S. Afr. J. Agric. Ext. Msuya
Vol. 49 No. 1, 2021: 42-58
http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

The important determinants of the adoption behavior: a case study of recommended maize production technologies in Tanzania

Msuya, C.P.[1]

Corresponding author: C.P. Msuya. Email: cat_msuya@yahoo.com

ABSTRACT

Numerous technologies have been developed in the agricultural sector to facilitate its contribution to the livelihood of the people. However the adoption of these technologies has been very low or non existence at all. This paper determined the important factors/variables that determine adoption behaviour. A validated, pre-tested structured questionnaire was used to collect data from 113 respondents, equivalent to 5 percent of a population selected to represent maize growers in selected villages of Njombe District. The collected data were analyzed using the statistical package for social sciences (SPSS) and the linear regression model was used to investigate the influence of the study variables. The study findings show both independent and intervening factors investigated determined the adoption behaviour. However in all the technologies investigated the intervening factors influenced highly the adoption behaviour. The results presented provide sufficient evidence in supporting the relevance of intervening variables as the most important determinants of the adoption behaviour. The study suggests that emphasis be put on these variables in agricultural extension programs in order to enhance adoption of technologies by farmers.

Key words: Adoption behaviour, important determinants, maize.

1. INTRODUCTION

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 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 behavior, including adoption behaviour. Some of these theories and models include the Traditional Approaches, the Classical 5-Stage Adoption process, the Campbell Model, the

[1] Associate professor, College of Agriculture, Department of Agricultural Extension and Community Development, Sokoine University of Agriculture, P.O Box 3002, Morogoro, Tanzania. CelIphone +255 787645330. Email: cat_msuya@yahoo.com and cat_msuya@sua.ac.tz

http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

Innovation Decision-Making process, the field theory, the Tollman-Model, the Theory of Reasoned action, and Düvel's Behaviour Analysis model.

Based on these theories and models, various empirical studies have been conducted to determine factors associated to non or poor adoption of technologies by farmers. Numerous studies associate adoption behavior by independent factors (traditional ones) like farmers' characteristics and socio-economic, institutional and environmental factors (Rogers, 1995; Okoye, 1989; Anosike and Coughenour, 1990; Obinne, 1991; Lugeye, 1994). Due to the inconsistency of the findings as regards the relationship between independent variables and the adoption behaviour, as well as continuation of non or poor adoption of recommended technologies, 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 necessitated further investigations. Taking into consideration of low or non adoption of recommended technologies in Tanzania including for maize production (improved maize seed varieties, seed spacing, Nitrogen and Phosphate fertilizers application), this study was proposed with the main aim of investigating the role of independent and intervening variables in predicting the adoption behaviour. The findings of this study will form the basis of recommending the most important determinants of the adoption behavior to various stakeholders including development partners for enhancing adoption of technologies by farmers.

2. DEFINITION OF TERMS

Independent variables

Duvel (1975) defines the independent factors as all factors initiating causes of the individual action. The independent factors resort mainly under the broad category of personal (age, sex, education, income etc), institutional (credit, government and other supports etc) and environmental factors (climate etc).

Intervening variables

The intervening factors are postulated exploratory entities conceived to be connected by one set of casual functions to the independent factors on the one side and by another set of functions to the dependent factors of behavior on the other hand. Duvel (1991) contends that the intervening factors are the immediate precursors of the adoption behaviors and the influence of the independent factors become manifested in behaviour via intervening factors. The author adds that the main important intervening factors are needs, perception and knowledge.

Needs

The concept of needs, aspirations, drives, motives, incentive, desires, goals have been associated with forces that incite the individual to action or that sustains or gives direction to motion. They refer to the forces that energise behavior and give it direction. Research results

http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

show existance of relationship between need related aspects like efficiency misperception, need tension and adoption behaviour (Duvel, 1991).

Efficiency misperception

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

Need tension

Need Tension is defined as a perceived discrepancy between the present situation and the desired situation or level of aspiration (Fig. 1). This variable has been shown by different research studies to have a direct and positive relationship with the adoption behaviour (Koch, 1987; Duvel and Botha, 1999; Duvel and Scholtz, 1986; Msuya, 2007). Distorted problem perceptions around the factual situation could lead to irrational decision-making that may include non-adoption, under adoption or even over adoption (Duvel, 1995).

