

## Factors influencing the use of improved inputs by smallholder farmers in central Mozambique, 2010/11

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This *flash* looks at the factors influencing the use of improved inputs, using data from a survey on Price Dynamics carried out in central and northern Mozambique in 2011. Findings suggest that at present the use of inorganic fertilizers is only closely tied to growing crops with higher economic value and an assured market. In addition, households with higher asset levels or headed by males are more likely to access fertilizers. Extension, credit and price information were strongly linked with the use of improved maize seeds. Given the importance of these inputs in increasing productivity and their limited use among most smallholder farmers, a greater emphasis should be placed on improving the access to information and input markets. This includes various options. First, there should be continued efforts to improve smallholder access to inputs through financial market development and strategic programs, including vouchers and credit. Second, increased market opportunities for cash crops and staple crops help to ensure farm income and investment options. Third, greater public and private investments should be made to improve the existing roads by expanding and refurbishing them, in addition to improvements in the access to electricity. Livestock may contribute to the assets available to the household for obtaining inputs. Given the potential contribution to soil fertility with manure, ensuring livestock health is another area for public and private investments.

### Introduction

Agricultural productivity levels in Mozambique lag behind most of its neighbors that have climatic and socioeconomic similarities. Data from the World Bank (2012) indicate that the average cereal yields in 2011/12 in Mozambique were estimated at 700 kg/ha, which is three and four times lower than the average cereal yields in Malawi (2.1 ton/ha) and Zambia (2.7 tons/ha), respectively. The limited use of improved inputs is one of the most important factors that limit agricultural productivity in Mozambique.

Data from the National Agricultural Survey of 2012, known as *Inquérito Agrícola Integrado*, show that less than 3% of smallholder farmers used inorganic fertilizers, 6% used pesticides, 9% used improved maize seeds, and only 8% used animal traction. Some authors argue that the low use of agricultural inputs, especially for basic food crops, is related to their high prices and lack of credit (Langyintuo and Mungoma, 2008). There are earlier adoption studies for Mozambique, looking the use of improved inputs. However, few studies have examined specifically the zones with greater use of improved inputs, and the lessons learned from those successes. Tete is one example, with 33.5% of smallholder farmers in the highest potential areas of the province using inorganic fertilizers in the 2010/11 growing season. This exceeds the national average of Malawi (30%) and Zambia (32%), two countries that had

extensive programs of input subsidies in 2011 (FAO, 2011). This *flash* seeks to provide new analysis, evaluating the factors associated with the use of inorganic fertilizers and improved maize seeds in order to identify alternatives to increase their use among the smallholder farmers.

### Data sources and methods

This *flash* uses data from the Survey on Price Dynamics, carried out in 2011, by Michigan State University (MSU) in Mozambique, in collaboration with the Ministry of Agriculture (MINAG) and Technoserve. The survey data covered 31 districts selected in five provinces: Manica, Nampula, Sofala, Tete, and Zambezia (Figure 1). The districts were selected based on their production potential of maize, sesame, soybeans, and sunflower. The total sample was 1,186 households, of which 256 in Tete and 210 in Manica. The data are representative at the level of the region where they were collected and therefore analyses will show the regional averages. The results presented here are weighted.

The questionnaire included binary questions indicating the use of inorganic fertilizers and improved seed varieties of maize. The findings presented in this *flash* are based on both descriptive and analytical tools, including the logistic regression model. *T*-tests were computed for comparisons of means between those who used improved inputs and their counterparts. A statistical test called the Chow test was used to determine whether to group all data

**Figure 1 Districts included in the survey on Price Dynamics**



Source: Survey on Price Dynamics, 2011. MINAG, MSU e Technoserve.

or estimate separate regression models for each province.

### Use of improved inputs in central and northern Mozambique in 2010/11

Table 1 shows that in Tete about 34% of farmers use inorganic fertilizers, while in Manica 30% of farmers use improved maize seeds, both relatively high numbers of users compared to the other provinces.

**Table 1 Use of inorganic fertilizers and improved seeds of maize in 2010/11**

Province	Inorganic fertilizers (%)	Improved maize seeds (%)	Nr. of HH's
Nampula	4.0	2.3	200
Zambezia	2.4	13.1	252
Tete	33.5	14.9	256
Manica	5.1	30.5	210
Sofala	0.3	18.3	268
Total	8.2	14.9	1,186

Source: Survey on price dynamics, 2011. MINAG, MSU, and Technoserve.

