-30 Av. Yield (bags/acre) V42
    4. 30-40
    5. >40 Code V43

19. How do you intend to achieve your future goal (Q. 18)?

    1. --------------------------------
    2. --------------------------------
    3. --------------------------------
    4. --------------------------------

. **Researchers** assessment based on responses in Q. 19

1. Not applicable (no future goal or aspiration)
2. Has no idea
3. Has some vague ideas
4. Has very clear, well set out goals

V44

Research findings regarding optimum yield per acre = 40 bags

Calculation: Optimum No. of bags (Total) [V13*40] V45

Percentage of optimum [V21/(V13*40)*100] V46

Need Compatibility

20. Do you think getting higher yields might in any way cause problems or concerns to you?

1. No
2. Yes

V47

21. If yes, what could be problems or concerns?

____

____

. ____

22. Yield is important when choosing a maize variety, but other characteristics such as taste, grain quality, storability and early maturity. can also be important. (*Use assessment scale below)*

Much less important than yield ↓	As important as yield ↓	Much more important than yield ↓
1	2	3

Do you regard taste to be more important than yield? V48

Do you regard grain quality to be more important than yield? V49

Do you regard storability to be more important than yield? V50

Do you regard early maturity to be more important than yield? V51

23. Could you please place the following characteristics in rank order of importance

Yield	(1)						
Taste	(2)						V52-56
Grain quality	(3)	1st	2nd	3rd	4th	5th	Position
Storability	(4)						
Early maturity	(5)						

24. In assessing your own grain crop (harvest of last season), how do you rate the following characteristics, using the following 5-point scale:

Very poor ↓ ... Excellent ↓

1	2	3	4	5

Yield	(1)		V57
Taste	(2)		V58
Grain quality	(3)		V59
Storability	(4)		V60
Early maturity	(5)		V61

E. ADOPTION OF RECOMMENDED PRACTICES

PRACTICE 1: RECOMMENDED MAIZE VARIETIES

25. Which maize varieties did you plant last season? Also indicate the source of seed and the area of your farm used to grow the variety you chose. Use the following codes to fill in the table.

	Variety and or Source 1 = Yes ↘		Source of seed Own seed (1) Seed from neighbour (2) Bought (seed merchant) (3)	Proportion %	
1	Select from Hybrid				V62-64
2	Not recommended hybr. ……………………… ………………………				V65-67
3	Select local (unknown)				V68-70
	Lomba-L				V71-73
	Kitale-L				V74-76
	Yellow-L				V77-79
4	TMV2				V80-82
5	H625				V83-85
	H628				V86-88
	UH 615				V89-91
	H614				V92-94
					V95-97
					V98-100

Researcher/Enumerator; Use the scale below to indicate this farmer's efficiency of variety choice

1	Select from previously planted hybrid
2	Buy hybrid (not recommended or optimal)
3	Select or buy local variety- unknown
	Select or buy Lomba, Kitale or Yellow
4	Buy composite (TMV2)
5	Buy hybrid (recommended)

☐ V101

Need Related Aspects

Perceived Current Efficiency

26. How do you rate, on the following scale, the efficiency of your choice (decision) regarding varieties?

Very Low ↓ Very High ↓

1	2	3	4	5

[ ] V102

Need Tension

27. Did you change your variety since last season?

1. No
2. Yes

[ ] V103

28. If yes, what variety did you plant this season?

1	Select from previously planted hybrid
2	Buy hybrid (not recommended or optimal)
3	Select or buy local variety- unknown
	Select or buy Lomba, Kitale or Yellow
4	Buy composite (TMV2)
5	Buy hybrid (recommended)

[ ] V104

Awareness of Recommended Variety

29. What are the recommended maize seed varieties in this area?

0 Don't Know
1 Replanted hybrid
2 Non-recommended hybrids and composites Staha, situka , H6302, SC407, SC403, SC513
3 Local varieties Kitale, Lomba, Yellow
4 Composites TMV2,
5 Recommended hybrids UH 615, H614, H625, SC627, P67, H628, S627

☐ V105

30. What is your view about replanting hybrid seed? Do you support it or not?

1. Yes
2. Don't know
3. No - can't provide reasons
5. No – can provide reasons

☐ V106

31 Farmer' knowledge of recommended hybrid (Assessment by enumerator)

1. Has no idea
2. Seems to have some knowledge
3. Has knowledge
4. Has very good knowledge

☐ V107

Need Compatibility

32. a. (For those who used recommended hybrid maize variety) You told me your yield was -----bags. What do you think it would have been, had you used a local variety?

b. (For those who did not use recommended maize variety) You told me your yield was ---bags. What do you think it would have been, had you used the recommended (hybrid) variety?

