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Factors influencing the demand for improved maize open pollinated varieties (OPVs) by smallholder farmers in the Eastern Cape Province, South Africa

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Maize is one of the most important crops grown by smallholder farmers in Amatole and O.R. Tambo Districts of the Eastern Cape Province. Improved open pollinated varieties of maize have been shown by studies to be relatively drought tolerant as compared to hybrids, and can be a valuable step if adopted and used by smallholder farmers. This study assessed the factors that influence the demand for improved maize OPVs in the Eastern Cape Province by smallholder farmers. One hundred and thirty seven sample households were interviewed using a structured questionnaire. The demand model that employed a multiple regression model was used, and data was analyzed using Statistical Package for Social Sciences computer software. Results showed that extension contact, access to credit, availability of household income and proportion of land area under cultivation, positively influenced the demand for the improved maize OPVs whereas the unavailability of the improved maize OPV seeds on the local shops, proportion of land area under hybrids and landraces and perceptions on seed color negatively influenced the demand for the improved maize OPVs. The findings confirm the role of improved access to extension, access to credit, household income, land sizes, farmers' perceptions and the availability of the improved OPV seeds on the market are crucial for decision making and planning in determining the uptake and use of improved maize OPVs.

Key words: Demand, Eastern Cape province, hybrids, improved open pollinated varieties (OPVs), smallholder farmers.

INTRODUCTION

This study assessed the factors that determine the demand for improved maize Open Pollinated Varieties (OPVs) by smallholder farmers in the Eastern Cape (EC) Province in South Africa. Improved maize OPVs were

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introduced in the Eastern Cape agriculture in 2009.

Open pollinated varieties have been usually associated with marginal agriculture and traditional farming systems practicing subsistence production (Cleveland et al., 1994). Open pollinated plants or seeds are also termed as non-hybrid. A hybrid variety on the other hand is a cross between two different strains and lines or crop types such as in maize, in order to maintain purity and heterosis of F_1 seed so that high performance is carried through to the commercial product (Sparks, 1992). Maize (*Zea mays*) is a staple food, and the most commonly grown crop by smallholder farmers in South Africa (Mashingaidze, 2006). It is the main diet, as well as being a cash crop for resource poor farmers. As the main diet, it becomes the source of calories, protein, iron, vitamin B and minerals Maize contributes for greater than 40% of total cereal production in Sub-Saharan Africa (Ebro, 2001). Smallholder farmers in South Africa are resource-poor (Ebro, 2001), and cannot afford to buy hybrid seed. As a result, they tend to grow old OPVs and other recycled seeds (Mashingaidze, 2006).

According to Ebro (2001), South Africa is drought-prone and has nutrient-depleted soils. This is a challenge to smallholder farmers. However, institutions under the Consultative Group on International Agricultural Research have developing new improved maize OPVs. In addition, the International Maize and Wheat Improvement Centre in Mexico (CIMMYT) supported by the Consultative Group on International Agricultural Research, and in collaboration with South Africa's national Agriculture Department, have been engaged in research to develop new maize OPVs in South Africa (Zhuwakinyu, 2001). In the Eastern Cape, stress tolerant improved maize OPVs have been introduced from CIMMYT (Zimbabwe) and International Institute of Tropical Agriculture and are being adopted mostly by dry-land farmers because they can do well under low rainfall conditions and low soil fertility areas. Farmers growing maize under irrigation conditions are also expected to produce seed of maize OPVs after receiving training. Examples of improved maize OPVs include ZM (521, 1421, 1523, 1611 & 1623), Nelson’s Choice and Obatanpa. These improved OPVs of maize have advantages of increasing yield by 30 to 50% compared to conventional varieties produced by smallholder farmers in South Africa (Ebro, 2001). Some of the improve maize OPVs are tolerant to drought and resistant to diseases such maize streak virus (Ininda et al., 2007).

Furthermore, improved OPV seed can be recycled for up to three years. This reduces the cost of the seed of improved OPVs than hybrid seed (MacRobert et al., 2007). A study conducted by Pixley and Banziger (2001) in Zimbabwe concluded that the growing of improved maize OPVs may be more profitable and sustainable than the use of hybrid seeds. A number of factors are limiting maize production by smallholder farmers.

The major factors particularly in the Eastern Cape Province are poor soil fertility and low rainfall. Other challenges include the use of inadequate inputs such as seeds, poor adoption and inadequate information on seed varieties. This has implications on food security and sustainability of livelihoods by smallholder farmers. Improved maize OPVs in some farming systems, particularly where yield is low have indicated that they can be more profitable and sustainable than hybrids. Therefore, improved maize OPVs can be a valuable step for farmers as they have been shown to be drought prone and profitable when grown under drought conditions compared to hybrids. Studies have been done on the factors that influence the adoption of improved maize OPVs but the factors that determine the actual use or demand (extent of adoption) for the improved maize OPV seed by smallholder farmers need to be investigated. The specific objective of this study was to identify the determinants of demand of improved OPV maize seeds by smallholder farmers in the Eastern Cape Province.

MATERIALS AND METHODS

Study areas

The study was conducted in Amathole and OR Tambo Districts of the Eastern Cape Province. The specific study sites in Amathole District were Keiskammahoek (Silwindlala Women’s Project (SWP)) and Zanyokwe Irrigation Scheme (ZIS) which fall under the former Ciskei homelands. In OR Tambo District, the study sites were Mqekezweni, Mkhwezo, Jixini, Gxididi and Gogozayo which all fall under the former Transkei homelands. These areas were purposefully selected by an agronomic team from the university of Fort Hare because of their agricultural potential, cropping history, geo-climatic and soil characteristics. The rural Eastern Cape Province is generally economically deprived. Economic related activities in the study areas are mainly based on agricultural activities.