Various African countries have adopted an input subsidy policy to encourage the use of agricultural inputs. Due to social instability observed in Mozambique and elsewhere in the region in early 2008, resulting from a sharp rise in fuel prices, the government of Mozambique introduced the Action Plan on Agricultural Production (PAPA) which aimed at reducing the deficit of staple food production from 2008 to 2011 as well as reducing dependence on imports. One of the priority actions of the government to achieve the objectives of PAPA was to increase the use of inorganic fertilizers and improved maize seeds by distributing vouchers in

the high potential provinces covered by the Survey on Price Dynamics of 2011 (MINAG, 2008). However, only 1% of households in Manica and Tete provinces had access to the vouchers distributed under PAPA. This excludes the possibility that input subsidy has been the main factor in the high levels of input use observed in Manica and Tete.<sup>1</sup>

In Tete, about 96% of smallholder farmers who grew tobacco used inorganic fertilizers, showing a strong link between tobacco cropping and inorganic fertilizer use, and there are several reasons for that. First, tobacco and other cash crops tend to have higher profitability than staple crops (Howard et al., 2003). Farmers who grow tobacco may have more money to invest in new technologies compared to their counterparts. Second, the contract farming system observed with many of tobacco farmers in Tete facilitates the access to fertilizers (Benfica, 2006). Third, tobacco has an assured market which implies lower risk with the crop, facilitating investments.

However, about 40% of those using inorganic fertilizers in Tete stated that they applied this input to maize, 38% to tobacco and 11% to potato. The survey does not allow identification of the source of fertilizer applied to each crop. Thus, while almost all farmers growing tobacco used inorganic fertilizers, there is a higher proportion of farmers who indicated using inorganic fertilizers on maize. This may be associated with the role of maize not only as food crop but also as a cash crop, with all farmers (100%) interviewed in Tete stating that they grew maize in the 2010/11 growing season. Moreover, some tobacco companies encourage maize production as part of rotation with tobacco with the aim of ensuring food security. For example, in 2013, Mozambique Leaf Tobacco (MLT) distributed about 250 tons of improved maize seeds and inorganic fertilizers to about 1,100 farmers in Manica, Tete and Zambezia (*Jornal Notícias*, November 28, 2013).

Another important factor for relatively high inorganic fertilizer use in Tete is the geographical location. Some districts of Tete are located near Malawi. About 41% of smallholder farmers in Tete purchased inorganic fertilizers from outside the

<sup>1</sup> The government program did not cover all districts of the country and had a limited coverage. The Survey on Price Dynamics may not have reached the specific focus areas of the PAPA program.

country, and about 64% used the Malawian Kwacha as the main exchange currency. Similarly, according to a study by Benson et al. (2012), carried out in the 2011/12 growing season, the average price of urea was 15% lower in Malawi than the average price in Mozambique, as result of input subsidies program in Malawi.

Turning to the use of improved maize seeds in Manica, there are also several factors that can explain higher adoption. First, there were input market development programs in the province, which led to the introduction of small packages of seeds (1-5Kg), facilitating the acquisition by poorer smallholder farmers (Uaiene, 2006). Second, there were several companies selling seeds which distribute inorganic fertilizers as part of the small packages of the improved seeds (Uaiene, 2006).

Cavane and Donovan (2011) indicate in their study, carried out in Manica province, that the districts nearby Zimbabwe have more experience with improved input use than their counterparts. However, the Survey on Dynamics of Prices shows that most of the farmers who used improved maize seeds bought them within the village (56.2%) and nobody bought seeds from outside the country. This may be due to the political and economic crisis in Zimbabwe or increased domestic access in Mozambique.

#### **Characteristics of smallholder farmers who used improved inputs in 2010/11**

The use of inorganic fertilizers was significantly more common among male-headed households in Tete (Table 2). A similar pattern occurs with the use of improved maize seeds in Manica. The size and composition of the household differ significantly between those who used improved maize seeds and their counterparts. Households that used improved maize seeds had more adults.

The level of education of the household head is another significant demographic variable for technology adoption. High levels of education of

household heads are associated with higher use of both improved maize seeds and inorganic fertilizers. The household heads that used improved maize seeds have an average of four years of schooling, one additional year more than their counterparts.

In addition to education, membership in a farmers' association is significantly associated with higher technology adoption. Almost 20% of household who belong to a farmers' association used inorganic fertilizers, compared to 9% among households who do not belong to associations. Access to extension agents was associated with high probability of inorganic fertilizer and improved maize seed use, with almost 30% of using households indicating they received an extension visit compared to just 15% among households that did not use such inputs. Similarly, access to credit was significantly higher among those who used inorganic fertilizers and improved maize seeds although the proportions of access to credit in general were lower.

