The Influence of Independent and Intervening Variables on Adoption of Recommended Maize Varieties in Tanzania

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Abstract
Njombe is one of the districts in Tanzania that suffers from the problem of poor adoption of recommended maize varieties. The study was conducted to investigate the influence of independent and intervening variables in determining the adoption behaviour of recommended maize varieties among maize growers in Njombe District of Tanzania. The study employed a cross sectional research design where data were collected from 113 respondents randomly selected to represent other maize growers from four villages namely, Kibena, Ulembwe, Uwemba and Igagala. The findings show that each investigated intervening variable has influence on adoption of recommended maize varieties as expected. They explain 86.6 percent of the variation in adoption (R2 =0.866, p=0.000). In particular, the NT (Beta = 0.659, p=0.000) and the efficiency misperception (Beta = -0.232, p=0.008) that make the biggest contribution. On the other hand, most of the independent variables investigated have no influence except for the level of education and area used to grow maize. The total contribution of independent variable towards explaining the variance in adoption is only 18.7 percent. This is reflected in the significant R2 of 0.187, which implies that the total influence of intervening variables highly explains the influence compared to that of independent variables. This indicates that the intervening variables are the best predictors of the adoption behaviour and the influence of independent variables is manifested in the adoption behaviour through the intervening variables as postulated in Duvels (1991) model of behaviour determinants. This calls for further testing of the model in different social cultural settings and crops to see its relevance in determining the adoption behaviour.
Key Words: Independent variables, intervening variables, adoption, recommended maize varieties

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, various adoption studies have revealed an inconsistency in the relationship between independent variables and adoption behaviour (Matata *et al.,* 2010, Crook *et al.,* 2011; Rogers, 1983; Adesina and Baidu-Forson, 1995; CIMMYT, 1993; Amir and Pannel, 1999; John, 1995; Kalineza, 2000). Due to unclear relationship between the independent variables and adoption behaviour, other studies (Düvel, 1975; Louw and Düvel, 1993; Düvel and Scholtz, 1986; Botha, 1986; Düvel and Botha, 1999; Habtemariam, 2004) were conducted to identify other variables that have a better prediction value of adoption behaviour, and came up with the 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 illustrated in Fig. 1, Düvel (1991) makes provision for both the independent variables (personal and environmental factors) and intervening (mediating) variables. Among the intervening variables he identified needs, knowledge and perception and argues that the influence of independent variables becomes manifested in decision - making (adoption behaviour) via the intervening variables. The

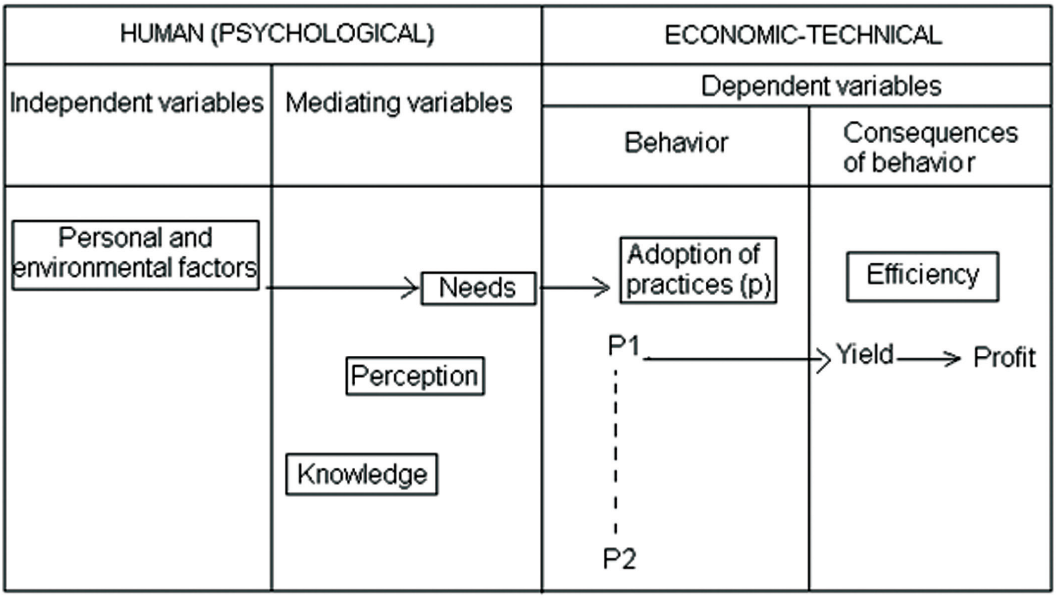

Fig. 1: Düvel's (1991) model of the behavior determinants

intervening variables are thus considered to be the most immanent and direct forerunners of the behaviour.

Düvel's model is a new model that was tested in only two African countries namely, South Africa and Ethiopia (Habtemariam, 2004). There is need of testing it in different social cultural settings to test its relevance in explaining the adoption behavior. Due to the fact that Njombe is one of the districts in Tanzania that suffers from the problem of poor adoption of recommended maize varieties (UH 615, UH 625, H 614, H 628, SC 627, S 627 and P 67) a study was conducted to determine factors that are important in determining the adoption of recommended maize varieties among maize growers in the District by employing Duvel's Model.

