

Why is the Development of Agricultural Input Markets Sluggish in Mozambique?

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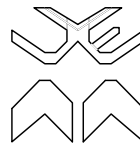
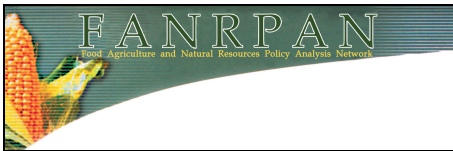
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Abstract

One issue that has long troubled development economist is how to make agricultural markets work better for the poor in less developed countries such as Mozambique. Recently, seed vouchers have been used to distribute seed during emergencies, but some worry that seed emergency programs are setting up a parallel distribution channel that crowds out private investment in the commercial seed sector. This study determines smallholder's probability of buying maize seed in markets with both emergency and commercial seed. Results show that smallholder's probability of purchasing maize seed remains very low, especially in north (0.12-0.22) and central Mozambique (0.19-0.38). Results also show that producers who receive emergency seed are relatively less likely to buy seed. These results are consistent with the view that continued distribution of emergency seed may prevent development of seed markets in emerging economies. Based on these results, several recommendations are offered to policy makers.

Key words: emergency seed, formal seed sector, informal seed sector, private investment

“...no country has been able to sustain rapid economic growth without solving its the problem of macro-food security.” (Timmer, 1995, p. 457).

1. Introduction

Mozambique is a poor country by most economic standards. About 40% of children are malnourished (Government of Mozambique, 2006) and about two thirds of Mozambicans live below the poverty line (MPF/IFPRI/PU, 2004, Government of Mozambique, 2006). Most of the poor live in rural areas and work in the agricultural sector, which accounts for about 30% of the GDP and employs 80% of the active population (INE, 2004). Given that most of the poor live in rural areas and depend on agriculture for food and income, sustained agricultural growth is needed for reducing poverty and food insecurity in Mozambique.

Sustainable increase in agricultural productivity in Mozambique will ultimately depend on improvements in a number of factors that can trigger agricultural transformation, including farmer’s access to and use of improved seeds. Seeds are very important because they determine the biological yield frontier and the productivity of land, labor, and capital. Even when smallholders lack money to buy other marketed inputs such as inorganic fertilizer, drought and disease-resistant seeds can still help raise agricultural yields (Rusike, Howard, and Maredia, 1997). But Mozambique has under-invested in its national seed system, and has lost about \$77 million in recent years from the failure to disseminate known grain technologies alone (Rohrbach et al., 2001). Smallholders lacking improved seeds are bound to have low yields, which propels hunger and poverty across generations.

Prior to market reforms in Mozambique, initiated twenty years ago, government-owned companies controlled the procurement and distribution of food staples and marketed inputs (Tostão and Brorsen, 2005). Fiscal deficits and budget instabilities led to market reforms during the 1980s which assumed that once the government got out of the market, a formal private sector would then emerge to fill the void left by state-owned companies. However, contrary to expectations, the emergence of a formal private sector has been sluggish, which has led to a sharp decrease in use of marketed inputs by smallholders (World Bank, 2001).

Currently, there is a consensus among African Union states that increases in agricultural productivity to reduce food insecurity will require investing in agriculture, particularly in input markets. The regional policy framework summarized by the Maputo Declaration of 2003, the 2006 Declaration of Abuja on Fertilizer for Green Revolution, and the Mozambique domestic policy summarized in the Poverty Reduction Strategy (Government of Mozambique, 2006), suggest a twin commitment to poverty alleviation and input market development. The question is how can the dual objectives of poverty alleviation and input market development be achieved?

Input vouchers have been suggested as a mechanism with the potential to achieving the dual objective of poverty alleviation and input market development (IFDC, 2003). Input vouchers have the potential to increase the purchasing power of the poor, thus crystallizing latent demand for marketed inputs, which promotes development and expansion of seed and fertilizer markets.

Input vouchers have been used to market agricultural inputs in Mozambique, particularly seed vouchers. More than 100,000 smallholders received seed worth about

USD 950,000 via seed vouchers and fairs over the last six years (Longley et al. 2005). But work by Longley et al. (2005) suggests the intriguing possibility that vouchers have offered little incentive for development of the formal seed sector¹ in Mozambique, which suggests that the commercial seed sector is not yet experiencing a needed transformation since the importance of the commercial seed sector is expected increase during the transformation phase (Meredia, et al., 1999).

But why is the formal seed sector not developing if it is expected to supply high-yield high-quality seed relative to the informal seed sector, which typically sells grain as seed? One potential explanation is asymmetric information. Unless smallholders have credible information about the quality of seed supplied by the commercial sector (yield, appearance, taste, storageability, etc.) and attach value to this information, then one would not expect them to buy commercial seed, which in turn precludes development of the formal seed sector.

An alternative explanation for sluggish emergence of the formal seed marketing systems is high transportation costs. Shipping in bulk would provide some scale economies to seed companies but local input markets are often thin. Longley et al. (2005, p.34) note that "...the most successful fairs (in terms of levels of participation and overall turnover) are those that take place in areas where markets are already well developed," suggesting that vouchers may not be effective if roads are undersupplied.