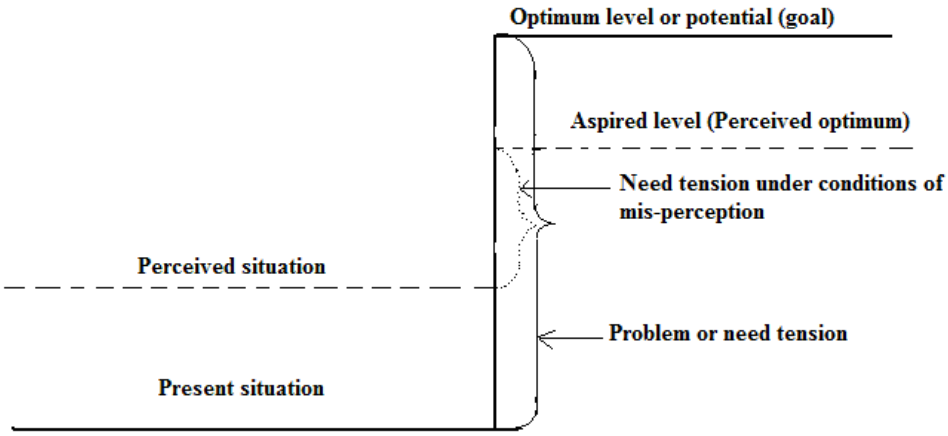

Figure 1 Diagrammatic illustration of problem magnitude or need tension as influenced by perception

Perception

Where needs usually relate to all positive or driving forces that in total constitute the attractiveness, perceptions are here understood to be of more specific nature and are analysed based on attribute of innovation (Duvel, 1991). According to him perception is measured in terms of prominence, knowledge, relative advantages).

http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

Prominence

According to Duvel (1975), prominence is synonymous with Rodger's (1983) concept of relative advantage, which he defines as the degree to which an innovation is perceived as being better than the idea it supersedes.

Knowledge

It refers to an awareness of recommended solutions or the optimum that is achievable in terms of efficiency. This aspect has been found to be important in determining the adoption behaviour by other researchers like Duvel, 1991 and Msuya, 2007.

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 and awareness of disadvantages.

Dependent factors

The dependent factors are defined as the interventions that mainly focus on the adoption behaviour with respect to the recommended practice (Duvel, 1991). The independent and dependent factors are regarded as observable while the intervening factors are not accessible to observation. Figure 2 provides a summary of various factors (variables) explained.

