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THE COMPARATIVE ROLE OF INDEPENDENT AND INTERVENING VARIABLES ON INFLUENCING THE ADOPTION OF NITROGEN FERTILIZATION AMONG MAIZE GROWERS IN THE NJOMBE DISTRICT.

Msuya, C. P.[1]

ABSTRACT

Various practices including Nitrogen fertilization have been recommended in the Njombe District to maintain its status as one of the districts that is famous in maize production in Tanzania. Despite the recommendation the level of adoption is not convincing that forced this study to investigate variables that are most important in determining the adoption behaviour. A cross sectional research design was used to collect data from 113 respondents selected from four villages namely, Ulembwe, Igagala, Kibena and Uwemba. The statistical package for social sciences (SPSS) was used for data analysis. The findings reveal that the intervening variables (like efficiency misperception (EM), need tension (NT), prominence and knowledge) played a great role in determining the adoption behaviour compared to independent variables (like age, sex, level of education, farm size and area under maize production). It is therefore recommended that more emphasis should be placed in addressing intervening variables in order to enhance adoption in the study area.

Keywords: Independent, Intervening, adoption, Nitrogen fertilizers, Agricultural Extension

1. INTRODUCTION

Njombe district is one of the districts that is famous for the production and supply of maize in the country (Msuya, 2007). 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 Tanzania particularly in areas 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). For example the average national maize production is approximately 0.75 ton per hectare instead of 7.2 ton per hectare expected under good management practices (Agriculture Research Institute - ARI Uyole, 2006).

As far as fertilizer application is concerned, the recommended fertilizer for maize production is phosphates fertilizer for planting like Triple Super Phosphate (TSP), Diammonium Phosphate (DAP) or Minjingu Rock Phosphate (MRP), and nitrogenous fertilizer for top dressing like Urea and Calcium Ammonium Nitrate (CAN). Phosphate and Nitrogen nutrients are the most important nutrients in maize production. Nitrogen (N) is the most limiting nutrient to maize production therefore increased nitrogen use efficiency will translate into yield increase (Mustapha, 2004). The amount of nitrogen to be applied for maize is dependent upon a number of factors, such as likely losses of N through leaching, immobilization, mineralization and de-nitrification, plant characteristics (tillering potential, leaf area index,

[1] Sokoine University of Agriculture, Morogoro, Tanzania. Email: cat_msuya@yahoo.com. Cell: +255 787 645330 / +255 714 555020.

resistance to lodging and length of growing cycle), management practices (dry land/irrigated systems, sowing/planting density, pest and diseases and weed control) (Mustapha, 2004).

Despite the recommended type and rate of fertilizers, evidence shows that in Tanzania, among the farmers who apply fertilizer in their fields, majority of them apply at a very low level about 8 kg/Ha (Shetto, 2007; Isaac, 2007; Kilima, 2011). The same situation applies in Njombe District. For example the recommended Nitrogen fertilizers in the Njombe District are CAN or UREA at a rate of at least 75kg per acre. About 25kg per acre is recommended at planting and at least 50 kg per acre as top dressing. This implies that two practices, namely the rate and time of application are recommended for full nitrogen fertilizer package application. Although this is the case research findings show that only 30 percent and 25 percent of farmers in the Njombe District apply the recommended rate and time of nitrogen fertilizer application, respectively (Msuya, 2007). This calls a need to study the factors influencing the adoption of recommended Nitrogen fertilizers in the study area. Understanding the reasons for low adoption will help extension staff, researchers and policy makers to come up with the strategies that will enhance its adoption and increase maize production.

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, 1995; Okoye, 1989; Anosike & Coughenour, 1990; Obinne, 1991; Lugeye, 1994). 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 & 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 of Nitrogen fertilizer among the maize growers in the Njombe district.

2. METHODOLOGY

A validated, pre-tested structured questionnaire was used to collect data through personal interviews from 113 farmers. These were randomly drawn, representing five percent samples of four villages selected to represent the biggest variation in terms of bio-climatic conditions within the Njombe district of Tanzania. The surveyed villages were Kibena, Ulembwe, Uwemba and Igagala. The collected data were coded, computer-captured, cleansed and then analyzed using the statistical package for social sciences (SPSS). Chi- square was used to test whether there is any significant difference between variables while correlation was used to test whether there is any relationship between the variables under investigation. The linear regression model represented in equation 1 was used for analysis.