Livestock ownership, proxied by tropical livestock units, is higher among those who used improved inputs compared to their counterparts (Table 2). Apart from access to credit and/or animal ownership, the acquisition of improved inputs can also be facilitated by engagement in wage employment and non-farm self-employment activities. The proportion of household heads engaged in wage employment showed a positive association with the use of improved inputs. Household heads engaged in self-employment activities used improved maize seeds more frequently.

These analyses only provide a description of the households that use or do not use improved inputs, but do not imply a causal relationship. In the next section we will use methods to better understand the factors associated with the use of improved inputs. The following analysis was performed considering existing analytical difficulties, since the use of inorganic fertilizers is highly associated with the growing of tobacco, so it is difficult to isolate the effect of each factor analyzed.

**Table 2 Typology of smallholder farmers, comparing households that used inorganic fertilizers and improved maize seeds with their counterparts**

Variables	Inorganic fertilizers			Improved maize seeds		
	Yes	No	P-value	Yes	No	P-value
Male headed households (%)	95.3	78.8	0.000	82.6	79.7	0.147
HH Head Schooling (completed years)	3.1	3.0	0.058	4.2	2.8	0.000
Age of HH Head (years)	42.3	43.4	0.366	40.4	43.8	0.081
Head is engaged in salaried activities (%)	23.2	37.5	0.007	47.1	34.5	0.007
Head is self-employed (%)	35.5	44.7	0.925	44.3	43.9	0.024
HH size in adult equivalent scale (AE)	5.2	4.9	0.615	5.2	4.9	0.087
HH received credit (%)	8.6	3.6	0.082	8.5	3.3	0.000
HH received extension services (%)	36.1	15.5	0.000	29.0	15.1	0.000
Member of a farmers' association (%)	19.5	8.7	0.000	13.1	9.0	0.003
HH received price information (%)	68.9	55.5	0.053	66.4	54.9	0.019
Tropical livestock unit	3.6	1.9	0.001	3.1	1.8	0.000
Cropped area (hectares)	2.4	2.4	0.863	2.5	2.3	0.128
Number of fields	2.3	2.4	0.505	2.5	2.4	0.128
Distance to nearest fertilizer/seeds retailer (km)	26.0	29.5	0.042	46.0	26.3	0.130
Distance to nearest formal market (km)	12.4	16.7	0.061	15.0	16.6	0.502
Distance to nearest informal market (km)	17.3	17.1	0.278	30.9	14.8	0.310
Elevation above sea level of HH house (metres)	1124	515	0.000	633	557	0.003
Main season rainfall (melimetres)	302	333	0.016	313	333	0.200

Source: Survey on price dynamics, 2011. MINAG, MSU, and Technoserve.

### Regression analysis

A *Chow* test was used to choose the econometric model which best explains the use of each input, i.e. if it would be a model that includes all provinces or several models of each province separately. Results of the testing indicate that separate modeling for use of inorganic fertilizers in Tete and improved seeds of maize in Manica would be appropriate. A diagnostic regression test was also used to find out whether or not there were outliers or observations that could strongly influence results. Influential observations were found for both input regression models. Such observations were excluded from the regression analysis, although included in general descriptive analysis.

Table 3 shows the results of logistic regression indicating the importance of several factors on the likelihood of using either inorganic fertilizers or improved maize seeds. For example, an "odds ratio" of magnitude 6.9 for the explanatory variable on gender of household head indicates that male-headed households are almost six times more likely to use inorganic fertilizers in Tete. The regression results confirmed most of the descriptive statistics outcomes and similar discussion will not be repeated in this

section; but it is worth emphasizing some of the key findings.

While male-headed households were much more likely to have used inorganic fertilizers in Tete province, the same pattern was not seen for improved maize seeds in Manica province. The education of household head also influences positively the use of inorganic fertilizers, with users having a significantly higher level of education than non-users. The participation in wage employment by the household heads is negatively associated with the use of inorganic fertilizers. On the other hand, participation on self-employment activities was positively correlated to the use of improved maize seeds.

Access to extension services had significant effects only on the use of improved maize seeds and increases the likelihood of its use eightfold. This value is very high because the majority of farmers that received a visit from an agricultural extension worker used improved maize seeds in Manica. Surprisingly, access to credit had less influence on the use of inorganic fertilizers, although the use of improved maize seeds was highly correlated to access to credit.