A third potential explanation is that missing or shallow output markets increase smallholder's risk of using marketed inputs, thereby further reducing demand for them: if

¹ The formal sector includes all organizations with specialized tasks in development, multiplication, processing, and marketing of seed (Meredia et al., 1999; Howard et al., 2001). On the contrary, the informal seed sector has little or no specialized role in the seed supply chain.

you cannot sell what you produce, why should you produce more than you consume? Facing low demand for seed, formal seed companies would have to charge relatively higher prices to be profitable, which would further reduce the quantity of seed demand by the smallholder sector and make seed companies unprofitable. In addition to decreasing effective demand for commercial seed, lack of roads also means that it is expensive to setup and run seed testing sites, and seed depot and dealers in most rural areas where agricultural smallholders live and work.

A fourth potential explanation is that government's provision of seed during droughts, floods, or chronic poverty sets up a parallel seed network that inhibits private investment in the commercial seed system. But, a counter to this argument is that if there is shortage in seed supply for whatever reason, then government intervention is justified to correct for market failure.

While there are several possible theoretical explanations for sluggish development of the formal seed sector, empirical evidence using actual data on seed purchases and sound statistical analytical methods is lacking. The objective of this study is to use real data and statistical analysis to estimate smallholders' probability of purchasing maize seed where there are both emergency and commercial seed.

2. Maize Seed Markets and Constraints

Seed markets before economic liberalization

Development of the seed system in Mozambique was heavily affected by Mozambique's policy choice following its independence in 1975, a brutal civil war that lasted seventeen years, and emergency interventions in more recent years. At the time of

independence in 1975, the government of Mozambique adopted a system of centrally planned economy, regulated the market in a way that heavily restricted entry, and created state-owned subsidized monopolies that controlled production, processing and marketing of agricultural outputs and inputs. These state-owned agricultural monopolies were conceived as development engines with a mandate to disseminate agricultural technology and provide extension services (Bay, 1998).

One prominent state enterprise that received large government investments was the *sementes de Moçambique* (SEMOC). SEMOC was a state monopoly created in late 1980's with the daunting task of supplying all commercial seed in Mozambique. But, instead of fulfilling smallholders' demand for seed, SEMOC became exclusively involved in emergency programs. Ninety percent of SEMOC's sales were directed to emergency programs via the multi-million dollar 10-year Emergency Programme for Seeds and Tools (PESU), which distributed free kits of seeds and tools to about 1.2 million smallholders annually (Howard et al., 2001). PESU was phased out in 1997, and SEMOC's sales plunged from about 14,000 tons in 1993 to about 3,000 tons in 1997, which show that what sustained SEMOC was demand for seed aid (Howard et al., 2001; Longley, 2005). SEMOC, then the only commercial seed company in Mozambique, was bought by Seed-Co, a Zimbabwean company, in 1998.

Seed markets after economic liberalization

The system of subsidized state-owned companies and uniform producer prices across Mozambique lead to heavy budget deficits that culminated with adoption of donor supported structural adjustment programs in late 1980's. The reform in the agricultural sector included the breakup of the largest state farms initiated in 1987, the cashew market

liberalization in 1995, the Land Law in 1997, the privatization of SEMOC in 1998, and the start of the national Agricultural Program (PROAGRI) in 1999 (White, 1999). One key assumption of market reforms was that once the government got out of the market, a formal private sector would then emerge to fill the void left by state-owned companies. But despite market reforms, the development a commercial seed sector has remained sluggish (Howard et al., 2001, p.7; Rohrbach et al., 2001, p.12).

Seed production

SEMOC, the biggest seed company in Mozambique, was the sole company authorized to produce maize seed until the year 2000 when a second company, PANNAR, was registered. In addition to these two companies, a number of NGOs became involved in both seed production and seed import. Also, over fifteen seed traders had licenses to import seed. Recently, SEMOC and PANNAR have also imported seed, confirming Mozambique's long history of a net seed importer (Rohrbach et al., 2001).

The Eduardo Mondlane University and the Mozambique Agricultural Reserach Institute are the main domestic seed breeders. But, breeder seed for 70% of the 120 varieties in Mozambique's seed list has been lacking in recent years (Rohrbach et al., 2001).

Variety release and registration

The requirements for variety release and registration are complex in Mozambique (Bay, 1998). To give an idea of the magnitude of the problem, Mozambique has not officially released any new varieties of seed during the last twelve years. In contrast, South Africa has released at least thirty new varieties of seed (Rohrbach et al., 2001).

Enforcement of seed standards also seems to be a problem in Mozambique. Some commercial seed sold in Mozambique has a lower than expected germination rate and is not adapted to local growing conditions (Longley, 2005; Massingue et al., 2004). Low enforcement of seed standards leads to asymmetric information between buyers and sellers because it is often assumed that commercial seed is of high quality. Asymmetric information is a known type of market failure.

Infrastructure and seed distribution system

Agricultural producers in Mozambique face limited access to seed markets. Thirty seven percent of the 128 districts in Mozambique do not have any seed shop and 34 % have only one shop. In 2001, the ratio of agricultural producer to seed shop was more than 40,000 (Rohrbach et al., 2001), and this likely true in current days. To make things worse, SEMOC cut its 279 retail depots in central Mozambique and 57 depots in north Mozambique by more than half during years 2001/02 (Massingue at al., 2004).

