Farmers' Attitude and Adoption of Improved Maize Varieties and Chemical Fertilizers in Mozambique

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ABSTRACT

In Mozambique, maize crop (Zea mays L.) is important for provision of food and income to the rural poor, yet adoption of improved seed and chemical fertilizers to boost production is still limited. This study determined the influence of farmers' characteristics, attitudes, source of information, and agro-ecological conditions on adoption of hybrid maize SC513, application of NPK and urea fertilizers in Manica district. A questionnaire was administrated to a randomly selected sample of 293 households. The findings showed that farmers do support the use of improved maize varieties and chemical fertilizers. The three most important factors associated with adoption of improved maize were agro ecological conditions, attitudes toward production, traits of improved maize and knowledge of improved varieties. Information on fertilizer use, knowledge of fertilizer application, and agro-ecological conditions had significant influence on adoption of chemical fertilizers. To contribute to a widespread adoption, researchers should develop fertilizer recommendations which are attuned to agro-ecological region, and maize varieties that have wide adaptation. Extension should strengthen positive attitudes toward improved maize and farmers' knowledge of fertilizer application. Input suppliers should tailor their marketing campaigns emphasizing knowledge, attitudes and agro-ecological conditions.

Key Words : *Adoption; Attitudes; Chemical Fertilizer; Extension; Improved Maize;*

Maize is a major food crop and accounts for about 75 per cent of the total value of smallholder crop production (*INE, 2001*). Improving maize production is considered to be one of the most important strategies for food security in Mozambique. However, chemical fertilizers and improved maize varieties, i.e., hybrids and open pollinated varieties (OPVs) whose traits have been improved for selected characteristics such as drought tolerance, disease resistance, short maturity rate, increased yield per unit of land, and quality protein (*Byerlee, 1994*), are not yet widely adopted in Mozambique. For example, in 2001 only 8 per cent of approximately three million farmers used fertilizers, pesticides and herbicides (*INE, 2001*). The efficacy of technology dissemination programs depends mostly on the factors that influence adoption by the farmers. Extension educators need to understand the factors affecting technology adoption in order to deliver effective programs (*Abebaw and Belay, 2001*).

Adoption of technology is influenced by physical, socio-economic, and mental factors including, agro-ecological conditions, age, family size, education, how-to-knowledge, source of information, and farmer's attitudes towards the technology (*Feder et al., 1985; Neupane et al., 2002; Rogers, 2003*). Agro-ecological conditions determine adoption. High levels of adoption of improved maize varieties and chemical fertilizers are more likely to be found among farmers located in regions with high rainfall (*Kaliba et al., 2000; Hintze et al., 2003*). Young farmers are more likely to adopt a new technology because they have had more schooling and are more susceptible to attitude change than old farmers (*CIMMYT, 1993*). Education is expected to enhance the decision making and the adoption of agricultural technologies. Family size plays a role on labor provision. Adoption of new varieties requires more labor inputs (*Feder et al., 1985*). It is assumed that large families provide the labor required for improved maize production practices. Sources of information, including extension, enhance the adoption of technology (*Abebaw and Belay, 2001*). Knowledge influences adoption. Farmers who have adequate knowledge of technology use are likely to adopt it (*Abebaw and Belay, 2001; Rogers, 2003*). Farmers' attitudes determine adoption of improved technology. Attitudes are evaluative responses towards the technology, and are formed as farmers gain information about it. Adopters tend to hold positive attitudes towards the technology (*Chilonda and Van Huylenbroeck, 2001*).

The objectives of this study were to assess farmers' attitudes towards adoption of hybrid maize SC513, NPK and urea fertilizer use in highlands and lowlands of Manica district, to study the influence of information sources on attitudes was compared and to determine the influence of farmers' characteristics, attitudes, source of information, and agro-ecological conditions on adoption of hybrid maize SC513, NPK, and urea fertilizers.