Actual no. of bags V108

Percentage change V109

Perception: Prominence

33. Which variety do you regard to be the best?

0 Don't Know
1 Replanted hybrid
2 Non-recommended hybrids and composites Staha, situka , H6302, SC407, SC403, SC513
3 Local varieties Kitale, Lomba, Yellow
4 Composites TMV2,
5 Recommended hybrids UH 615, H614, H625, SC627, P67, H628, S627

V110

Advantages and Disadvantages of Recommended Maize Varieties

34. What, in your opinion, are the advantages of improved maize seed varieties? Please use the scale below to rate the importance of each of the advantages for yourself.

Very Low ↓ … Very High ↓

1	2	3	4	5

35. What, in your opinion, are the disadvantages of improved maize seed varieties? Please use the scale below to rate the importance of each of the disadvantages for yourself.

Very Low ↓ … Very High ↓

1	2	3	4	5

36. a. (For adopters) We have talked about advantages of recommended hybrid varieties. Which of the advantages (in Q34) played an important role in your decision making? (*Indicate the answers in last column by using the following scale (Q34).)*

b. Which of the disadvantages weighed heavily at the time when you made the decision to adopt?

1. Unimportant
2. Little important (hardly considered)
3. Neutral/undecided
4. Important (serious consideration)
5. Very important (critical/decisive)

37. a. (<u>For non-adopters</u>) We have talked about the disadvantages of recommended hybrid varieties(Q. 35). Which of them played an important role in your decision not to adopt them.? (*Indicate the answers in last column by using the following scale*.)

b. Which of the advantages did you consider or were important at the time when you decided not to adopt the recommended hybrid variety?

Advantages and Disadvantages	Importance (1-5)	Importance in decision making . (1-5)	
ADVANTAGES			
1. High yield			V111-112
2. Early maturity			V113-114
3. Good taste			V115-116
4. Resistance to draught			V117-118
5. Resistance to diseases and pests			V119-120
6. Easy to harvest			V121-122
7. Migagi mizuri			V123-124
8.			
DISADVANTAGES			
1. Poor hauling quality of grains			V125-126
2. Less flour			V127-128
3. Don't fill the stomach			V129-130
4. Low storability			V131-132
5. Need for fresh seeds each season			V133-134
6. Rot while in the fields			V135-136
7. Buy expired seeds			V137-138
8. Yanashambuliwa migagi.			V139-140
10. Un availability of improved seeds			V141-142

11. High seeds costs			V143-144
12. High implementation costs			V145-146

Compatibility (Situational factors)

38. (For non-adopters) Had you wanted to adopt the recommended variety, is there anything that would have made it impossible or very difficult to do so?

…………………………………………………………………………………..……

…………………………………………………………………………………..……

…………………………………………………………………………………………

39. (For adopters) what made it difficult for you to adopt the recommended maize varieties?

…………………………………………………………………………………..……

…………………………………………………………………………………..……

…………………………………………………………………………………………

PRACTICE 2: FERTILIZER APPLICATION

40. Did you use fertilizer in your maize fields last season? ☐ V147

0. No

1.Yes

41. If yes, what type of fertilizer did you use

(a) at planting time (and how much)

(b) as topdressing (and how much)

Type	Planting			Topdressing			
	Yes=1	Kg per acre	Total(farm)	Yes=1	Kg per acre	Total(farm)	V148-153
Nil							
TSP							V154-159
DAP							V160-165
MRP							V166-171
NPK							V172-177
CAN							V178-183
Urea							V184-189
FYM/Compost							V190-195
Other							V196-201

Phosfate fertilizers (TSP, DAP and MRP)

TSP or DAP, or NPK	**MRP**
(0) Nil	(0) Nil
(1) <20	(1) <40
(2) 20-30	(2) 40-60
(3) 30-40	(3) 60-80
(4) 40-50	(4) 80-100
(5)>50	(5)>100

☐ V202

Nitrogen fertilizers (CAN or Urea or FYM)