Transportation costs are also very high in Mozambique. For example, the cost of shipping a container from Nacala to Maputo (\$2,500) is the same as the cost of shipping a container from Dubai to Maputo, and is about three times the cost of shipping a container from Maputo to Dar-es-Salam, Tanzania (\$845) (Coughlin, 2006, citing Global Development Solutions). So it is no wonder that retail prices for the same varieties of maize, sorghum, cowpea and sugar beans tend to be 18 to 48 percent higher in Mozambique than in Zimbabwe (Rohrbach et al., 2001).

High transportation costs also mean high costs for other essential services such as banking and financial services. Arndt, Schiller, and Tarp (2001) found that interest rates in rural areas of Mozambique are higher than in urban areas. Reducing transportation

costs would reduce production and marketing costs in Mozambique, but it is somewhat surprising that Mozambique has not used barge transportation along its 2,500 km long coast.

Transportation costs also limit the market where smallholders' outputs could be sold at a profit, which induces smallholders to keep engaging in subsistence agriculture.

Why should producers increase agricultural production if they cannot sell it?

Emergency seed distribution

Emergency seed is distributed almost every year in Mozambique, and has been the main source of commercial seed over the last 15 years or so, including 75% of all maize seed and 95% of sorghum, pear millet, and groundnut seed distributed to producers in Mozambique (Rohrbach et al., 2001).

From 1987 to 1997 relief seed was distributed freely to 1.2 million producers via PESU, which was a resettlement program following the civil war (Howard et al., 2001). During the last 6 years, emergency inputs worth US\$ 950,000 have been distributed to over 100,000 small producers using the vouchers and fairs approach (Longley et al., 2005).

Although emergency programs have been the main source of seed, a national database on quantities and quality of seed being distributed is not known to exist (Rohrbach et al., 2001). This is a huge information gap since Mozambique is now planning its own green revolution.

A further limitation of emergency seed distribution is that seed companies seem content to sell seed to a handful of large buyers distributing emergency seed rather than investing in retail seed markets that would supply seed to smallholder producers. As a

result, smallholders' seed needs and preferences are not usually passed to the commercial seed sector (Longley et al. 2005). But, without a strong demand from smallholders, the commercial seed sector will likely remain undeveloped.

An additional limitation is lack of policy clarity, which leads to diversion of scarce resources. Input vouchers take place twice every year, yet nobody in Mozambique seems to know what the objective of input voucher and fairs is (Longley et al. 2005).

3. Theory

Every growing season, agricultural producers in Mozambique must decide what source of seed to use in growing maize. They might purchase seed in the market or use a portion of their own maize production as "seed." Adoption of commercial seed technologies may inevitably lead to costly changes in the mix of other productive inputs such as land and labor, thus making any investment in seed technologies more costly and riskier than is often perceived. Facing nontrivial costs and risks, maize producers must choose between buying or not buying seed in a manner that maximizes their utility given both market and non-market factors.

The choice of source of seed is discrete, and the value assigned to each alternative choice can be assumed as randomly distributed. Then, smallholders' probability of purchasing seed can be modeled using a random utility framework. Unobserved transactions costs (due to asymmetric information, poor roads, and other market failures) are perceived by smallholders and enter their decision of which source of seed to use.

Let y_{ij}^* value attained by smallholder i using seed from source j . Then, only if $y_{ij}^* > y_{ik}^*$ for $j \neq k$ will producers chose to use seed from source j . Because smallholder's actual utility y_{ij}^* is unobserved, the best we can do is to estimate the producer's probability of buying maize seed by relating y_{ij}^* with the producer's socio-economic characteristics and the market environment.

Following Green (2000), y_{ij}^* can be represented as:

$$(1) \quad y_{ij}^* = \mathbf{X}_{ij}\beta_j + \varepsilon_{ij}, \quad y_{ij} = 1[y_{ij}^* \geq 0],$$

where \mathbf{X}_{ij} is a vector of smallholders characteristics, β_j is a vector of parameters to be estimated and ε_{ij} is a random error term, and y_{ij} is the observed choice of seed source by smallholder i . The indicator function $1[y_{ij}^* \geq 0]$, relating smallholder's unobserved benefit (y_{ij}^*) to the actual choice of source of seed (y_{ij}), takes the value of one if the argument in brackets is true and zero otherwise.

The response probability can be written as (Woodridge, 2006):

$$(2) \quad P(y_{ij} = 1 | \mathbf{X}_{ij}) = P(y_{ij}^* > 0 | \mathbf{X}_{ij}) = P(\varepsilon_{ij} > -\mathbf{X}_{ij}\beta_j | \mathbf{X}_{ij}) = 1 - P(\varepsilon_{ij} \leq -\mathbf{X}_{ij}\beta_j | \mathbf{X}_{ij}) \\ = 1 - H(-\mathbf{X}_{ij}\beta_j) = H(\mathbf{X}_{ij}\beta_j).$$

Here, H is a cumulative distribution function (CDF) of a continuous random variable that has a symmetric distribution around zero. In most applications, H is assumed to follow either a logistic distribution or a standard normal distribution.

4. Data

Data are from the 2003² Trabalho de Inquérito Agrícola (TIA). TIA is an annual agricultural survey carried out by Mozambique's Ministry of Agriculture. In addition to containing smallholder's socio-demographic information, the data include some information about the source of seed used by smallholders in Mozambique.