METHODOLOGY

This study involved a cross-sectional survey with 293 randomly selected households growing maize in the highlands of Machipanda and lowlands of Vanduzi in the Manica district. Machipanda and Vanduzi were selected purposely because of the importance of maize in the farming systems and the availability of maize technology dissemination programs in the two areas. Vanduzi and Machipanda represent two distinct agro-ecological zones, R4 and R10 respectively. Machipanda is located at higher altitude (900-1500 m), and gets higher annual rainfall (900-1500 mm) than Vanduzi which is located at 200-1000 m above sea level with annual rainfall of about 900-1000 mm.

Data were collected using personal interviews with 120 respondents from Machipanda and 173 from Vanduzi. The explanatory variables measured in the questionnaire are presented in Table 1.

The Logistic Model : In the field of agriculture, adoption of technologies is measured as a dichotomous response variable (0 = non - adoption of innovation and 1= adoption of innovation). The logistic model is the standard method of analysis, when the outcome variable is dichotomous (*Hosmer and Lemeshow, 2000*). The logistic regression model characterizing adoption of SC513, NPK or urea by the sample of households is specified as follows:

Table 1 Description of explanatory variables measured in the questionnaire

Variable name	Variable type	Description
Agro ecological region (X1)	Dichotomous	0 = Low lands (Vanduzi), 1 = Highlands (Machipanda)
Age (X2)	Continuous	Respondent's age (years)
Family size (X3)	Continuous	Number of members in the family
Level of education (X4)	Dichotomous	0 = illiterate, 1 = some schooling
Knowledge of advantages and disadvantages of improved maize and knowledge of fertilizer application(X5)	Dichotomous	0 = not knowledgeable, 1 = knowledgeable
Source of information (X6)	Multiple category variable	For improved maize SC513: 1 = neighbors, 2 = market, 3 = extension For chemical fertilizers: 1= market, 2 = extension, 3 = neighbors
Attitude (X7)	Interval(a)	Factor scores for attitude toward marketability of grain of improved maize SC513(a) Factor scores for attitude toward production traits of improved maize SC513(b) Factor scores for attitude toward NPK Factor scores for attitude toward urea

(a) Maize produce is marketable

(b) Enhanced germination, drought tolerance, and quality maize meal

Equation 1.0 :

$$p = \frac{e^{a + b1X1 + b2X2 + \dots\dots\dots + bpXp + e}}{1 + e^{a + b1X1 + b2X2 + \dots\dots\dots + pXp + e}}$$

Where:

p, is the actual proportion of farmers adopting the technology for particular values of independent variables X1, X2, …, Xp, that influence adoption of SC513, NPK or urea. b 1, b 2,…, bp denote the regression coefficients associated with independent variables X1, X2, …, Xp. e is the error term. From the equation (1.0), we arrive at a simple linear regression equation through logit transformation (*Hosmer and Lemeshow, 2000):*

Equation 2.0 :

$$\ell og = [p/(1-p)] = a + b1X1 + b2X2 + \dots + bpXp + e$$

Data analysis : Data were analyzed using the Statistical Package for Social Sciences SPSS version 15 (*SPSS Inc. 2006*). Attitude statements were measured using a 5-point Likert scale with 1 = Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree, and 5 = Strongly Disagree. Exploratory and confirmatory factor analyses were used to create summated scales of attitudes towards SC513, NPK and urea. For the scale on attitudes towards maize variety SC513, two-factor model were obtained: attitudes towards marketability of maize variety SC513; and attitudes towards production characteristics of maize variety SC513. Each factor on SC513 had three items. Hence, for each factor the summed score across items for a given respondent ranged from 3 to 15, with scores lower than 9 indicating favorable attitudes, and scores greater than 9 indicating unfavorable attitudes. One factor model was obtained for attitudes towards NPK /Urea, with four items. The summed score across items for a given respondent ranged from 4 to 20, with scores lower than 12 indicating favorable attitudes, and scores greater than 12 indicating unfavorable attitudes. One-Way ANOVA was used to compare mean attitude scores for the three groups of sources of information on the technology, neighbors, market, and extension.