**Table 3 Logistic regression results: likelihood of input use**

Variables	Inorganic fertilizers		Improved maize seeds	
	Odds ratio	P-value	Odds ratio	P-value
Male headed households	6.85	0.009	0.44	0.449
HH Head Schooling (completed years)	1.17	0.035	1.06	0.629
Age of HH Head (years)	0.98	0.171	1.01	0.752
Head is engaged in salaried activities (1=yes)	0.34	0.019	3.64	0.130
Head is self-employed (1=yes)	0.81	0.650	5.70	0.030
HH size in adult equivalent scale (AE)	1.07	0.551	0.79	0.075
HH received credit (1=yes)	2.61	0.280	11.10	0.023
HH received extension services (1=yes)	1.12	0.794	9.01	0.011
Member of a farmers' association (1=yes)	6.87	0.011	1.92	0.539
HH received price information (1=yes)	3.17	0.008	0.16	0.016
Tropical livestock unit	1.07	0.019	1.17	0.007
Cropped area (hectares)	0.82	0.115	1.76	0.031
Number of fields	2.21	0.002	0.79	0.622
Distance to nearest fertilizer/seeds retailer (km)	0.86	0.009	1.01	0.295
Distance to nearest formal market (km)	1.08	0.152		
Distance to nearest informal market (km)	0.98	0.472	0.99	0.510
Dummy variable (1=Chifunde)	17.53	0.015		
Dummy variable (1=Maravia)	0.05	0.041		
Dummy variable (1=Tsangano)	2.05	0.263		
Dummy variable (1=Gondola)			0.44	0.590
Dummy variable (1=Macossa)			0.34	0.539
Dummy variable (1=Sussundenga)			0.04	0.026

Source: Survey on price dynamics, 2011. MINAG, MSU, and Technoserve.

Membership in a farmers' association has a significant effect on the use of inorganic fertilizers in Tete province, although membership was in general very low. Most of the farmers who belong to a farmers' association used inorganic fertilizers. Livestock ownership increases the likelihood of use of both inputs considered in this *flash*. When they face difficulties to access to credit services, farmers may sell part of their animals to address their needs either for immediate consumption or for investments in agriculture, through purchase of improved inputs.

An increase in cropped area apparently reduces the likelihood of use inorganic fertilizers. This may be related to the fact that the regression already controls for the effect of farm size, through the inclusion of an explanatory variable indicating the number of plots owned. The likelihood of using inorganic fertilizers increases with the increase in the number of plots. It is likely that farmers will use inorganic fertilizers if they have more than one plot, because

they will be able to use one to grow food crops in order to guarantee food security which traditionally do not take inorganic fertilizer application, while other fields will be used to grow crops with application of inorganic fertilizers.

The same pattern does not occur with the use of improved maize seeds. An increase in cropped area increases the likelihood of using improved seeds while the number of plots has no significant effect on adoption decision. Access to output market, as measured in terms of distance to the nearest formal and informal market had no significant effect on either fertilizer or improved maize seed use. Access to input market, measured in terms of distance to the nearest fertilizer or seed retailer, had significant effect only on the use of inorganic fertilizers in Tete.

## Conclusion and implications

This *flash* looks at factors influencing the use of inorganic fertilizers and improved maize seeds to identify alternatives to improve their use in Mozambique. Findings suggest that at present the use of inorganic fertilizers is only closely tied to growing crops with higher economic value and an assured market, as well as with having higher household assets and male heads more likely to access fertilizers. Extension, credit and price information were strongly linked with improved maize seeds. Given the importance of these inputs in increasing productivity and their limited use among most smallholder farmers, a greater emphasis should be placed on improving the access to information and input markets. This would include such actions as the following:

- Continued efforts to improve smallholder access to inputs through financial market development and strategic programs, including vouchers and credit;
- Increased market opportunities for cash crops and staple crops to ensure farm income and investment options;
- Greater public and private investment in order to improve the existing roads by expanding and refurbishing them, in addition to improvements in the access to electricity.

Livestock may contribute to the assets available to the household for obtaining inputs. Given the potential contribution to soil fertility with manure, ensuring livestock health is another area for public and private investments. Modeling the factors related to the use of inorganic fertilizers in Tete province is a huge challenge because almost all farmers growing tobacco use inorganic fertilizers. To understand this dynamic, qualitative and experimental approaches may be needed to identify the factors of this very close relationship between tobacco production and the use of inorganic fertilizers in Tete province.

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