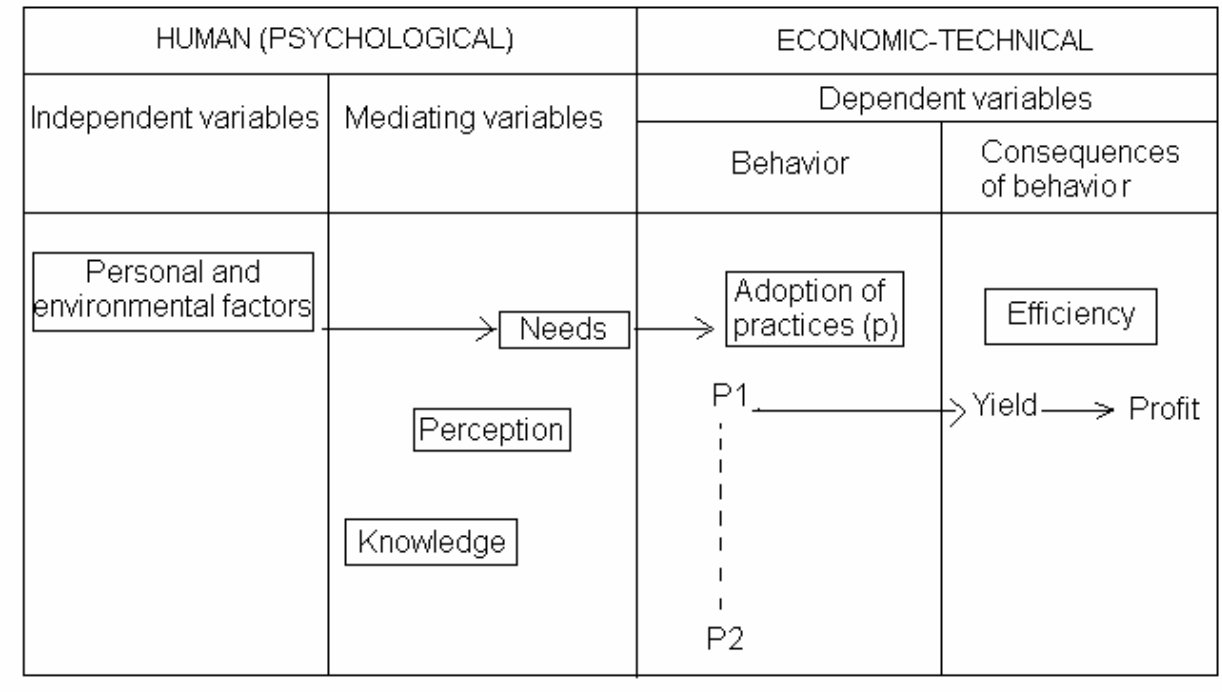

Figure 2 The relationship Between Behaviour determining variables in Agricultural Development (Düvel, 1991)

http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

1. METHODOLOGY

In this study data were collected from 113 respondents, equivalent to 5 percent of a population selected to represent maize growers in selected villages of Njombe District. These were randomly drawn from four villages selected to represent the biggest variation in terms of bio-climatic conditions within the Njombe district of Tanzania. The selected villages were Kibena, Ulembwe, Uwemba and Igagala. A validated, pre-tested structured questionnaire was used to collect data through personal interviews. Observations were used to supplement the collected information.The collected data were coded, computer-captured, cleansed and then analyzed using the statistical package for social sciences (SPSS). The linear regression model represented in equation 1 was used for analysis.

Equation 1: $Y = \beta 0 + \beta 1X1 + \beta 2X2 + ...+ \beta kXk + \varepsilon 0$

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.

2. RESULTS AND DISCUSSION

4.1 Adoption of recommended maize varieties

Different varieties of improved maize seeds have been recommended, however 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. The recommended maize varieties in the study area include UH 615, UH 625, H 614, H 628, SC 627, S 627 and P 67. This study investigated the influence of independent and intervening variables on the adoption of these recommended maize varieties.

4.1.1 The influence of independent variables on adoption of recommended maize varieties

The linear regression model was used to investigate the influence of independent variables on the adoption of recommended maize varieties. The independent variables entered into the model include age, sex, formal education, farm size, and the area under maize. Table 1 summarizes the model results.

http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

Table 1 Linear regression analysis showing the relationship between intervening variables and adoption of recommended maize varieties

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 1 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%. This is reflected in the significant R^2 of 0.187. 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.

4.1.2 The influence of intervening variables on adoption of recommended maize varieties

Various intervening variables were entered into the regression model to determine their influence on the adoption of recommended maize varieties. These include efficiency misperception; need tension, need compatibility, awareness, prominence and advantages like high yield, early maturity, good taste, good grain quality. The disadvantages considered were poor hauling quality of grain, high implementation costs, low storability and poor resistance to drought. In Table 2 the influence of the different individual intervening variables is shown, as well as their combined contribution towards the explanation of total variance in adoption.

The intervening variables entered into the model contribute very significantly to the adoption of recommended maize varieties. According to Table 2 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.

Table 2 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

http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

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

4.1.3 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, conspicuous is the comparison of the total influence of these categories of variables. As shown in Fig 3, the influence of intervening variables far outweighs that of the independent variables in terms of the percentage variation explained. The intervening variables explain 86.6 percent of the variation in recommended maize varieties adoption as opposed to the 18.7 percent contributed by the independent variables. Similar findings were reported by Düvel, 1995; Düvel (2004), Koch (1986).