Descriptive statistics by province, reported in Tables 1a to 1j, suggest that smallholders in the south (Maputo, Gaza, and Inhambane) tend to be older than those in central (Tete, Manica, Sofala, and Zambezia) and north (Nampula, Cabo Delgado, Niassa) Mozambique. Older producers tend to be relatively more risk averse and experience relatively high learning costs. The average number of adults also seem to decrease from south to north Mozambique, suggesting differences in labor constraints across provinces in Mozambique.

Smallholder participation in the maize output market also varies across Mozambique. The percentage of the smallholders who sell maize tends to decrease from central Mozambique (18 % - 44 %) to south (3 % - 4 %) Mozambique. This pattern is consistent with the south being a maize deficit region.

The percentage of smallholders receiving emergency seed also decreases from south (7 % - 24%) to north Mozambique (0 % - 4 %). South Mozambique is more vulnerable to droughts and floods, which may explain why more smallholders receive maize seed in the south relative to central and north Mozambique.

Descriptive statistics suggest that the percentage of producers buying seed from the market also differs across space. About 50 % of producers in south Mozambique buy

² To date there is no official release of the TIA data. Another important limitation is that variable labels in the TIA data are not consistent across years, which make it difficult to compare information across years or construct a panel.

their seed maize, compared to less than 20 % in north Mozambique and a little over 25 % in central Mozambique. Thus, while descriptive statistics suggest that smallholders' market participation in output markets is bigger in central and north relative to south Mozambique, participation in input markets is bigger in south relative to north and central Mozambique.

5. Procedures

Equation (3) is used to estimate smallholders' probability of buying maize seed. Assuming that the data generation process follows an extreme value distribution, smallholders' probability of buying seed ($Y = 1$) can be estimated with a simple binary logit model³ (Greene, 2000), as:

$$(3) \quad \text{Prob}(Y = 1) = \frac{\exp(\beta'_{ji} X_i)}{1 + \sum_{j=1}^J \exp(\beta'_{ji} X_i)}$$

Marginal effects are often used to assess the impact of exogenous variables on explanatory variables because logit models are nonlinear in parameters. For a binary logit model, the marginal effect δ_i of a change in a continuous explanatory variable (x_i) on the probability of buying maize seed is (Green, 2000)⁴:

$$(4) \quad \delta_i = \frac{\partial P_j}{\partial x_i} = P_j (1 - P_j) \beta_{ji},$$

where P_j is the probability of buying seed. Notice that δ_i need not have to have the same sign as the β 's (Greene, 2000).

³ **The multinomial logit model is appealing because our data consist of individual households' attributes and choices of maize seed sources.**

⁴ Marginal effects for indicator variables is given by $P(Y = 1 | \mathbf{X}_{ij}) - P(Y = 0 | \mathbf{X}_{ij})$

5. Results

Table 2 reports predicted probabilities estimated with equation (3) and the marginal effects of explanatory variables included in the model. Consistent with descriptive statistics, regression results show that most smallholders in the south (Inhambane, Gaza, and Maputo) are expected to buy seed. The probability of smallholders buying maize seed is 0.57-0.58 in south Mozambique, 0.19-0.38 in central Mozambique (Zambézia, Tete, Manica, and Sofala), and 0.12-0.22 in north Mozambique (Niassa, Cabo Delgado, Nampula). Clearly, demand for marketed seed in Mozambique remains low, especially in central and north provinces. These results may explain why SEMOC has closed more than half of its 279 seed depots in central Mozambique and 57 depots in north Mozambique.

Tables 3a to 3j show the marginal effects of key independent variables on smallholders' probability of purchasing maize from a given market outlet. The estimate of the coefficient of the variable indicating whether or not smallholders have received emergency seed is of particular interest in testing the intriguing possibility that emergency seed distribution leads to low investment in seed markets by decreasing demand for seed. Table Tables 3a to 3j show that emergency seed distribution is associated with a 3%-22% decrease in producers' probability of buying seed. Strikingly, the strong negative association between emergency seed and the chance of buying maize is consistent across all ten provinces and increases as we move from north to south Mozambique.⁵ Results suggest that emergency seed programs may be reducing demand for commercial seed, which precludes development of seed markets in Mozambique. In

⁵ This is true except in Niassa and Cabo Delgado in the very north of Mozambique. There was no emergency seed distributed in Niassa, and the marginal effects associated with seed was positive in Cabo Delgado.

what follows, we only discuss the marginal effects of the remaining explanatory variables that show a clear pattern across the ten provinces of Mozambique.

Participation in maize output markets

Agricultural surplus is often associated with use of improved technologies including marketed seed, so we would expect producers who sell maize to be more likely to buy seed. But results suggest quite the opposite: those who produce surplus maize are less likely to buy maize seed, except in Maputo, Niassa and Gaza. Longley et al. (2005, p.3) note that "...until the formal seed sector is better able to provide high quality seed for a range of varieties that are well adapted to locally specific conditions, farmers are likely to continue to be disappointed by formal sector seed." Put differently, the commercial seed sector is not likely selling seed that producers want. Producers who have surplus of grain may prefer to save some seed and use it as grain rather than buying from the commercial sector.

Source of income

Producers who have a paid job are more likely to buy maize seed in Mozambique generally but not in Maputo. This result could mean that maize producers are willing to finance agricultural production using off farm income and highlight the importance of credit markets in agricultural development.

Labor availability in the household

Household labor availability was proxied by the number of adults. Results show that labor availability is associated with a greater chance of purchasing maize seed, except in three provinces (Tete, Nampula, and Cabo Delgado). Overall, the results are

consistent with the view that commercial seed varieties are relatively more labor demanding than local varieties. Also the results suggest that agricultural households rely primarily on family labor.