	CAN or Urea(kg)	FYM (tins)	
(0)	Nil	Nil	
(1)	<15	<160	
(2)	15-30	160-320	
(3)	30-45	320-480	No of tons…………
(4)	45-60	480-640	
(5)	60-75	640-800	
(6)	>75	>800	

☐ V203

Topdressing with nitrogen

(0) Nil V204

(1) 100% at planting (75kg at planting)

(2) 100% as topdressing (75kg as topdressing)

(3) 50% at planting / 50 % as topdressing (equal at planting and topdressing)

(4) 33% planting / 66% as topdressing (25Kg at planting and 50kg as topdressing)

Total Fertilization Assessment

Total adoption score V205

(0) Nil

(1) 1-3

(2) 4-6 V206

(3) 7-9

(4) 10-12

(5) 13-15

Need Related Aspects

Perceived Current Efficiency

42. How do you rate, on the following scale, your general level of fertilization efficiency (or nutrient provision)?

Very Low ↓ 0 … Very High ↓ 5 V207

0	1	2	3	4	5

Need Tension

43. Did you change your fertilization since last season? ☐ V208

1. No
2. Yes

44. If yes, what type of fertilizer did you use this year

(c) at planting time (and how much) and

(d) as topdressing (and how much)?

Type	Planting			Topdressing			
	Yes=1	Kg per acre	Total(farm)	Yes=1	Kg per acre	Total (farm)	
Nil							V209-214
TSP							V215-220
DAP							V221-226
MRP							V227-232
NPK							V233-238
CAN							V239-244
Urea							V245-249
FYM/Compost							V250-255
Other							V256-261

Phosfate fertilizers (TSP, DAP and MRP)

TSP or DAP, or NPK	**MRP**
(0) Nil	(0) Nil
(1) <20	(1) <40
(2) 20-30	(2) 40-60
(3) 30-40	(3) 60-80
(4) 40-50	(4) 80-100
(5)>50	(5) >100

☐ V262

Nitrogen fertilizers (CAN or Urea or FYM)

	CAN or Urea(kg)	FYM (tins)
(0)	Nil/don't know	Nil/Don't know
(1)	<15	<160
(2)	15-30	160-320
(3)	30-45	320-480
(4)	45-60	480-640
(5)	60-75	640-800
(6)	>75	>800

☐ V263

Time when Nitrogen fertilizer is applied

(0) Nil

(1) 100% at planting (75kg at planting)

(2) 100% as topdressing (75kg as topdressing)

(3) 50% at planting / 50 % as topdressing (equal at planting and topdressing)

(4) 33% planting / 66% as topdressing (25Kg at planting and 50kg as topdressing)

☐ V264

Total Fertilization Assessment

Total adoption score (Actual score) ☐ V265

(0) Nil

(1) 1-3

(2) 4-6 (Code) ☐ V266

(3) 7-9

(4) 10-12

(5) 13-15

AWARENESS OF RECOMMENDED FERTILIZATION

45. What are the recommended fertilizers and the recommended rates of application in your area

(b) at planting time (and how much) and

(c) as topdressing (and how much)?

Type	Planting			Topdressing			
	Yes=1	Kg per acre	Total(farm)	Yes=1	Kg per acre	Total (farm)	
Nil							V267-272
TSP							V273-278
DAP							V279-284
MRP							V285-290
NPK							V291-296
CAN							V297-302
Urea							V303-308
FYM/Compost							V309-314
Other							V315-320

Phosfate fertilizers (TSP, DAP and MRP)

TSP or DAP, or NPK	**MRP**
(0) Nil	(0) Nil
(1) <20	(1) <40
(2) 20-30	(2) 40-60
(3) 30-40	(3) 60-80
(4) 40-50	(4) 80-100
(5)>50	(5)>100

☐ V321

Nitrogen fertilizers (CAN or Urea or FYM)

	CAN or Urea (kg)	FYM (tins)
(0)	Nil	Nil
(1)	<15	<160
(2)	15-30	160-320
(3)	30-45	320-480
(4)	45-60	480-640
(5)	60-75	640-800
(6)	>75	>800

☐ V322

Time when Nitrogen fertilizer will be applied

(0) Nil ☐ V323

(1) 100% at planting (75kg at planting)

(2) 100% as topdressing (75kg as topdressing)

(3) 50% at planting / 50 % as topdressing (equal at planting and topdressing)

(4) 33% planting / 66% as topdressing (25Kg at planting and 50kg as topdressing)