Equation 1: $Y = \beta0 + \beta1X1 + \beta2X2 + ...+ \beta kXk + \varepsilon0$

Where Y is the predicted value on the dependent variable, β0 is the Y intercept, the Xs represent the various independent variables (of which there are k), and the βs are the coefficients assigned to each of the independent variables during regression and ε0 is error term.

It is important to note that the two recommended practices (the rate and time of nitrogen fertilization) were computed in order to have an adoption score for total nitrogen fertilizer package adoption. The scale points of the individual practices 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.

3. RESULTS AND DISCUSSION

This section describes the influence of individual independent and intervening variable on the adoption of recommended nitrogen fertilizer package. There after it will discuss the total influence of all independent and intervening variables investigated in order to determine which set of variables among the two is important in explaining the adoption behaviour in the study area. The independent variables will be discussed first followed by the intervening variables.

3.1 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 age, sex, farm size and formal education influence the adoption of nitrogen fertilization in the Njombe district.

3.1.1 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 1 below.

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Table 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-fertilization								
<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 of 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 Van den Ban & Hawkins, 1996 cited by Msuya, 2007). 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.

3.1.2 Sex

An overview of the influence of sex as a behaviour determinant is given in Table 2

Table 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-fertilization						
<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 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 & Bigs, 1993).

3.1.3 Formal education

Formal education is also assumed to be an important factor in the adoption of nitrogen fertilization. Its influence is shown in Table 3.

Table 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-fertilization								
<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 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

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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.

3.1.4 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 (Kalineza, 2000). The findings regarding the influence of farm size on nitrogen fertilization are presented in Table 4.

Table 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-fertilization								
<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 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.

3.1.5 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 5.

Table 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-fertilization								
<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								

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.

3.1.6 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 6.

Table 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 6 formal education seems to be the only variable contributing very significantly to the adoption behaviour.

3.2 Intervening Variables

To establish the relative influence of intervening variables, namely needs (efficiency misperception - EM and need tension - NT), knowledge (awareness) and perception (prominence) compared to the independent personal and environmental factors on nitrogen fertilization, the former are analyzed in a similar fashion. First the influences of the individual intervening variables are analysed, and then the overall influence is analysed and compared.

3.2.1 Efficiency misperception (EM)

The efficiency misperception is one of the results of insufficient or absent aspiration. The insufficient aspiration is a function of overrating own efficiency. Therefore efficiency misperception refers to the degree to which individuals incorrectly (usually overrate) their efficiency (Düvel, 1995). Düvel (1991) noted that, there is a tendency of individuals to overrating (or underrating) their own production and/or practice adoption efficiency. This has been argued by the author to have a tremendously effect on adoption behaviour due to the fact that the more the current efficiency is overrated, the smaller the problem scope or need tension becomes and thus the smaller the incentive to adopt recommended innovations.

The efficiency misperception of nitrogen fertilization is assumed to have an influence on the adoption behaviour. Table 7 shows the relationship between EM and adoption of recommended rate of nitrogen fertilization.

Table 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-fertilization												
<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												

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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.

3.2.2 Need Tension (NT)

Need Tension is defined as a perceived discrepancy between the present situation and the desired situation or level of aspiration (Düvel, 1995). This variable has been shown by different research studies to have a direct and positive relationship with the adoption behaviour (Koch, 1987; Düvel and Botha, 1999; Düvel and Scholtz, 1986; Msuya, 2007). Distorted problem perceptions around the factual situation could lead to irrational decision-making that may include non-adoption, under adoption or even over adoption (Düvel, 1995). The influence of NT on the adoption of nitrogen fertilization is indicated in Table 8

Table 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-fertilization								
<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.

3.2.3 Awareness of solution

The aspect of awareness or knowledge looked at in this study is the knowledge in respect of the application of recommended innovation or practices. It refers to an awareness of recommended solutions or the optimum that is achievable in terms of efficiency Düvel (1991). This aspect has been found to be important in determining the adoption behaviour by other researchers like Düvel (1991) and Msuya (2007). Table 9 below presents the findings of the relationship between knowledge or awareness of the recommended practice, in this case the recommended nitrogen fertilization.