Methodology

The study was conducted in four villages in Njombe District namely, Kibena, Ulembwe, Uwemba and Igagala. A cross sectional research design was used to collect data at a single point in time from 5% percent of the population randomly selected to represent maize growers in the study area, and therefore a total of 113 respondents were interviewed. The collected data were analyzed by the Statistical Package for Social Sciences (SPSS) computer program where 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.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \varepsilon_0$$

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.

Results and Discussion

This paper presents the results of the influence of independent and intervening variables (factors) on adoption of recommended maize varieties. The influence of independent variables will be investigated first followed by the influence of intervening variables. This will assist to determine the comparative contribution of the independent and intervening variables to the adoption behaviour.

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 also identifies the independent variables that contribute most to the adoption behaviour.

Literature shows that young and energetic people have been found to be more venturesome, active and ready to try innovations (Mattee, 2009; Byron and MacKay, 2005; John, 1995; Rogers, 1983). It is therefore assumed in this study that adoption of recommended maize varieties is higher among young farmers than in the case of old farmers. The study results with respect to the relation of age and adoption of recommended maize varieties is summarized in Table 1.

Table 1: Distribution of respondents according to age and adoption of maize varieties

	Adoption							
Age (years)	**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; Mean =45.4; Minimum=20; Maximum=80

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. The findings are inline with Mussei *et al.,* (2001) and Mattee (2009) who reported inexistence of relationship between age and adoption of recommended practices.

Women are reported to be the heads of one third of households worldwide (Gass and Bigs, 1993). In most cultures, women have always been actively involved in agriculture (International Labour Organization (ILO), (2007). 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 (Matata *et al.,* 2010). 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 sex and adoption are summarized in Table 2.

Table 2: Distribution of respondents according to sex and adoption of maize varieties

	Adoption							
Sex	**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

χ^2 = 3.893; df=2; p=0.143; r= -0.178; p=0.060

Although the differences between the sex 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 maize varieties as reported by Furahisha (2013) and Matata *et al.,* (2010). 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 sex has a direct influence on adoption behaviour, but could imply that the influence is due to sex related factors like contact with extension or other sources of technology.

Better-educated farmers are assumed to have enhanced information processing abilities allowing them to make better decisions (Amir, 2006). The more complex the recommended practice is, the more likely it is that education will play a role in its adoption. Reviewed literature (Crook *et al.,* 2011; Anosike and Coughenour, 1990; CIMMYT, 1993; Lugeye, 1994; Rogers, 1983) 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 3 below.

Table 3: Distribution of respondents according to formal education and 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

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) had seven years of formal education (primary education), which is common in Tanzania. The correlation analysis reveals 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 3 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 findings by Crook *et al.,* (2011) and Lugeye (1994), who reported a significant positive relationship between formal education and adoption.

Farm size is an independent variable of assumed importance that was also examined 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, Oluwasola (2010); Kalineza (2000); Senkondo *et al.,* (1998); Hussain et al., (1994). The distribution of the respondents' farm sizes in relation to their adoption of maize varieties is presented in Table 4.

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 4). 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,

Table 4: Distribution of respondents according to farm size and 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

χ^2 = 5.596; df=4; p=0.231; r= 0.184; p=0.051

the higher the adoption tends to be as contended by Oluwasola (2010). 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.

The survey went further to assess the influence of area under maize on the adoption of recommended maize varieties. As presented in Table 5 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 as indicated in Kalineza (2000). 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.

Although these findings 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.

Total influence of the independent variables

The study went further to investigate 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 6 summarizes the model results.

According to Table 6 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 R2 of 0.187. In accordance with the research hypothesis, the findings provide clear evidence of the influence of some independent

Table 5: Distribution of respondents according to area under maize and 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	33.3	113	100

χ^2 = 9.464; df=4; p=0.050; r= 0.235; p=0.012

variables on decision making or adoption behaviour, but the total influence is somewhat limited and, according to literature (Rogers, 1983) not always consistent.

Intervening Variables

Table 6: Total influence 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

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 (Efficiency misperception, need tension, need compatibility), perception (prominence, advantages and disadvantages) and knowledge (awareness). Each intervening variable's relationship with the adoption of recommended maize varieties will be analyzed separately in this section.

Efficiency misperception (EM) 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 to the hypothesis that there is a significant negative relationship between the EM and adoption of recommended maize seeds. The EM was measured by asking farmers to estimate their own adoption efficiency in a five point scale. Table 7 summarizes the relationship between EM and adoption of recommended maize varieties.

More than half 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

Table 7: Relationship between EM and adoption of recommended maize varieties

Efficiency perception Assessment	Adoption							
	Local varieties		Replanted hybrid		Recommended hybrid		Total	
	n	%	n	%	n	%	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

χ^2 = 157.817; df = 8; p=0.000; r= -0.860; p=0.000

Table 8: 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 = 32.953; df=4; p=0.000; r= 0.410; p=0.000

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. The findings are in line with Düvel (2004); Düvel (2007); Furahisha (2013) who reported an existance of negative relationship between EM and adoption.