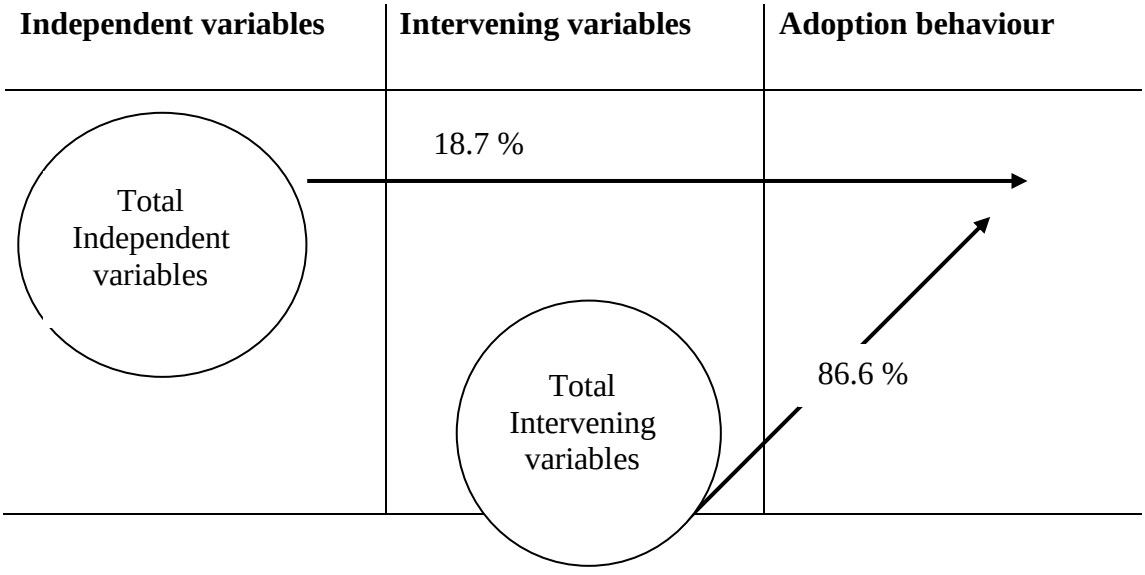

Figure 3 Comparative contribution of independent and intervening variables on adoption behaviour

http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

4.2 Adoption of Recommended Phosphate fertilizers

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. The most common recommended fertilizers in the study area are TSP and DAP.

This study compared the influence of various independent variable and intervening variables in the adoption of Phosphate fertilizers in maize production. A regression analysis was used to assess the influence of all the independent and intervening variables on the adoption of phosphate fertilization. The influence of independent variables is presented first (Table 3) followed by the influence of intervening variables (Table 4).

4.2.1 The influence of independent variables

The independent variables investigated were sex, age, formal education, farm size and area under maize (Table 3).

Table 3 The influences of independent variables on adoption behavior

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

R2 = 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 (R2 = 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 as also reported by Mlyuka (2011) and Furahisha (2012).

4.2.2 The influence of intervening variables

Table 4 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.

http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

Table 4 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 4 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. Similar findings were reported by Habtemariam and Düvel (2003); Düvel, 1995; Düvel (2004), Koch (1986). 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.

4.2.3 Comparison between the influence of Independent and Intervening variables

This part provides a brief summary of the comparison between the two variables namely independent and intervening; 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 phosphate fertilizer application in the study area is concerned. Figure 4 summarizes the results.