Smallholder farmers grow tomatoes, vegetables, cabbages, potatoes, pumpkins, butternut, dry beans and field crops such as maize. They produce mainly for subsistence. A study done by Monde et al. (2005) shows that the majority of the farming households in the Eastern Cape Province can be described as low-income and resource-poor.

Sampling techniques and data collection

Multi-stage random sampling procedure was used to select respondents (maize farming household heads). First, 2 local district municipalities (Amathole and OR Tambo) were selected because of their agro-climatic locations. In the second stage, 2 villages (Zanyokwe and Keiskammahoek) in Amathole District and 5 villages (Mqekezweni, Mkhwezo, Jixini, Gxididi and Gogozayo) in OR Tambo District were purposively selected because of their agricultural potential. In the third stage, a total of 135 maize farmers were sampled. In Keiskammahoek, SWP was comprised of 15 members and 14 farmers who were available during the time of data collection were interviewed.

In ZIS, according to Fanadzo et al. (2009) there were about 22 active maize farmers and 20 farmers who were readily available during the time of data collection were interviewed. In OR Tambo, 100 farmers (20 farmers from each study site) were sampled from the 5 villages. Availability sampling methods were used on a door-to-door basis. The advantage for using availability-sampling method was that people who were conveniently available were interviewed so as to obtain a large number of completed questionnaires quickly and economically as argued by Monette et al. (1998). Snowball sampling method was also used in addition, whereby the available farmer identified and referred to other farmers in the population. In situations where it is difficult to locate members of a population, snowball sampling is helpful (Ntsonto, 2005). Structured, interviewer-administered questionnaires were used to acquire information. The questionnaires were interviewer-administered so as to eliminate misinterpretations or misunderstandings of words or questions by respondents. The questionnaire consisted of both open ended and close-ended questions. Most of the questionnaire questions were close-ended for ease of coding and close-ended questions take less time for respondents to answer.

Research design

A cross-sectional research design was employed by the study. Data was collected at one point in time on several variables such as demographics, household socio-economic factors and data on demand for improved maize OPVs. Only a subset to represent the population thereof was selected. Both qualitative and quantitative data was gathered on demographics, household socio-economic factors, and seed demand for improved maize OPVs by farming households. The study was carried out in two phases: orientation and a survey during the 2009/2010 farming seasons.

Firstly, the orientation stage involved a visit to the study area in 2009. During this phase, informal discussions with project participants (farmers) were done. Main objectives of the research project were outlined to the farmers through agricultural extension officials. The aim of this phase was to familiarize with the study area, to preliminarily interact with farmers and to identify key issues.

This was done in 2009 and 2010. A structured interview administered questionnaire was used as a data collection instrument. A structured questionnaire standardizes the order in which questions are asked to respondents and ensures that questions are answered within the same context.

Data analysis

After collecting data, raw data was captured and encoded in the form of spreadsheets in Microsoft Excel and exported to Statistical Package for Social Sciences (SPSS) soft wares. Descriptive analysis was applied; here simple statistics, tables, pie charts and graphs were used. The demand model employing a multiple regression model was used to assess the factors that influence farmers' demand of improved maize OPV seeds. Factors influencing technology demand is divided into two categories; the demand side (such as the farm and farmer characteristics) and the supply side (such as technology characteristics and availability) (Feder et al., 1985). Therefore, household seed buying decisions are determined by input market factors, household income and certain farmer attributes andperceptions that may be form part of the adoption decision model. The newly introduced improved maize OPVs were relatively new at the time of the study and farmers were in the process of adopting them. The anticipated amount of the new improved maize seeds farmers would buy when the varieties were made available was used as a proxy for the demand of the improved maize OPVs. Socio- economic factors (household specific attributes) and input market factors that may influence farmer's demand for the new improved maize OPVs were investigated. The following demand model was adapted from Langyintuo et al. (2006). The demand model is specified as follows in equation 1:

$$\boldsymbol{D}_i = \boldsymbol{\beta}_k Z_{ik} + \boldsymbol{\gamma}_j E_{ij} + \boldsymbol{\mu}_{\mathrm{I}} \quad (1)$$

where

Di = the quantity of seed demand by the *i*th household (taken to mean anticipated seed to be purchased after adopting the improved OPVs),
Z = a matrix of household socio-economic attributes influencing seed demand,
E = a matrix of exogenous input market factors,
ß and **γ** are parameters to be estimated,
ε is a stochastic error term.

Multiple regression modeling is defined by Gujarati (1992) as a statistical technique that allows the prediction of scores of a dependent variable on the basis of scores on several other variables (independent variables). By fitting the variables into the demand model, it is presented in equation 2:

$$\boldsymbol{D} = \boldsymbol{\beta}_0 + \boldsymbol{\beta}\,(Z_1 + Z_2 + Z_3 + Z_4 + Z_5 + Z_6 + Z_7 + \ldots + Z_{16}) + \boldsymbol{\gamma}\,(E_1 + E_2 + \ldots + E_5) + \ldots\ldots \boldsymbol{\mu}_{\mathrm{I}} \quad (2)$$

where

D = Anticipated seed demand to be purchased when farmers have adopted the improved maize OPVs.
Z_1 = Age
Z_2 = Gender
Z_3 = Education
Z_4 = Extension contact
Z_5 = Access to credit
Z_6 = Family size
Z_7 = Farm size
Z_8 = Proportion of land area under improved varieties
Z_9 = Proportion of land area under hybrids
Z_{10} = Proportion of land area under landraces
Z_{11} = Expected Income from maize sales
Z_{12} = Expected crop yields
Z_{13} = Household Income
Z14 = Farmer perceptions on seed color
Z15 = Farmer perceptions on pest resistance
Z_{16} = Farmer perceptions on drought resistance
E_1 = Potential competitors
E_2 = Knowledge on improved maize OPVs