Total Fertilization Assessment

Total awareness score (Actual score ☐ V324

(0) Nil/don't know

(1) 1-3

(2) 4-6 (Code) ☐ V325

(3) 7-9

(4) 10-12

(5) 13-15

Need Compatibility

46. a. (For those who used the recommended fertilization) You told me your yield was -----bags. (i) What do you think it would have been, had you not used any fertilizer?

a. and b (i)

Actual No. of bags V326

Percentage change V327

b. (For those who did not fully use the recommended fertilization) You told me your yield was ---bags. (i)What do you think it would have been, had you used the recommended type and rates of fertilization

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

b (ii)

Actual No. of bags V328

Percentage change V329

iii. Why don't you adopt the recommended fertilization?

……………………………………………………………………………………………

PERCEPTION: PROMINENCE

47. What, in your view, is the best fertilization (Type and rate and time of application

Type	Planting			Topdressing			
	Yes=1	Kg per acre	Total(farm)	Yes=1	Kg per acre	Total (farm)	
Nil							V330-335
TSP							V336-341
DAP							V342-347
MRP							V348-353
NPK							V354-359
CAN							V360-365
Urea							V366-371
FYM/Compost							V372-377
Other							V378-383

Phosphate fertilizers (TSP, DAP and MRP)

TSP or DAP, or NPK	MRP
(0) Nil	(0) Nil
(1) <20	(1) <40
(2) 20-30	(2) 40-60
(3) 30-40	(3) 60-80
(4) 40-50	(4) 80-100
(5)>50	(5)>100

V384

Nitrogen fertilizers (CAN or Urea or FYM)

	CAN or Urea	FYM
(0)	Nil	Nil
(1)	<15	<160
(2)	15-30	160-320
(3)	30-45	320-480
(4)	45-60	480-640
(5)	60-75	640-800
(6)	>75	>800

V385

Time when Nitrogen fertilizer is applied

V386

(0) Nil
(1) 100% at planting (75kg at planting)
(2) 100% as topdressing (75kg as topdressing)
(3) 50% at planting / 50 % as topdressing (equal at planting and topdressing)
(4) 33% planting / 66% as topdressing (25Kg at planting and 50kg as topdressing)

Total Fertilization Assessment

Total score   Actual score) ☐ V387

(0) Nil/don't know

(1) 1-3

(2) 4-6   (Code) ☐ V388

(3) 7-9

(4) 10-12

(5) 13-15

Advantages of Recommended fertilizer

48. What in your opinion are the advantages of recommended fertilization? Please use the scale below to rate the importance of each of the advantages for yourself.

Very Low ↓   Very High ↓

1	2	3	4	5

49. What in your opinion are the disadvantages of recommended fertilization? Please use the scale below to rate the importance of each of the disadvantages for yourself.

Very Low ↓   Very High ↓

1	2	3	4	5

Advantages And Disadvantages	Importance (1-5)	Importance in decision making (1-5)	
ADVANTAGES			
1. High yield			V389-390
2. Facilitate growth			V391-392
3. Good grain quality			V393-394
4. High Stover yield			V395-396
5.			
6.			
7.			
8.			
DISADVANTAGES			
1. Destroy soil productivity			V397-398
2. Requires skills			V399-400
3. Effect in human body			V401-402
4. Higher labour requirements			V403-404
5. Reduce taste			V405-406
6. High fertilizer costs			V407-408
7. Unavailability of fertilizers when needed			V409-410
8. Unavailability of credits			V411-412
10.			
11.			
12.			
13.			

50. a. (For adopters) Which of the advantages (in Q49) played an important role in your decision making to adopt the recommended fertilization? (*Indicate the answers in last column by using the following scale.)*

*b.*Which of the disadvantages weighed heavily at the time when you made the decision to adopt?

1. Unimportant
2. Little important (hardly considered)
3. Neutral/undecided
4. Important (serious consideration)
5. Very important (critical/decisive)

51. (For non-adopters) (Q. 50). Which of disadvantages played an important role in your decision not to adopt the recommended fertilization (type and application rate)? (*Indicate the answers in last column by using the following scale*.)

b. Which of the advantages did you consider or were important at the time when you decided not to completely adopt the recommended fertilization?

1. Unimportant
2. Little important (hardly considered)
3. Neutral/undecided
4. Important (serious consideration)
5. Very important (critical/decisive)

Compatibility (Situational factors)

52. (For non-adopters) If you had wanted to adopt fully the recommended fertilization (type and rate of application), is there anything that would have made it impossible or very difficult for you to do so?