Participation in other input markets

An indicator variable indicating whether smallholders purchased fertilizer or pesticides or both is used to proxy access to input markets⁶. Surprisingly, results show that smallholders who purchase other agricultural inputs markets are less likely to buy maize seed. This might suggest that smallholders face severe budget constraints, so that buying fertilizer or pesticides or both would leave less money to buy other inputs such as maize seed. If credit markets worked reasonably, this problem could be mitigated.

Age of the household head

Age of the household head was found to be associated with low probability of buying seed maize in all provinces except Maputo, Gaza and Cabo Delgado. These results suggest that as producers age they become more risk averse and thus, tend to stick to their own traditional practices. Older producer may face relatively high learning costs, which reduce incentives invest in new maize varieties.

6. Conclusions and Policy Implications

Recently, some researchers have questioned the effectiveness of input vouchers to deliver emergency seed (see for example Lonely, 2005). This study determined smallholders' probability of buying maize seed in Mozambique, and the effect of seed emergency programs on smallholders' likelihood to purchase maize. Overall the results

⁶ Most previous studies used distance to market to proxy access to market. However the TIA survey lacks data on distance to the nearest market or road.

show that smallholders' probability of buying maize seed in Mozambique is small, and it is generally bigger in the south relative to central and north Mozambique. Results also showed that smallholders who receive emergency seed are less likely to buy marketed seed. Thus, emergency seed programs are likely preventing development of Mozambique's commercial maize seed markets. Location also seems to matter since some variables did not have the same sign and size across provinces.

These results suggest some policy options to spur development of seed markets in Mozambique. First, First, it is necessary to clearly define what "emergency" is and the objective of seed emergency programs. The voucher and fairs approach does have the potential to accomplish both seed market development and seed aid objectives but this requires a clear definition of what emergency "emergency" is, the objective of emergency intervention, and a clear definition of the target population. Otherwise emergency programs may prevent development of commercial seed markets by keeping demand for marketed inputs low.

Second, production of maize surplus and subsequent participation in maize output markets do not seem related to the use of commercial seed. This raises questions about the quality of the seed sold by the commercial sector and the quality of enforcement by the responsible agency, the *Serviço Nacional de Sementes*. If the promised quality is not attained, then demand for commercial seed is likely to remain low. As Longley et al. (2005, p.3) put it "...until the formal seed sector is better able to provide high quality seed for a range of varieties that are well adapted to locally specific conditions, farmers are likely to continue to be disappointed by formal sector seeds. Therefore, it might be necessary to review the certification process and enforce the quality standards.

Third, participation in seed markets is related to producers' characteristics, and access to access markets of complementary inputs. Successful strategies to develop the commercial seed market may have to target younger producers, and create incentives for private investment in market development. Long term measures include continued public investment on roads, and simplification and enforcements of quality standards to spur develop of both input and output markets. But in the short run, incentives such as income tax breaks and/or gasoline allowances could be considered for agricultural companies, small business or agricultural producers working in rural areas where transportation costs are high.

Lastly, the results showed that geography matters. For example, it was found that age is important in the decision to buy seed maize, and younger producers are concentrated in central in north Mozambique. If policy it is to support regional comparative advantages and specialization then it must carefully consider spatial constraints that define regions' absolute advantages. The usual "one size fits all" policy approach might not work in Mozambique.

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Table 1a. Descriptive statistics for Maputo province

Variables	Data used in the estimation (N= 1218)		
	Mean	Standard deviation	Frequency
Age of household head	50.92	14.64	
Square of age household head	2806.92	1558.24	
Number of adults	4.25	2.61	
Head of household reads and writes			55.86%
Active member of an association			17.59%
Sold maize			3.45%
Received credit services			2.41%
Received emergency relief seed			19.31%
Used other market inputs			7.24%
Received extension services			15.52%
Worked for money			56.55%
other income sources (Ganho–Ganho)			38.28%
Did not buy maize seed			58.62%
Bought maize seed			41.38%

Table 1b. Descriptive statistics for Gaza province

Variables	Data used in the estimation (N= 1218)		
	Mean	Standard deviation	Frequency
Age of household head	51.72	15.15	
Square of age household head	2904.52	1653.35	
Number of adults	5.04	3.13	
Head of household reads and writes			43.01%
Active member of an association			10.02%
Sold maize			4.15%
Received credit services			2.42%
Received emergency relief seed			24.01%
Used other market inputs			6.39%
Received extension services			20.90%
Worked for money			53.89%
other income sources (Ganho–Ganho)			23.14%
Did not buy maize seed			56.13%
Bought maize seed			43.87%

Table 1c. Descriptive statistics for Inhambane province

Variables	Data used in the estimation (N= 1218)		
	Mean	Standard deviation	Frequency
Age of household head	50.69	14.92	
Square of age household head	2791.76	1559.48	
Number of adults	4.14	2.79	
Head of household reads and writes			41.83%
Active member of an association			6.02%
Sold maize			2.87%
Received credit services			0.86%
Received emergency relief seed			7.74%
Used other market inputs			5.73%
Received extension services			15.47%
Worked for money			35.82%
other income sources (Ganho–Ganho)			20.34%
Did not buy maize seed			49.00%
Bought maize seed			51.00%