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. Based on this definition farmers were asked to indicate their present and aspired level (goal) of adoption. 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 8 summarizes the survey results.

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 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. The findings are in line with Düvel (2001) who reported the existence of a positive relationship between need tension and adoption of recommended practices.

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 it is not perceived as either a need related goal, or as a means of achieving it. 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 (for non adopters) or not used (for adopters) the suggested practices. The survey results on the relationship between need compatibility and the adoption of maize varieties are presented in Table 9.

According to Table 5.10 the majority of respondent farmers (75.5 percent) had low need compatibility or perceived that the suggested maize varieties do not fit into the psychological

Table 9: Relationship between Need compatibility (NC) and adoption of maize varieties

Need compatibility	Adoption							
	Replanted hybrid		Local varieties		Recommended 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

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 as observed also in the study done by Louw and Düvel (1993); Düvel and Botha (1999); Habtemariam (2004). 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 be attributed to the fact that the recommended varieties are perceived to be incompatible with most of the farmers need.

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 to 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 10.

According to Table 10, 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 as contended by Düvel (2004). For example 51.3 percent of the respondents that were 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.

Prominence, which is defined as the degree to which an innovation is perceived as being

Table 10: 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

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). 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. Table 11 summarizes the survey results.

Table 11: Relationship between prominence and adoption of recommended maize varieties

	Adoption							
Prominence	**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

χ^2 = 863.919; 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 11, the majority of 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). The results are in line with Habtemariam, 2004 who reported existence of positive relationship between prominence and adoption.

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. 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 12). In a five point scale farmers were requested to indicate the importance of each advantage and disadvantage in influencing their adoption behavior. These were regarded as positive forces and negative forces, respectively.

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 highly 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, as reported by Düvel (2004).

As far as the perceived disadvantages of recommended maize varieties are concerned,

Table 12: 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	28	33.3
Low positive	13	46.4	14	38.9	0	0	27	32.1
Medium positive	0	0	1	2.8	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
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
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
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
χ^2 =11.875; df =4; p=0.018; r= 0.835, p= 0.000								

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 13).

According to Table 13 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.

Table 13: 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
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
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
χ^2 = 20.977; df = 4; p=0.000; r= -0.548, p= 0.000								
Poor drought tolerance								
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
χ^2 =5.000; df =1; p=0.025; r= -1.000, p= 0.000								

This is proved by a highly negative significant correlation (r= -0.540, p= 0.000). In accord with expectations, Table 13 depicts the existence of a highly negative significant correlation between the perceived disadvantages and the adoption of recommended maize varieties. The influence of poor tolerance 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 14). The total number of advantages and disadvantages was obtained from adding all the listed advantages and disadvantages, respectively. While the total number of positive forces and total number of negative forces was obtained by adding the importance of advantages and disadvantages indicated in a five point scale mentioned above.

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

Table 14: 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 14 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. 2).

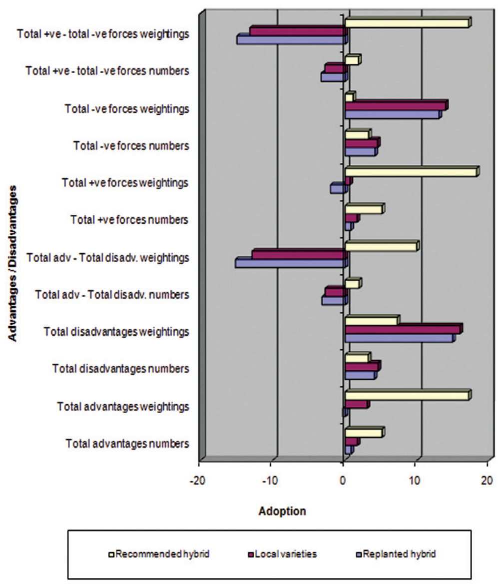

Figure 2: The mean numbers and weightings of advantages and disadvantages of recommended maize varieties as perceived by respondents in different categories of adoption

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.

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 15 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 15 they explain 86.6 percent of the variation in adoption ($R2 = 0.866$, $p = 0.000$). In particular, the NT (Beta = 0.659, $p = 0.000$) and the efficiency misperception (Beta = -0.232, $p = 0.008$) that make the biggest contribution.

Conclusion and Recommendations

When comparing the influences of the individual independent and intervening variables on adoption, it appears that the latter indicates existence of a highly significant correlation with adoption at one percent probability level in each investigated variable, while not a single independent variable appears to have influence on adoption at this probability level. Furthermore, some of the independent variables like age, sex and farm size of the respondents showed lack of the relationship with adoption behaviour as hypothesized. As far as the total influence of the two variables on adoption behaviour is concerned, the total influence of intervening variables highly explains the influence compared to that of independent variables. This indicates that the intervening variables are the best predictors of the adoption behaviour and the influence of independent variables is manifested in the adoption behaviour through the intervening variables as postulated in Düvel's (1991) model of behaviour determinants. This calls for a need to further test the model in different social cultural settings and crops to check its relevance in determining the adoption behaviour.

Table 15: 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

$R2 = 0.866$, $p = 0.000$

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