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

53. (For adopters) what made it difficult for you to adopt the recommended maize varieties?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

PRACTICE 3: SPACING

54. How many seeds do you plant per hill?

1.One seed per hill

2. Two seeds per hill

3. Three seeds per hill

4. Others, specify

V413

55. Which spacing (in cm) do you use when

a) Planting 1 seed per hill?	b) Planting 2 seeds per hill?
1. Broadcasting	1. Broadcasting
2. <20 X <60	2. <25 X <75
3. 20-25 X 60-75	3. 25-50 X 75-90
4. 25-30 X (60)75-90	4. 50 X 90
5.(3) > 30 X 90	5.(3) > 50 X 90

Category V414

Score V415

Need Related Aspects

Perceived Current Efficiency

56. How do you rate, on the following scale, your general level of spacing efficiency?

Very Low ↓ … Very High ↓

1	2	3	4	5

V416

Need Tension

57. Have you changed your seeding rate since last season? V417

1. No
2. Yes

58. If yes, what spacing did you use this year?

a) Planting 1 seed per hill b) Planting 2 seeds per hill

Category V418

a) Planting 1 seed per hill?	**b) Planting 2 seeds per hill?**
1. Broadcasting	1. Broadcasting
2. <20 X <60	2. <25 X <75
3. 20-25 X 60-75	3. 25-50 X 75-90
4. 25-30 X (60)75-90	4. 50 X 90
5.(3) > 30 X 90	5.(3) > 50 X 90

Score V419

Need Compatibility

59. You told me earlier (Q.7) that your yield is -------- What do you think it would have been

(a) if you increased your popula Actual and %age V420-421

(give example on spacing)

(b) if you decreased your population? Actual and %age V422-423

Awareness of Recommended Spacing

60. What is the recommended spacing for maize production?

a) Planting 1 seed per hill?	b) Planting 2 seeds per hill?
0. Don't know	0. Don't know
1. Broadcasting	1. Broadcasting
2. <20 X <60	2. <25 X <75
3. 20-25 X 60-75	3. 25-50 X 75-90
4. 25-30 X (60)75-90	4. 50 X 90
5.(3) > 30 X 90	5.(3) > 50 X 90

Category ☐ V424

Score ☐ V425

Perception

Prominence

61. What, in your view, is the best spacing for this area?

a) Planting 1 seed per hill?	b) Planting 2 seeds per hill?
0. Don't know	0. Don't know
1. Broadcasting	1. Broadcasting
2. <20 X <60	2. <25 X <75
3. 20-25 X 60-75	3. 25-50 X 75-90
4. 25-30 X (60)75-90	4. 50 X 90
5.(3) > 30 X 90	5.(3) > 50 X 90

Category ☐ V426

Score ☐ V427

<u>Measurement in field:</u>

(a) No of plants counted   Sample A (2.1msq)............   V428

Sample B ....

No of plants/acre based on block count   V429

No. of plants/acre based on reported spacing for this year (V411)   V430

Percentage over-estimation   V431

PRACTICE 4: WEED CONTROL

62. How do you control weeds in your maize fields?

(a) When do you start hoeing: V432

(1) When maize is <15cm

(2) When maize is 15-30cm

(3) When maize is 30-45cm

(4) When at knee height or later

(b) How long does it take you, considering the weather and the help that you normally have at you disposal, to hoe your maize field once.

- Number of days   V433
- Interval between two operations (days)   V434
- Total interval   V435

(c) Do you have the following weeds: (X)

(1) Couch grass

(2) Nut grass

(3) Wandering Jew

Number of types: V436

(d) How often do you hoe your maize

(1) Less than once

(2) Once

(3) Twice

(4) Three times or more

V437

63. How do you rate your weed control efficiency using the following scale?

V438

Very poor — Very

1	2	3	4	5

b. Can you please tell me what is "5"

…………………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………………

64. How do you rate the degree of weed infestation as a problem on your farm, when using the following scale?

No — Same as — Very serious problem

1	2	3	4	5

V439

65. Your current yield is ………..bags. What do you think it would have been

(a) if your maize had always been free of weeds

No of bags:		V440
% Increase		V441

(b) If you had not controlled weeds at all

No of bags:		V442
% decrease		V443

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