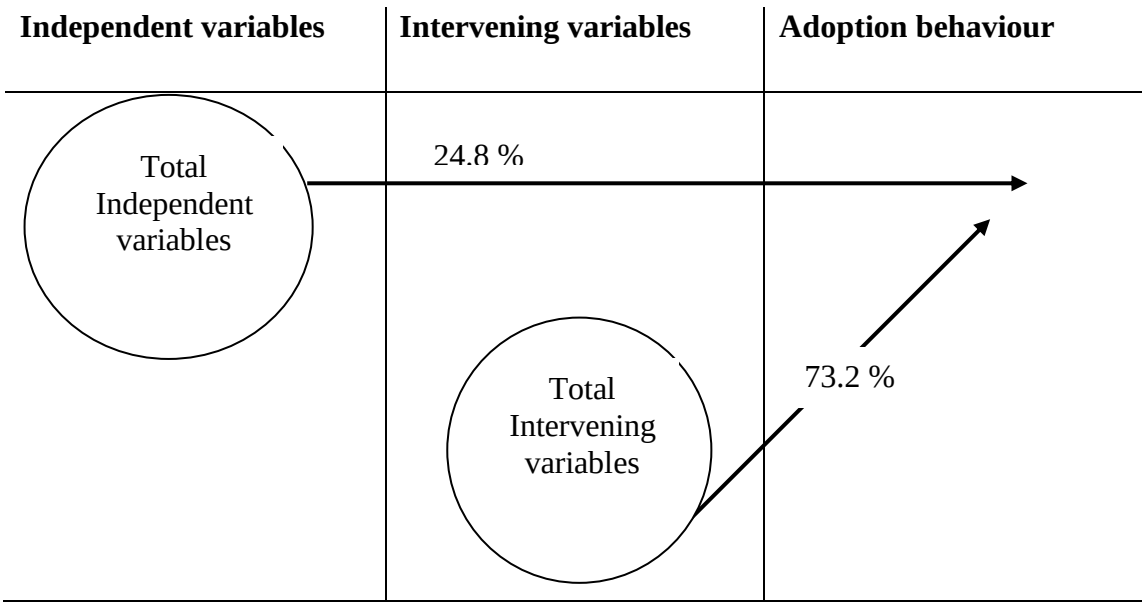

Figure 4 Comparative contribution of independent and intervening variables on adoption behaviour

http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

As presented in Fig 4 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 73.2 percent while independent variables contribute only at 24.8 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 and Scholtz, 1986; Koch, 1986; Koch, 1987; Düvel, 1995; Habtemariam, 2004).

4.3 Adoption of recommended Nitrogen Fertilizers

In order to improve maize production farmers are recommended to top dress their maize farms with Nitrogen fertilizers. The recommended rate of nitrogen fertilizer is at least 75 kg/acre. About 33 percent (25 kg per acre) is recommended at planting and 67% (50kg per acre) as top dressing. As in the case of phosphate fertilizer the adoption rate of the nitrogen fertilizer in the study area is very low. Only 30 percent apply the recommended rate while 70 percent of farmers do not apply Nitrogen fertilizers. Furthermore, only (25.7 percent) apply nitrogen fertilizer at planting and as topdressing as it is recommended. The larger majority of the farmers apply all of it as top dressing only (Msuya, 2007).

This study investigated the influence of independent and intervening variables on the adoption of Nigrogen fertilizers in maize production. The linear regression model was used to evaluate the total contribution of independent and intervening variables to the variance regarding the adoption of nitrogen fertilization. The model results are presented in Table 5, Table 6 and Figure 5.

4.3.1 Influence of independent variables

Table 5 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

http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

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

4.3.2 Influence of intervening variables

The intervening variables investigated include efficiency misperception; need tension, awareness and prominence. The need aspects namely, need tension (Beta = 0.411 and p = 0.000) and the efficiency misperception (Beta = -0.281 and p = 0.000) seem to have the biggest influence on the adoption of the recommended rate of nitrogen fertilization. They are followed by prominence (Beta = 0.250 and p = 0.000), which similarly contributes in a highly significant degree to the variance in adoption. Awareness is the only intervening variable, which does not contribute (Beta = 0.085 and p = 0.116) 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 reported by Habtemarium (2004). As indicated in Table 6 they explain 74.8 percent of the adoption variance, which is reflected in R square of 0.748.

Table 6 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

4.3.3 Comparison between the influence of independent and intervening variables

When comparing the total influence of the independent and intervening variables on adoption of nitrogen fertlilizer, it appears that the latter indicates existence of a highly significant influence represented by p= 0.000 influence. The study findings are summarized in Fig 5. As far as the total influence of the two variables on adoption behaviour is concerned, the total influence of intervening variables explains up to 74.8 percent while independent variables contribute only at 29.5 percent.

As presented in Fig 5 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

http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

(Düvel, 1975; Botha, 1985; Düvel and Scholtz, 1986; Koch, 1986; Koch, 1987; Düvel, 1995; Habtemariam, 2004).