Table 1d. Descriptive statistics for Sofala province

Variables	Data used in the estimation (N= 1218)		
	Mean	Standard deviation	Frequency
Age of household head	43.83	14.89	
Square of age household head	2142.50	1457.41	
Number of adults	3.96	2.69	
Head of household reads and writes			40.44%
Active member of an association			3.43%
Sold maize			23.28%
Hired labor			33.82%
Received credit services			6.86%
Received emergency relief seed			13.73%
Used other market inputs			15.44%
Received extension services			25.00%
Worked for money			51.47%
other income sources (Ganho–Ganho)			35.54%
Did not buy maize seed			33.58%
Bought maize seed			66.42%

Table 1e. Descriptive statistics for Manica province

Variables	Data used in the estimation (N= 1218)		
	Mean	Standard deviation	Frequency
Age of household head	43.97	14.14	
Square of age household head	2132.89	1377.24	
Number of adults	3.80	2.18	
Head of household reads and writes			47.08%
Active member of an association			3.50%
Sold maize			23.93%
Received credit services			2.72%
Received emergency relief seed			9.14%
Used other market inputs			4.28%
Received extension services			13.04%
Worked for money			31.71%
other income sources (Ganho–Ganho)			21.01%
Did not buy maize seed			26.46%
Bought maize seed			73.54%

Table 1f. Descriptive statistics for Tete province

Variables	Data used in the estimation (N= 1218)		
	Mean	Standard deviation	Frequency
Age of household head	45.88	16.00	
Square of age household head	2360.30	1610.76	
Number of adults	3.46	1.89	
Head of household reads and writes			42.00%
Active member of an association			6.30%
Sold maize			18.26%
Hired labor			40.87%
Received credit services			12.60%
Received emergency relief seed			7.59%
Used other market inputs			18.58%
Received extension services			15.51%
Worked for money			39.26%
other income sources (Ganho–Ganho)			22.29%
Did not buy maize seed			34.89%
Bought maize seed			65.11%

Table 1g. Descriptive statistics for Zambezia province

Variables	Data used in the estimation (N= 1218)		
	Mean	Standard deviation	Frequency
Age of household head	41.10	13.49	
Square of age household head	1870.55	1230.05	
Number of adults	2.87	1.34	
Head of household reads and writes			41.71%
Active member of an association			2.67%
Sold maize			44.00%
Hired labor			16.76%
Received credit services			1.14%
Received emergency relief seed			3.05%
Used other market inputs			2.48%
Received extension services			8.95%
Worked for money			18.86%
other income sources (Ganho–Ganho)			29.14%
Did not buy maize seed			16.38%
Bought maize seed			83.62%

Table 1h. Descriptive statistics for Nampula province

Variables	Data used in the estimation (N= 1218)		
	Mean	Standard deviation	Frequency
Age of household head	41.61	13.45	
Square of age household head	1912.17	1239.58	
Number of adults	2.77	1.21	
Head of household reads and writes			46.72%
Active member of an association			8.08%
Sold maize			26.26%
Hired labor			12.12%
Received credit services			4.04%
Received emergency relief seed			4.80%
Used other market inputs			15.66%
Received extension services			18.18%
Worked for money			21.46%
Worked for money			16.41%
other income sources (Ganho–Ganho)			21.72%
Bought maize seed			78.28%

Table 1i. Descriptive statistics for Cabo Delgado province

Variables	Data used in the estimation (N= 1218)		
	Mean	Standard deviation	Frequency
Age of household head	41.29	14.60	
Square of age household head	1917.79	1356.48	
Number of adults	2.85	1.40	
Head of household reads and writes			40.50%
Active member of an association			2.75%
Sold maize			20.94%
Hired labor			16.53%
Received credit services			1.10%
Received emergency relief seed			1.65%
Used other market inputs			7.44%
Received extension services			19.01%
Worked for money			8.54%
Worked for money			33.06%
other income sources (Ganho–Ganho)			18.73%
Bought maize seed			81.27%

Table 1j. Descriptive statistics for Niassa province

Variables	Data used in the estimation (N= 1218)		
	Mean	Standard deviation	Frequency
Age of household head	39.51	13.23	
Square of age household head	1735.62	1149.83	
Household size	5.24	2.33	
Number of adults	3.01	1.57	
Head of household reads and writes			38.93%
Active member of an association			0.38%
Sold maize			29.01%
Hired labor			24.05%
Received credit services			6.87%
Received emergency relief seed			0.00%
Used other market inputs			11.83%
Received extension services			8.78%
Worked for money			24.43%
other income sources (Ganho–Ganho)			25.57%
Did not buy maize seed			13.36%
Bought maize seed			86.64%

Table 2. Predicted probabilities of buying maize seed by province

Province	Probabilty of buying seed	Probability of not buying seed
Niassa	0.124	0.876
Cabo Delgado	0.209	0.791
Nampula	0.216	0.784
Zambezia	0.190	0.810
Tete	0.380	0.620
Manica	0.235	0.765
Sofala	0.382	0.618
Inhambane	0.568	0.432
Gaza	0.583	0.417
Maputo	0.578	0.422