E_3 = Availability of improved maize OPV seeds in the local market
E_4= Distance to input market
E_5= Cost of hybrid seed
$\boldsymbol{\mu}_{\mathrm{I}}$ = Error term,
$\boldsymbol{\beta}_0$ = the intercept and
ß and **γ** are partial regression coefficients

Table 1 shows the variables used in the regression model and their

Table 1. Variables used in the demand model and their expected outcomes.

Variable	Description	Type of measurement	Apriori expectation (+/-)
Dependent			
Demand of improved maize OPVs	Actual OPV seed purchase (kgs)	Continuous	-
Explanatory			
Age	Actual number of years	Continuous	-
Gender	Gender of respondent (male/female) Dummy	Dummy	+/-
Education	Highest education of respondent	Categorical	+
Extension	Access to extension (yes/no) Dummy	Dummy	+
Household labor force	Actual number of family labor	Continuous	+
Access to credit	Access to credit (yes/no) Dummy	Dummy	-
Family size	Actual number of family size	Continuous	+
Farm size	Actual farm size (ha)	Continuous	+
Proportion of land area under improved varieties	Actual proportion of land area under improved varieties	Continuous	+
Proportion of land area under hybrids	Actual proportion of land area under hybrids	Continuous	-
Proportion of land area under landraces	Actual proportion of land area under landraces	Continuous	-
Expected income from maize sales	Actual expected income from maize sales	Continuous	+
Expected crop yields	Actual expected crop yields	Continuous	+
Household income	Actual household income	Continuous	+
Potential competitors	Potential competitors (yes/no) Dummy	Dummy	-
Knowledge on improved maize OPVs	Knowledge on improved maize OPVs (yes/no) Dummy	Dummy	-
Improved OPV seed unavailability on the market	Improved OPV seed unavailability on the local market (yes/no) Dummy	Dummy	-
Distance to market	Actual distance to input market (km)	Continuous	-
Cost of hybrid seed	Actual cost of hybrid seeds purchased	Continuous	+
Seed color	Seed color (red/white) Dummy	Dummy	+/-
Perceptions on drought tolerance	Household perceptions on whether improved maize OPVs are drought (yes/no) Dummy	Dummy	+
Perceptions on pest resistance	Household perceptions on whether improved maize OPVs are pest resistant (yes/no) Dummy	Dummy	+

(+/-) Expected outcome direction of the variable based on literature.

expected outcomes.

RESULTS

Descriptive results

Age

According to Hofferth (2003), age of a household head is a vital feature in agricultural performance as it associated with farming experience. Table 2 summarizes the age distribution of respondents. The minimum age of respondents in SWP, ZIS and O.R. Tambo was 34, 28 and 24 years respectively. The maximum age in SWP, ZIS and OR Tambo was 69, 64 and 89 years respectively. The mean age of interviewed farmers was 49.79 years (SWP), 51.2 years (ZIS) and 61 years (O.R. Tambo). Generally the results suggest that in SWP and ZIS, these were younger farmers unlike in OR Tambo. Although findings from other studies not decisive on the effect of age and the use of new technology, it is anticipated young farmers are more likely to adopt and use new technologies such as the improved maize OPVs.

Gender

In SWP, there were more females (66.6%) than males. Females dominated because this was a women's project (Silwindlala Women's Project); however, there were also some male members in the project. ZIS had more males (80%) than females. This can be attributed to the fact that most households are headed by men; therefore they were the most likely respondents. In O.R. Tambo, there was a fair distribution of gender for the respondents, males accounted for about 54.9% and females 45.1%. The influence of gender on the use of new technology can be indeterminate implying that its influence is not fixed or known in advance.

Education

Education has been noted to be one of the factors enabling farmers to acquire and process relevant information effectively. A higher educational attainment is usually associated with increased adoption rates and use. In this study (Table 2), generally the majority of the respondents had attained some formal education. In SWP, 35.7% had primary education and 50.0% had high school education, and 7.2% reached tertiary education. In ZIS, most farmers (71.4%) had primary education and 28.6% had reached high school. In the O.R. Tambo District, about 31.4% of the interviewed farmers never went to school and 31.4% had primary education respectively, and about 33.3 and 3.9% had reached high school and tertiary education respectively. Therefore, education is a variable that can influence the demand for the new improved maize OPV seeds.

Family size

Family size in this study was considered as the number of individuals who reside in the respondent's household. Table 2 shows the household size distribution in the study sites. The mean household sizes were 4.86 (SWP), 5.52 (ZIS) and 6.36 (O.R. Tambo). The study also revealed that household sizes were in the range of 1 to 18 per household. The maximum household size was about 6 people per household (SWP), 5 people per household (ZIS) and 18 people per household (O.R. Tambo). Taking family size, as a proxy for labor availability, it can be inferred that the farming households would not have problems with farm labor. These findings are supported by Phororo (2001) and Hages et al., (1997) that a large family size is likely to have various forms of labor availability in the form of young, middle aged and elderly household members

Extension contact

Extension plays a crucial role in empowering farmers with farming knowledge, techniques and skills (Kaliba et al., 2000). Therefore, it is critical to assess the availability of extension services as it can influence a farmer's decision on which maize variety to grow. The majority (100 and 70%) of the interviewed farmers in SWP and ZIS respectively had access to extension services. In contrast, most of the respondents (52.9%) in O.R. Tambo had no access to extension services. Only 47.1% of the interviewed farmers in O.R. Tambo had access to extension support such as farmer training and education programmes. SWP and ZIS had better access to extension support than O.R. Tambo because they are irrigation schemes unlike the dry land farming in O.R. Tambo practiced by individuals. Irrigation schemes usually have fulltime production facilities and programs. Increased access to extension is therefore expected to increase the demand for improved maize OPV seed.