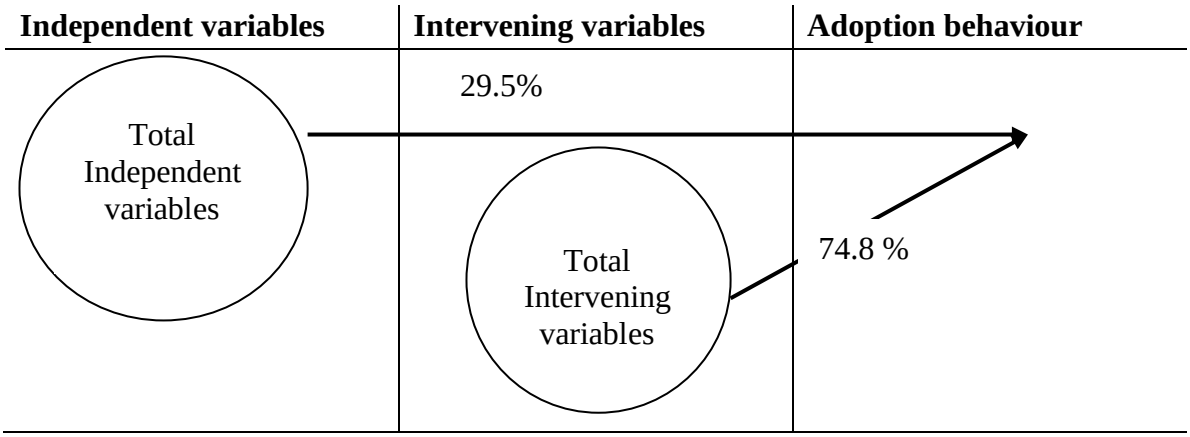

Figure 5 Comparative contribution of independent and intervening variables on adoption behaviour

4.4 Adoption of recommended 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 cited by Msuya, 2007). In order to obtain accurate measures farmers are recommended to use rope or stick but most of them use step or foot measures estimations which make them to use incorrect spacing contrary to what is recommended. This study investigated the independent and intervening factors influencing adoption of recommended seed spacing

4.4.1 Influence of independent variables on adoption of seed spacing

The independent variables investigated are sex, age, formal education, farm size and area under maize production. The study findings are summarized in Table 7.

Table 7 The 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

R2 = 0.060, p = 0.343

http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

The total contribution of the tested independent variables on the adoption behavior 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.

4.4.2 The influence of intervening variables on adoption of seed spacing

The results of all the intervening variables entered into the regression model are presented in Table 8 below.

Table 8 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

R2 = 0.936; p = 0.000

According to Table 8 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.

4.4.3 Comparisons between independent and intervening variables

Figure 6 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.

http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

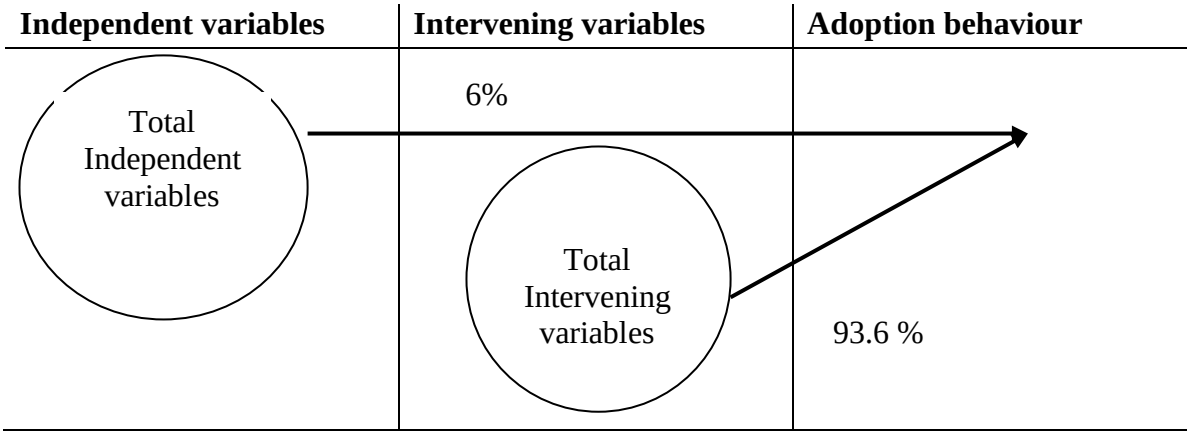

Figure 6 Comparative contribution of independent and intervening variables on adoption behaviour of seed spacing

5. CONCLUSION AND RECOMMENDATIONS

In all the practices investigated namely, recommended maize varieties, fertilizers (phosphate and Nitrogen) and seed spacing, the contributions of intervening variables on the adoption behaviour far outweigh those of independent variables.

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. Since the results provide sufficient evidence in supporting the relevance of intervening variables in adoption behaviour, the study suggests that emphasis be put on these variables in agricultural extension programs for enhancing the adoption of recommended technologies.