Table 3a. Logit parameter estimates and marginal effects for Maputo province

Variables	Parameter estimate	Std. error	p-Value	Marg. Effect
Intercept	-0.668	0.086	<.0001	
Age	0.079	0.003	<.0001	0.001
Square of Age	-0.001	0.000	<.0001	
Total adult	-0.075	0.004	<.0001	-0.016
Reads and writes	0.053	0.017	0.003	0.011
Association Member	-0.138	0.023	<.0001	-0.030
Sold maize	-0.436	0.050	<.0001	-0.095
Received credit	1.776	0.065	<.0001	0.387
Received emergency seed	-1.029	0.022	<.0001	-0.224
Used other marketed inputs	1.140	0.045	<.0001	0.248
Received extension service	-0.930	0.024	<.0001	-0.202
Worked for money	-0.115	0.018	<.0001	-0.025
other income sources (<i>Ganho–Ganho</i>)	-0.047	0.017	0.006	-0.010
<i>Fit statistics</i>				
<i>Adjusted Estrela Pseudo R²</i>	0.98			
<i>Veall Zimermann Pseudo R²</i>	0.81			
<i>Percent of correct predictions</i>	66.2			

Table 3b. Logit parameter estimates and marginal effects for Gaza province

Variables	Parameter estimate	Std. error	<i>p</i> -Value	Marg. Effect
Intercept	-1.252	0.048	<.0001	
Age	0.057	0.002	<.0001	0.000
Square of Age	-0.001	0.000	<.0001	0.016
Total adult	0.072	0.002	<.0001	
Reads and writes	0.390	0.010	<.0001	0.085
Association Member	-1.558	0.018	<.0001	-0.338
Sold maize	0.236	0.028	<.0001	0.051
Received credit	0.900	0.031	<.0001	0.196
Received emergency seed	-0.146	0.013	<.0001	-0.032
Used other marketed inputs	-0.032	0.031	0.304	-0.007
Received extension service	0.356	0.014	<.0001	0.077
Worked for money	0.354	0.010	<.0001	0.077
other income sources (Ganho–Ganho)	0.091	0.011	<.0001	0.020
<i>Fit statistics</i>				
<i>Adjusted Estrela Pseudo R²</i>	1.00			
<i>Veall Zimermann Pseudo R²</i>	0.91			
<i>Percent of correct predictions</i>	58.8			

Table 3c. Logit parameter estimates and marginal effects for Inhambane province

Variables	Parameter estimate	Std. error	p-Value	Marg. Effect
Intercept	2.396	0.056	<.0001	
Age	-0.083	0.002	<.0001	-0.009
Square of Age	0.001	0.000	<.0001	
Total adult	0.262	0.003	<.0001	0.055
Reads and writes	-0.262	0.011	<.0001	-0.055
Association Member	-0.369	0.038	<.0001	-0.078
Sold maize	-0.514	0.041	<.0001	-0.109
Received credit	0.528	0.080	<.0001	0.111
Received emergency seed	-0.998	0.025	<.0001	-0.211
Used other marketed inputs	-0.984	0.033	<.0001	-0.208
Received extension service	0.841	0.017	<.0001	0.178
Worked for money	-0.313	0.011	<.0001	-0.066
other income sources (Ganho–Ganho)	-0.215	0.012	<.0001	-0.045
<i>Fit statistics</i>				
<i>Adjusted Estrela Pseudo R²</i>	1.00			
<i>Veall Zimermann Pseudo R²</i>	0.93			
<i>Percent of correct predictions</i>	64.5			

Table 3d. Logit parameter estimates and marginal effects for Sofala province

Variables	Parameter estimate	Std. error	<i>p</i> -Value	Marg. Effect
Intercept	1.433	0.048	<.0001	
Age	-0.083	0.002	<.0001	-0.003
Square of Age	0.001	0.000	<.0001	
Total adult	-0.091	0.003	<.0001	-0.019
Reads and writes	0.567	0.012	<.0001	0.115
Association Member	0.421	0.030	<.0001	0.086
Sold maize	-0.244	0.015	<.0001	-0.050
Received credit	-2.198	0.065	<.0001	-0.447
Received emergency seed	-0.946	0.017	<.0001	-0.192
Used other marketed inputs	-0.259	0.025	<.0001	-0.053
Received extension service	0.310	0.013	<.0001	0.063
Had a paid job	0.369	0.011	<.0001	0.075
Barter work (<i>Ganho-ganho</i>)	-0.114	0.012	<.0001	-0.023
<i>Fit statistics</i>				
<i>Adjusted Estrela Pseudo R²</i>	1.00			
<i>Veall Zimermann Pseudo R²</i>	0.90			
<i>Percent of correct predictions</i>	70.3			

Table 3e. Logit parameter estimates and marginal effects for Manica province

Variables	Parameter estimate	Std. error	p-Value	Marg. Effect
Intercept	-1.900	0.048	<.0001	
Age	0.029	0.002	<.0001	-0.000
Square of Age	0.000	0.000	<.0001	
Total adult	0.023	0.003	<.0001	0.004
Reads and writes	0.565	0.012	<.0001	0.098
Association Member	-2.226	0.056	<.0001	-0.385
Sold maize	-1.349	0.014	<.0001	-0.234
Received credit	1.608	0.046	<.0001	0.278
Received emergency seed	-0.297	0.028	<.0001	-0.051
Used other marketed inputs	-0.448	0.037	<.0001	-0.077
Received extension service	0.837	0.018	<.0001	0.145
Worked for money	0.292	0.011	<.0001	0.051
other income sources (Ganho–Ganho)	0.130	0.014	<.0001	0.022
<i>Fit statistics</i>				
<i>Adjusted Estrela Pseudo R²</i>	1.00			
<i>Veall Zimermann Pseudo R²</i>	0.93			
<i>Percent of correct predictions</i>	64.9			