To create attitude scores for subsequent use in logistic regression, factor scores were estimated through principal component and varimax procedure *(Hair et al., 2005).* Two-factor solutions for the attitude scale on SC513, explained about 59.3 per cent of the variance in attitudes toward SC513. One factor solution for the attitude scale on NPK explained about 48 per cent of the variance in attitude toward it. One factor solution for the attitude scale on urea explained about 56.4 per cent of the variance in attitudes toward urea. Variance Inflation Factor (VIF) estimates was examined for collinearity diagnostic in Multiple Logistic Regression. Most of VIF estimates had values less than 2, which indicate no serious problems of collineraity.

RESULTS AND DISCUSSION

*Characteristics of respondents:*The general characteristics of the respondents are described in Table 2. The respondents were similar regarding age and family size. However, for level of education the respondents showed differences. Vanduzi had a larger number (30.6 %) of illiterate farmers than Machipanda (14.2 %).

Table 2. Characteristics of respondents in Machipanda and Vanduzi in the Manica District

Characteristics	Study location			
	Machipanda (n = 120)		Vanduzi (n = 173)	
	No.	%	No.	%
Age (Years)				
Less than 44	65	54.2	89	51.4
45 to 60	38	31.7	59	34.1
61 to 76	12	10.0	21	12.1
More than 76	5	4.2	4	2.3
Level of education				
Illiterate	17	14.2	53	30.6
Primary School	95	79.2	109	63.0
Secondary/ High School	8	6.7	11	6.4
Family size				
Less than 8	79	65.8	112	64.7
9 to 12	30	25.0	44	25.4
More than 13	11	9.2	17	9.8

Farmers' attitudes towards improved maize SC513, NPK and urea fertilizers : Table 3 depicted farmers' attitudes by source of information. Overall, farmers held positive attitudes towards improved maize and fertilizers. Nonetheless, in the lowlands, the strength of positive attitudes towards fertilizers differed significantly (P<.01 and P<.001) between farmers who learned about fertilizers from extension and those who learned from neighbors. Farmers who learned from extension had stronger positive attitudes than farmers who learned about fertilizers from neighbors. These results indicate that, farmers do support the use of improved maize and chemical fertilizers. The results also suggest that, while all three sources of information can be used by farmers to learn and raise awareness about fertilizers, particular attention should be given to public extension to strengthen farmers' attitudes towards fertilizers.

Table 3. ANOVA for mean attitude toward improved maize variety SC513 by sources of information

Attitude toward	Information Source	Machipanda Source				Vanduzi Source			
		N	Mean	F	Sig.	N	Mean	F	Sig.
Marketability	Neighbors	72	6.81			28	7.43		
	Market	35	7.37	2.02	.138	26	7.15	2.05	.135
	Extension	8	6.25				37	6.73	
Production .	Neighbors	72	5.99				28	7.04	
	Market	35	6.26	.661	.518	26	7.08	2.79	.067
	Extension	8	5.75				37	6.14	
NPK.	Neighbors*	57	10.6				88	10.2	
	Market	41	10.7				25	9.52	
	Extension*	19	10.2	.512	.600	32	9.03	5.76	.004
Urea.	Neighbors**	58	8.05				88	10.06	
	Market	41	8.63				26	9.46	
	Extension**	19	8.47	1.34	.265	30	8.33	8.53	.000

Scheffe's post hoc multiple comparison method: * P<.01 ** P<.001

Table 4. Maximum likelihood estimates of logistic model for factors affecting adoption of SC513

Variables	β	S.E.	Wald	Sig.	Exp (β)
Agro-ecological zone	2.51	.512	24.0	.000	12.2
Knowledge of advantages and disadvantages	1.99	.732	7.40	.007	7.32
Attitude toward marketability of produce	-.497	.234	4.50	.034	.608
Attitude toward traits	-.812	.228	12.6	.000	.444
Constant	-.704	1.33	.279	.598	.495
Likelihood ratio chi-square df(10)	87.03	-	-	.000	-

Factors associated with adoption of improved maize SC513, NPK and urea fertilizers : Tables 4, 5 and 6 presented the maximum likelihood estimates of the logistic models for factors associated with adoption of SC513, NPK and urea. The fit of the models was satisfactory. The estimated coefficients for the likelihood ratio chi-square were significant (P<.001), with chi-square values of 87.0, 64.3, and 81.6. The models accounted ($R^2_{Logistic}$.) for 39, 24 and 27 per cent of the variation between adopters and non-adopters of SC513, NPK, and Urea respectively.