Farm sizes

Various studies have shown that farm size is one of the factors associated with the adoption and use of new technologies (Sain and Martínez, 1999). Farm size can be used as a proxy to describe the distributive bias new technology. According to Aina (2007), smallholder farmers in South Africa have land sizes of about 0.5 to 4 ha producing food for household consumption and little for selling. At SWP, the farmers were producing on arable land of about 36 ha which they collectively rented as a co-operative. Table 2 shows the land distribution and sizes in ZIS and O.R. Tambo.

In ZIS and O.R. Tambo, about 35 and 2% of the interviewed farmers each were farming in the land below 1 ha. These were most likely to be home gardens were farmers grew maize (landraces) and vegetables. A greater proportion in ZIS (60.8%) had arable land holdings of 1 to 5 ha. In O.R. Tambo, about 33.3% of the interviewed farmers had arable land holdings of 1 to 5 ha. A greater proportion (about 60.8%) in O.R. Tambo were farming the land between 5 to 10 ha, and about 3.9% have arable fields greater than 10 ha. Generally the farmers in OR Tambo had greater land holdings than those in ZIS. It is therefore expected that the bigger the farm size, the smaller will be the financial and land limitations for adopting and using new technologies, and the greater the likelihood for the demand of the improved seed.

Access to credit

Table 2 shows the proportion of farmers with and without access to credit in the study areas. The majority, about 60% (ZIS) and 82.4% (O.R. Tambo) of the interviewed farmers did not have access to credit. At SWP, these farmers confirmed access to credit because they operated as a co-operative. The organization of farmers to become members of co-operative societies facilitates access to credit as lending to a group reduces transaction costs. Generally, the results show that

Table 2. Descriptive results.

Variable	**SWP**				**ZIS**				**OR Tambo**			
Age	**Max**	**Min**	**Mean**	**SD**	**Max**	**Min**	**Mean**	**SD**	**Max**	**Min**	**Mean**	**SD**
	69	34	49.79	12.29	64	28	51.24	10.18	89	24	61	13.97
Gender		SWP (%)				ZIS (%)				OR Tambo (%)		
Male		33.3				80				54.9		
Female		66.6				20				45.1		
Total		100				100				100		
Education		SWP (%)				ZIS (%)				OR Tambo (%)		
Never went to school		7.1				-				31.4		
Primary		35.7				71.4				31.4		
Secondary		50				28.6				33.3		
Tertiary		7.2				-				3.9		
Total		100				100				100		
	SWP				ZIS				OR Tambo			
Family size	Max	Min	Mean	SD	Max	Min	Mean	SD	Max	Min	Mean	SD
	6	2	4.86	1.875	5	2	4.52	1.662	18	1	6.36	3.544
Extension contact		SWP (%)				ZIS (%)				OR Tambo (%)		
Yes		100				70				47.1		
No		-				30				52.9		
Total		100				100				100		
Farm sizes		SWP (%)				ZIS (%)				OR Tambo (%)		
<1ha		-				35				2		
1-5ha		-				65				33.3		
5-10ha		-				-				60.8		
>10		100				-				3.9		
Total		100				100				100		
Access to credit		SWP (%)				ZIS (%)				OR Tambo (%)		
Yes		100				40				17.6		
No		-				60				82.4		
Total		100				100				100		

Key: Maximum (Max); Minimum (Min); SD (Standard Deviation).