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

Nitrogen fertilization	Awareness					
	Not aware		Aware		Total	
	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-fertilization						
<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						

According to Table 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.

3.2.4 Prominence

According to Düvel (1975), prominence is synonymous with Rodger's (1995) concept of relative advantage, which he defines as the degree to which an innovation is perceived as being better than the idea it supersedes. Prominence on the other hand, was introduced to replace the global concept of relative advantage and is a measure of how prominent or how much more or less advantageous or attractive the innovation as a whole is, relative to the other alternative. The necessity for this global comparison lies in the phenomenon that innovation are frequently perceived very positively but nevertheless not implemented, simply because another alternative is preferred, that is perceived to be more prominent (Düvel, 1991). 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 10.

Table 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-fertilization								
<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								

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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.

3.2.5 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 11.

Table 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 11 they explain 74.8 percent of the adoption variance, which is reflected in R square of 0.748.

3.2.6 Comparison between 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 1 summarizes the results.

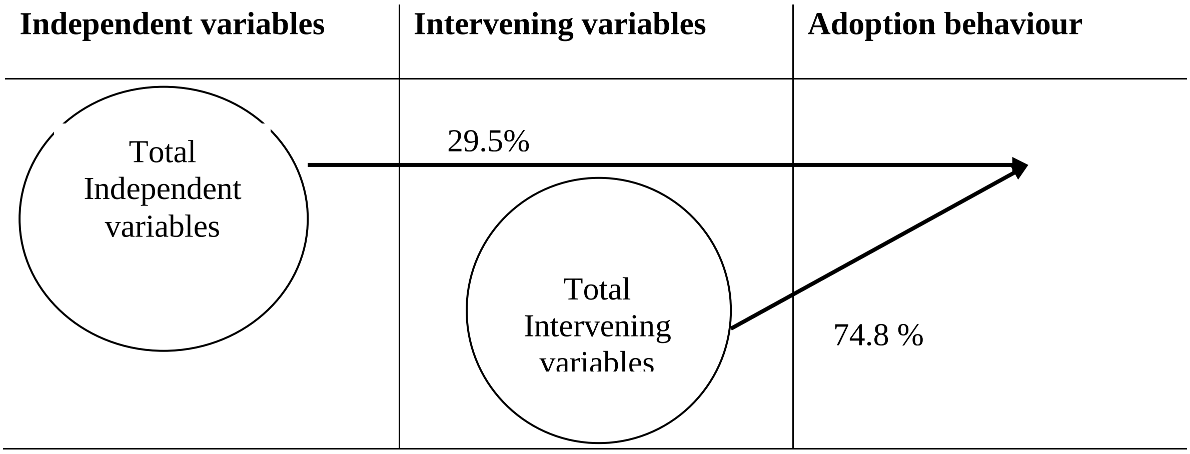

Figure 1: Comparative contribution of independent and intervening variables on adoption behaviour

As presented in Fig 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 other research findings, which state that the influence of intervening variables on adoption decision is higher than that of the independent variables (Düvel, 1975; Botha, 1985; Düvel & Scholtz, 1986; Koch, 1986; Koch, 1987; Düvel, 1995; Habtemariam, 2004).

4. CONCLUSION AND RECOMMENDATIONS

The study investigated the comparative role of independent and intervening variables in the adoption of Nitrogen fertilization in the study area. This study concludes that both set of variables play a significant role in influencing the adoption behaviour. However the role of intervening variables is much higher than that of independent variables. Taking into consideration that extension programs have been focusing much on addressing independent factors that have insufficiently addressed the problem of poor adoption; and inconsistency of research findings regarding the role of independent variables in determining the adoption of recommended technologies highlighted by numerous research findings, the extension system should adapt the extension programs to put great emphasis in the intervening variables considered to be the precursors of the adoption behaviour in order to address the problem of poor adoption.

For example awareness creation programs can be organized to farmers concerning the recommended Nitrogen fertilizers for maize production and the optimum level of adoption regarding the rate and time of fertilizer application. This understanding will avoid the problem of farmers overrating their adoption efficiency and create needs to adhere to correct recommendations that will enhance maize production in the Njombe District.

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