Table 5. Maximum likelihood estimates of logistic model for factors affecting adoption of NPK

Variables	β	S.E.	Wald	Sig.	Exp (β)
Agro-ecological zone	.794	.392	4.10	.043	2.21
Knowledge of application methods	2.61	.753	12.0	.001	13.6
Information sources	-	-	14.5	.001	-
Market (1)	.154	.442	.122	.727	1.17
Extension (2)	1.57	.430	13.3	.000	4.81
Constant	-4.32	1.11	15.1	.000	.013
Likelihood ratio chi-square df(8)	64.3	-	-	.000	-

Table 6 Maximum likelihood estimates of logistic model for factors affecting adoption of urea

Variables	β	S.E.	Wald	Sig.	Exp (β)
Agro-ecological zone	1.43	.369	14.9	.000	4.16
Knowledge of application methods	2.05	.521	15.5	.000	7.74
Information sources	-	-	9.99	.007	-
Market (1)	-.211	.418	.256	.613	.810
Extension (2)	1.23	.434	8.01	.005	3.41
Constant	-2.86	.964	8.81	.003	.057
Likelihood ratio chi-square df(8)	81.6	-	-	.000	

As expected, the agro - ecological zone and how-to knowledge were significant (P<.05) factors associated with the adoption of improved maize variety SC513, NPK, and urea fertilizers. Being in the highlands increased the probability of adoption of the three technologies, by a factor of 12, 2 and 4, respectively. Feeling knowledgeable about improved maize and application of chemical fertilizers increased the probability of adoption of the three technologies, by a factor of 7, 14, and 8. Extension was a significant factor (P<.05) for adoption of fertilizers. The probability of adoption of NPK and urea, for farmers who learned about these technologies from extension services, increased 5 and 3 times more than the probability of adoption by farmers who learned from neighbors. Farmers' attitudes were significant factors of adoption of improved maize. As expected, holding negative attitudes toward traits of SC513 and negative attitudes toward the marketability of produce from SC513 had a significant (P<.05) negative effect on the logarithm of the odds of adoption.

The three most important factors associated with adoption of improved maize SC513, were: agro ecological region, attitude toward production traits of improved maize SC513, and knowledge about advantages and disadvantages of improved maize varieties. Extension on NPK and urea, knowledge about fertilizer application, and agro-ecological conditions had significant influence on adoption of chemical fertilizers.

CONCLUSION

This study has confirmed earlier research which showed that adoption of improved maize technologies, is influenced by agro ecological conditions, attitude toward production traits and marketability of improved maize, how-to-knowledge to apply the technology, and the role of extension in dissemination of improved technology (*Kaliba et al., 2000; Abebaw and Belay, 2001; Hintze et al., 2003; Rogers, 2003*). The results suggest a collaborative approach for a widespread adoption of improved maize and chemical fertilizers, where soil scientists and plant breeders develop fertilizer recommendations which are attuned to agro-ecological region, and maize varieties that have wide adaptation, growing well in the highlands and lowlands. Extension should strengthen farmers' knowledge and skills in fertilizer application through literacy programs. Extension should also strengthen positive attitudes toward improved maize and fertilizers through educational campaigns and on-farm trials. Input suppliers should tailor their marketing campaigns emphasizing knowledge, attitudes and agro-ecological conditions.

Acknowledgment : I am deeply grateful to the Ford Foundation and the Department of Community, Agriculture, Recreation and Resource Studies at Michigan State University for providing the financial support for this research.

Paper received on : March 24, 2010

Paper accepted on : June 09, 2010

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