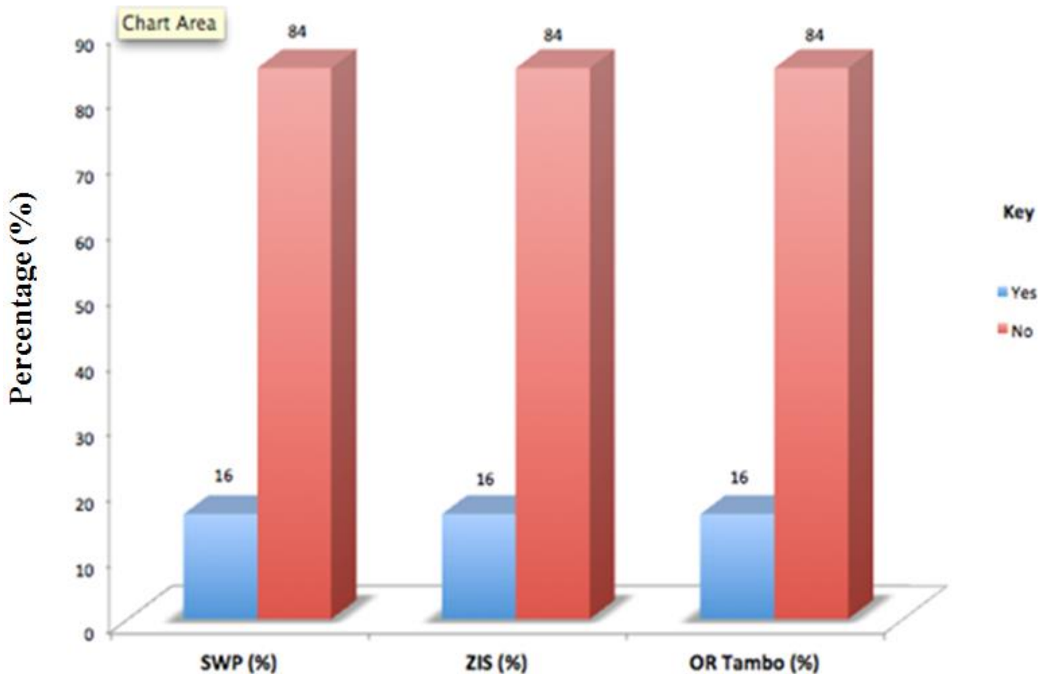

Figure 1. Availability of improved maize OPV seeds on the local market.

farmers at SWP had access to credit as compared to ZIS and OR Tambo. According to Diagne et al. (2000), access to credit increases the capability of a farmer with little or no savings to buy the essential farming inputs. It is more likely that access to credit will expedite facilitate the adoption and use of new technologies that will need to be acquired outside of the farm, such as improved seed.

Availability of improved maize OPV seeds on the local market

When deciding on the type of maize variety to grow farmers have three options landraces (traditional varieties) improved OPVs, and hybrid varieties. However, according to Sain and Martinez (1999) when deciding on which seed variety to purchase, farmers must decide on the seed sources and ease of availability. Figure 1 show that most of the interviewed farmers (84%) across all study areas indicated that the improved maize OPV seeds were not readily available on the market. This is in line with Langyintuo et al. (2006) that improved maize OPV seeds are not readily available on the local market for retail as compared to hybrids seeds and that where they were available, they were in small supplies. The unavailability of improved maize OPVs is a factor that can influence their demand (Ebro, 2001).

Household income

Figure 2 shows the household income of the respondents in the study areas. At SWP, all the farmers indicated they had household income of less than R700 per month. In ZIS, 45% of the interviewed farmers indicated they had household income of less than R700 per month, and 55% had income ranging between R700 and R1499 per month. In O.R. Tambo, the majority about 61% had household income of less than R1499 per month. These results generally show that in the study communities save for OR Tambo, farmers have low household incomes. This suggests that they may have low purchasing power for farm inputs such as seeds. The argument is that with a low household income, the farmers may want to satisfy a bigger part of their total household income to basic needs and, therefore, they may have financial limitations on the purchasing acquisition of improved seed.

Knowledge on improved maize OPVs

Awareness is an intervention variable that influences the use of an improved variety (Langyintuo and Setimela, 2009). Being aware means a farmer has knowledge on that particular technology. Farmers in SWP had knowledge on the improved maize OPVs. They were growing the improved maize OPV (Sahara) in the co-

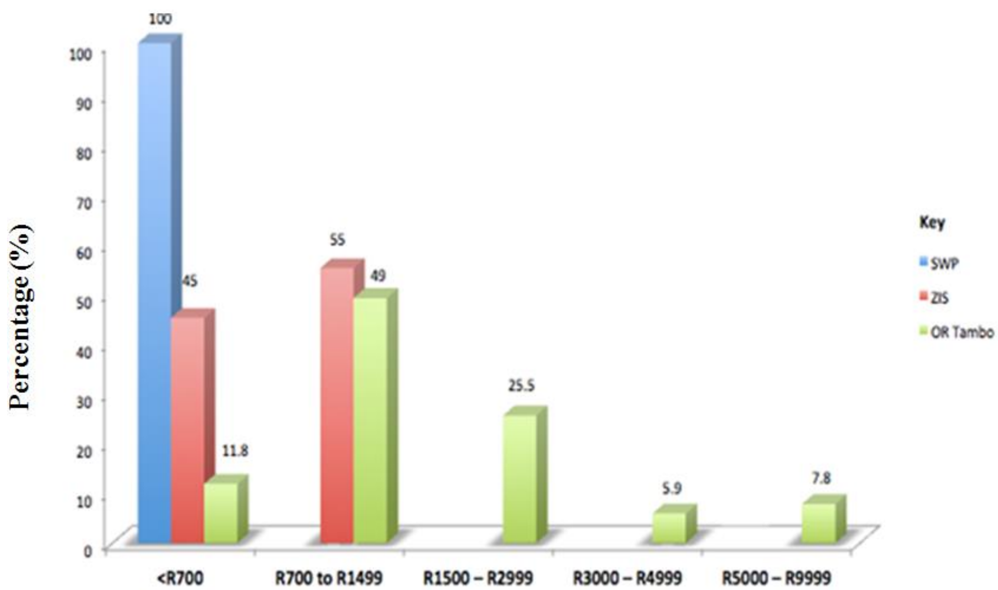

Figure 2. Household income.