REFERENCES

ANOSIKE, N. and C.M. COUGHENOUR, 1990. The social-economic basis of farm enterprise diversification decision. *Journal of Rural sociology* 55 (1):1-24

http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

BERELSON, B and G.A. STEINER, 1964. *Human Behaviour: An Inventory of Scientific Findings*. Harcourt, Brace and World, Inc. New York. Chicago. San Francisco. Atlanta

BOTHA, R.A., 1985. The influence of different perceptions on the adoption of practices related to draught resistance. *South African Journal of Agricultural Extension* 15:25-31

DUVEL, G.H and A.J. BOTHA, 1999. Human Constraints to Sustainable Agriculture in the arid regions of South Africa. *The Journal of agricultural Education and Extension* 6 (1): 47-60

DÜVEL, G.H and SCHOLTZ, H.P.J., 1986. The non acceptability of recommended level management practices. South African Journal of Agricultural Extension 15:1-10

DÜVEL, G.H, 1995. Resistance against stock reduction: A cognitive Field Analysis. South African Journal of Agricltural Extension. 24:45-60

DÜVEL, G.H., 1975. The mediating functions of perception in innovation decision-making. South African Journal of Agricultural Extension. 4:25-36

DÜVEL, G.H., 1991. Towards a model for the promotion of complex innovations through programmed extension. South African Journal of Agricultural Extension. 20:70-86

DÜVEL, G.H., 1995. Resistance against stock reduction: A cognitive Field Analysis. South African Journal of Agricltural Extension. 24:45-60

DÜVEL, G.H., 2004. Programmed extension (Program development and implementation). Study guide. Department of Agricultural Economics, Extension and Rural Development, University of Pretoria

FURAHISHA, E. H. (2012). Farmers Adoption of Recommended Rice Production Practices: A Case of Selected Areas in the Kilombero District of Morogoro Region, Tanzania. A Dissertation Submitted in Partial Fulfilment of the requirement for the degree of Master of Sciene in Agricultural Education and Extension of Sokoine University of Agricultural Education and Extension of Sokoine University of Agriculture, Morogoro, Tanzania

HABTEMARIAM, A.G (2004) The Comparative influence of intervening variables in the adoption behaviour of maize and dairy farmers in Shashemene and Debrezeit, Ethiopia. A desertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in agricultural extension in the Department of Agricultural Economics, Extension and Rural Development, Faculty of Natural and Agricultural Sciences, University of Pretoria

http://dx.doi.org/10.17159/2413-3221/2021/v49n1a10777

KOCH B.H., 1986. Perception Analysis as guideline in Agricultural Extension. South African Journal of Agricultural Extension 15:19-24

KOCH B.H., 1987., Problem perception as precondition of behaviour change. *South African Journal of Agricultural Extension* 16:19-25

LUGEYE, S. 1994. The role of farmers' indigenous knowledge in natural resources and management. In: *Proceeding of 1st Workshop on sustainable agriculture and conservation of environment.* Edited by Hatibu, N.; Mafu, S.T.A. Machang'u R.S.; and Rutatora, D.F. 26-27 July 1994, Morogoro, Tanzania, pp. 116-125

MLYUKA M. H. (2011). The Independent and Intervening Variables that Influence the Adoption of Recommended Fertilizer Package in the Namtumbo District of Ruvuma Region, Tanzania. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 84 pp

MSUYA, C. P. (2007). The Comparative role of intervening and independent variables in adoption behavior of maize growers in Njombe District, Tanzania. Thesis for Award of PhD Degree at University of Pretoria, South Africa, 199 pp

OBINNE, C.P., 1991. Adoption of improved cassava production technologies by small-scale farmers in Bendel State. *Journal of Agriculture, Science and Technology*

OKOYE, A.A., 1989. Factors affecting adoption process by farmers in selected local government areas of Anambra State, Nigeria. The Nigeria Agricultural Journal, 24: 9-20

ROGERS, E. M. (1995). Diffusion of Innovation. (4th Ed.), Macmillan Publisher, New York. 453pp

ROGERS, E.M., 1983. Diffusion of Innovations. Third Edition. The Free Press A Division of Macmillan Publishing Co., Inc. New York