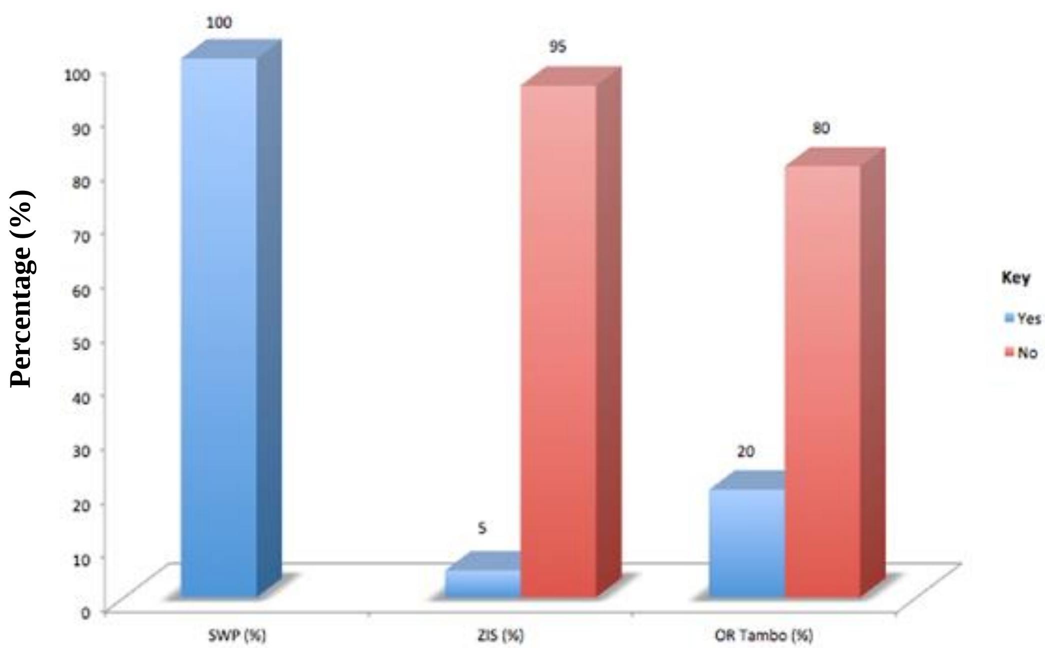

Figure 3. Knowledge on improved maize OPVs.

operative. In contrary, the majorities 95% (ZIS) and 80% (O.R. Tambo) indicated that they had no knowledge about the newly introduced improved maize OPVs (Figure 3). This is in line with Langyintuo and Setimela (2009) who noted that smallholder farmers generally lack knowledge of maize varieties. Lack of knowledge on

Table 3. Perceptions on yield potential, color, pest resistance and drought tolerance.

High yields	Hybrid (69%)	OPVs (31%)
Consider maize color when buying seed	Yes (94)	No (6)
Preferred color	Yellow (70.8)	White (29.2)
Pest resistant	Hybrid (55)	OPVs (45)
Drought resistant	Hybrid (37)	OPVs (63)

improved seed can therefore influence the adoption and thus the demand of a new technology.

Perceptions on yield potential, color, pest resistance and drought tolerance

Generally, in all the study communities, farmers preferred growing hybrids to landraces and improved maize OPVs. About 69% of the interviewed farmers perceived hybrids to be higher yielding than landraces and improved maize OPVs (Table 3). Expected crop yield is an essential factor to farmers when deciding on which crops to produce. According to Mayet (2007) farmers in the Eastern Cape are growing hybrid seeds but their food requirements have not yet improved. Therefore, farmers failing to meet household food requirements are more willing to adopt and use the improved seeds (Langyintuo et al., 2006). Table 3 shows that the majority (94%) of the interviewed farmers indicated that they considered the color of the seed when deciding on which maize cultivar to produce. For those who considered color, the majority (70.8%) preferred yellow maize (Table 3). Yellow maize was reported to be of multipurpose (feeding chickens, livestock and also for home consumption). They also indicated yellow maize had a better market when sold as green mealies and it was preferred by hawkers. According to McCann (2001), most African farmers and their agrarian systems, consider appearance in cultivars such as color to be offering distinctive characteristics in starch content, insect resistance and maturity dates.

Most of the interviewed farmers (55%) perceived hybrids to be more pest resistant than landraces and OPVs (Table 3). Farmers are more likely to prefer a variety they perceive to be resistant to the effect of pests and diseases (Mihiretu, 2008). Some of the newly introduced improved maize OPVs are resistant to pests (maize stalk borer and maize weevil) and diseases such as the leaf blight and gray leaf spot (Ininda et al., 2007). Therefore, if farmers can be informed about the range of pests and diseases to which the new varieties have some resistance, through demonstration plots, such efforts would increase the likelihood of adoption and use of the new improved OPVs.

Farmers at ZIS grew Sahara improved maize OPV. Most of the respondents (63%) at ZIS perceived improved maize OPVs to be more drought tolerant than hybrids (Table 3). Improved maize OPVs have genotypes (different members of the population) that may respond differently to environmental stresses such as moisture stress and temperature that make them to be more tolerant to harsh prone environments than hybrids and other varieties. The newly introduced improved maize OPVs from CGIAR such as ZM621, ZM305, ZM521 and ZM401 have gone through vigorous screening programs for numerous biotic stresses (drought tolerance, acidity, salinity and nutrient toxicity) and therefore, if farmers would be made aware of such developments, it would increase the demand for the improved maize OPVs in the Eastern Cape since it is drought-prone.

Factors influencing the demand of improved maize OPVs

Table 4 reports the results of the demand (multiple regressions) model for the determinants of demand for improved maize OPVs. The R^2 (R squared) of 0.65 (SWP), 0.69 (ZIS) and 0.71 (OR Tambo) are fairly high and indicates that about 65% (SWP), 69% (ZIS) and 71% (OR Tambo) in the demand for improved maize OPVs is caused by the explanatory variables in . Estimates of the regression model show that extension contact, access to credit, household income, improved maize OPV seed availability on the local market, proportion of land area under cultivation, proportion of land area under hybrids, proportion of land area under landraces and perceptions on seed color were the most important factors conditioning farmers' decisions to the demand of improved maize OPVs.

Extension contact showed a positive relationship and was statistically significant in SWP and O.R. Tambo with partial coefficients of 12.115 and 2.915 respectively. An improvement in access to extension services (coded with 1) in O.R. Tambo would mean it will increase the demand for improved maize OPVs by 12% whereas an improvement in access to extension services in SWP would mean it would increase the demand for improved

Table 4. Factors influencing the demand of improved maize OPVs in Eastern Cape Province.

Variable	SWP		ZIS		O.R. Tambo	
	ß	**Sig.**	**ß**	**Sig.**	**ß**	**Sig.**
Constant	2.372	0.395	-7.32072	-0.681	2.073	0.923
Age	-0.005	-0342	-0.506	-0.232	-0.069	-0.319
Gender (Male)	-0.840	-0.430	-0.670	-0.330	-0.759	-0.317
Education	1.719	0.685	1.821	0.885	0.382	0.618
Family size	1.990	0.103	1.495	0.124	-0.136	-0.489
Household labor force	0.125	0.434	0.125	0.434	-0.240	-0.554
Extension contact	12.115***	0.000	2.915	0.167	2.915*	0.140
Unavailability of improved OPV seeds on the local market	-2.990	-0.143	-72.559***	0.000	1.010	0.554
Distance to market	-0.125	-0.434	-1.125	-0.344	0.058	0.613
Access to credit	13.364***	0.000	0.364	0.780	1.018	0.740
Household income	-1.236	-0.746	-1.875	-0.847	1.277**	0.038
Expected income from maize sales	0.657	0.907	0.657	0.907	0.657	0.407
Potential competitors	1.885	0.706	-3.364	-0.201	1.785	0.706
Cost of hybrid seed	0.048	0.878	0.044	0.275	0.048	0.878
Proportion of land area under cultivation	0.240	0.554	2.230	0.554	11.842***	0.001
Proportion of land area under hybrid varieties	-0.658	-0.597	-14.457***	-0.000	-11.595***	-0.001
Proportion of land area under landraces	-1.890	-0.113	-1.225	-0.315	-3.897*	-0.092
Knowledge on improved maize OPVs	-1.795	-0.440	0.364	0.780	-1.402	-0.625
Perceptions on yield potential	2.372	0.395	1.674	0.946	-0.453	-0.717
Perceptions on seed color	-0.840	-0.430	0.757	0.817	-5.153*	-0.100
Perceptions on pest resistance	0.005	0.602	-1.126	-0.314	-0.115	-0.481
Perceptions on drought tolerance	1.719	0.685	0.657	0.907	0.658	0.597
R^2	0.65		0.69		0.71	

***; **; * Statistically significant at 1, 5 and 10% levels.

maize OPVs by about 3%. If access to extension services can be made more available especially in O.R. Tambo it would increase the demand for the improved maize OPVs. These findings are in line with those of Mihiretu (2008) who postulated that farmers with access to extension are more likely to get extension support and training that may increase farmer's use of new technologies that tries to address their farming needs.

Access to credit was positively related and statistically significant at SWP at 1% significance level. The regression model suggests an improvement in the access to credit (coded with 1) would increase the demand for improved maize OPVs by about 13% as indicated by the partial coefficient. This suggests that farmers with extra income and cash for purchasing farm inputs and implements through formal credits are more likely to adopt and use improved technology than those who have no access to formal credits. These findings are also supported by Diagne et al. (2000) that access to credit increases the ability of a farming household to purchase the necessary farming inputs. Therefore at SWP, access to credit is likely to increase the demand for the newly introduced improved maize OPVs.

Household income from the multiple regression models was statistically significant in O.R. Tambo at 5% significance level with a partial coefficient of 1.277. The positive sign on the coefficient suggests a positive relationship with the demand for the improved maize OPVs. Rwelamira et al. (2000) indicated that for a household to afford necessities such as food, water, education, and shelter, there has to be money. Household income therefore has an influence when purchasing seed inputs. Therefore, farmers with off-farm income sources are more likely to adopt and use improved maize OPVs. This is in line with Bonabana-Wabbi (2002) who showed that farmers with extra household income are more likely to increase the uptake of new technologies.

The proportion of land area under cultivation was statistically significant in O.R. Tambo at 1% significance level, where it had a coefficient value of 11.842. This suggests an increase in the proportion of land area under cultivation by a percentage point would increase the demand for improved maize OPVs by about 12%. The positive sign of the variable indicates that a larger access credit (coded with 1) which would increase the demand for improved maize OPVs by about 13% as indicated by the partial coefficient. This suggests that farmers with extra income and cash for purchasing farm inputs and implements through formal credits are more likely to adopt and use improved technology than those who have no access to formal credits. These findings are also supported by Diagne et al. (2000) that access to credit increases the ability of a household with little or no savings to acquire needed agricultural inputs. Therefore at SWP, access to credit is likely to increase the demand for the newly introduced improved maize OPVs.

Household income from the multiple regression models was statistically significant in O.R. Tambo at 5% significance level with a partial coefficient of 1.277. The positive sign on the coefficient suggests a positive relationship with the demand for the improved maize OPVs. Rwelamira et al. (2000) indicated that for a household to afford necessities such as food, water, education, and shelter, there has to be money. Household income therefore has an influence when purchasing seed inputs. Therefore, farmers with off-farm income sources are more likely to adopt and use improved maize OPVs. This is in line with Bonabana-Wabbi (2002) who showed that farmers with extra household income are more likely to increase the uptake of new technologies.

The proportion of land area under cultivation was statistically significant in O.R. Tambo at 1% significance level, where it had a coefficient value of 11.842. This means an increase in proportion of land area under cultivation by a percentage point would increase the demand for improved maize OPVs by about 12%. The positive sign of the variable indicates that a larger proportion of land area cultivated is likely to increase the use of new technologies such as the improved maize OPVs. Therefore, if farmers in O.R. Tambo can increase the proportion of cultivated land to the improved OPVs, it would increase the demand for the improved maize OPVs. These results are in line with Wubeneh (2003) and Bembridge (1988) who state that access to more land for cultivation is likely to influence the adoption of new farm technologies.

The proportion of land area under hybrids in ZIS and O.R. Tambo and the proportion of land area under landraces in O.R. Tambo were also statistically significant at 1% significance level. The proportion of land area under hybrids variables had partial coefficients of -14.457 (ZIS) and -11.595 (O.R. Tambo) respectively. The proportion of land area under landraces had a partial coefficient of -3.897 (OR Tambo). The negative sign on the variables indicates a negative relationship with the demand of improved maize OPVs. This confirms the assertion of Pixley et al. (undated) and Mayet (2007) that most of the cultivated maize areas in South Africa were grown to hybrids. Farmers who had more of their land allocated to hybrids and landraces were less likely to adopt other varieties either because they perceive hybrids to be more yielding or they want to stick to their methods of farming (Pixley et al., undated). This is also in agreement with MacRobert et al. (2007) who reported that competitor varieties of maize seed (hybrids) if grown under suitable conditions may be preferred because they have an advantage of higher yields over the use of open pollinated maize varieties.

The unavailability of the improved maize OPV seeds on the local shops was also statistically significant in ZIS. It had coefficient value of -72.559 at 1% significance level. The results suggest that the more the improved maize OPV seeds are unavailable on the market, the lesser is their demand by farmers. This is in agreement with Ebro (2001) that maize OPVs were not readily available on the market and if they were, they were in small supplies. On the contrary, large seed companies involved in the marketing of hybrids always ensure that they are widely available. Therefore, farmers may opt for competitor varieties such as hybrids in such circumstances. The negative coefficient, agrees with the priori expectation that the unavailability of improved maize OPV seed may negatively influence their demand.

Perceptions on maize seed color also proved to be a significant variable on decisions whether to acquire the improved maize OPV seed in OR Tambo. This variable is statistically significant at 10% significance level with a coefficient of -5.153. The newly introduced improved maize OPVs are white in color, and thus the negative sign on the variable indicates a negative relationship with the demand of improved maize OPVs. Descriptive statistics revealed that the majority of farmers in OR Tambo prefer growing yellow maize. The farmers preferred yellow maize because they used it for home consumption, feeding livestock and brewing beer (*Umqombothi*) for cultural purposes. This is in line with McCann (2001) who noted that most African societies have preference for maize varieties with some distinctive characteristics such color.

CONCLUSION AND RECOMMENDATIONS

Household socio-economic factors (extension contact, access to credit, availability of household income and proportion of land area under cultivation, proportion of land area under (hybrids and landraces) and perceptions on seed color) and an input market factors (unavailability of improved OPV seed on the local markets) significantly influenced the demand for improved maize OPV seeds in the study areas.

The results of the empirical analyses confirm the role of improved access to extension which can be used as a proxy to information access in improving farmers' awareness, which is important for decision making and planning. In gaining access to credit and household income, lands are crucial factors in determining the uptake and use of improved maize OPVs. Government should implement policies aimed at promoting smallholder farmers with special emphasis on the critical role of providing information (through extension services) and affordable credit facilities. Strengthening and expansion of credit institutions into rural farming areas can be an important step in facilitating credit needs of farmers, and thus, the adoption and use of new technologies such as the improved varieties. For a viable and successful farming business, there has to be availability of funds to carry out all the activities of the business. The provision of credit through bank loans may provide farmers with extra cash to buy essential farm implements including the seed varieties of improved maize OPVs thus increasing their demand.

Results show that land size is an important factor influencing the demand for improved maize OPV seed. The findings show that the demand of improved seed increases with the farm size. Again, the decision to use improved maize OPV seed was also conditioned by the cropped area under hybrids and local landraces. Farmers who devoted most of their plot areas to competitor varieties of maize tend to demand less of the improved OPV seeds. Therefore, the availability of land is a key component on the decision on what variety to grow. This has important implications for innovators and policymakers, who should consider the land factor when establishing or introducing new seed varieties.

The perception on seed color should not be ignored as a major determinant on the demand of improved maize OPV seed. Farmer's perceptions on an innovation or new varieties largely depend upon their knowledge and information about the innovation, socio-economic conditions and agro-ecological variables. Farmers have strong perceptions of associating seed color to higher yields and profitability. There is need to educate farmers on the new innovations and their benefits and this could be highlighted through extension agents and information sources so as to enhance the demand of improved maize OPVs.

The unavailability of improved OPV seed on the local markets negatively influenced their demand. This implies improved availability of improved maize OPV seed on the local input markets may increase the demand for improved maize OPVs. Improved maize OPV seed can be made more available in the Eastern Cape Province by training farmers in seed production both on on-farm trials and at farm based level. Seed companies, government and other stakeholders may put into place strategies to foster improved farmer productivity by providing crop Management information on seed packaging and offering agronomic advisory services, training and infrastructure investments.

Conflict of Interests

The authors have not declared any conflict of interests.

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