Table 3f. Logit parameter estimates and marginal effects for Tete province

Variables	Parameter estimate	Std. error	p-Value	Marg. Effect
Intercept	-1.263	0.035	<.0001	
Age	0.052	0.002	<.0001	-0.001
Square of Age	-0.001	0.000	<.0001	
Total adult	-0.020	0.003	<.0001	-0.004
Reads and writes	-0.033	0.009	0.000	-0.007
Association Member	0.049	0.017	0.004	0.011
Sold maize	-0.624	0.014	<.0001	-0.135
Received credit	-0.381	0.017	<.0001	-0.082
Received emergency seed	-0.384	0.017	<.0001	-0.083
Used other marketed inputs	0.091	0.014	<.0001	0.020
Received extension service	-0.334	0.012	<.0001	-0.072
Worked for money	0.009	0.009	0.305	0.002
other income sources (Ganho–Ganho)	0.821	0.010	<.0001	0.177
<i>Fit statistics</i>				
<i>Adjusted Estrela Pseudo R²</i>	1.00			
<i>Veall Zimermann Pseudo R²</i>	0.90			
<i>Percent of correct predictions</i>	62.8			

Table 3g. Logit parameter estimates and marginal effects for Zambezia province

Variables	Parameter estimate	Std. error	p-Value	Marg. Effect
Intercept	-2.136	0.038	<.0001	
Age	0.046	0.002	<.0001	-0.002
Square of Age	-0.001	0.000	<.0001	
Total adult	0.050	0.003	<.0001	0.007
Reads and writes	-0.651	0.008	<.0001	-0.088
Association Member	1.213	0.019	<.0001	0.165
Sold maize	-0.635	0.008	<.0001	-0.086
Received credit	1.416	0.030	<.0001	0.193
Received emergency seed	-0.927	0.028	<.0001	-0.126
Used other marketed inputs	-0.762	0.032	<.0001	-0.104
Received extension service	-0.189	0.014	<.0001	-0.026
Worked for money	0.661	0.008	<.0001	0.090
other income sources (Ganho–Ganho)	0.768	0.008	<.0001	0.104
<i>Fit statistics</i>				
<i>Adjusted Estrela Pseudo R²</i>	1.00			
<i>Veall Zimermann Pseudo R²</i>	0.96			
<i>Percent of correct predictions</i>	72.5			

Table 3h. Logit parameter estimates and marginal effects for Nampula province

Variables	Parameter estimate	Std. error	p-Value	Marg. Effect
Intercept	-1.780	0.037	<.0001	
Age	-0.017	0.002	<.0001	-0.003
Square of Age	0.000	0.000	0.001	
Total adult	0.347	0.003	<.0001	0.053
Reads and writes	0.423	0.008	<.0001	0.065
Association Member	-0.081	0.015	<.0001	-0.012
Sold maize	-0.210	0.009	<.0001	-0.032
Received credit	0.385	0.022	<.0001	0.059
Received emergency seed	-0.285	0.018	<.0001	-0.044
Used other marketed inputs	0.054	0.012	<.0001	0.008
Received extension service	-0.592	0.011	<.0001	-0.091
Worked for money	0.914	0.009	<.0001	0.140
other income sources (Ganho–Ganho)	-0.098	0.011	<.0001	-0.015
<i>Fit statistics</i>				
<i>Adjusted Estrela Pseudo R²</i>	1.00			
<i>Veall Zimermann Pseudo R²</i>	0.96			
<i>Percent of correct predictions</i>	67.4			

Table 3i. Logit parameter estimates and marginal effects for Cabo Delgado province

Variables	Parameter estimate	Std. error	p-Value	Marg. Effect
Intercept	-4.285	0.051	<.0001	
Age	0.108	0.002	<.0001	0.002
Square of Age	-0.001	0.000	<.0001	
Total adult	-0.031	0.004	<.0001	-0.004
Reads and writes	0.439	0.010	<.0001	0.064
Association Member	-0.323	0.033	<.0001	-0.047
Sold maize	-0.061	0.013	<.0001	-0.009
Received credit	-13.164	40.572	0.746	-1.927
Received emergency seed	0.377	0.030	<.0001	0.055
Used other marketed inputs	-0.910	0.028	<.0001	-0.133
Received extension service	-0.086	0.013	<.0001	-0.013
Worked for money	1.065	0.015	<.0001	0.156
other income sources (Ganho–Ganho)	1.041	0.010	<.0001	0.152
<i>Fit statistics</i>				
<i>Adjusted Estrela Pseudo R²</i>	1.00			
<i>Veall Zimermann Pseudo R²</i>	0.93			
<i>Percent of correct predictions</i>	66.3			

Table 3j. Logit parameter estimates and marginal effects for Niassa province

Variables	Parameter estimate	Std. error	<i>p</i> -Value	Marg. Effect
Intercept	-1.923	0.068	<.0001	
Age	0.000	0.004	0.975	-0.001
Square of Age	0.000	0.000	0.000	
Total adult	0.075	0.005	<.0001	0.008
Reads and writes	-0.251	0.016	<.0001	-0.027
Association Member	13.757	57.881	0.812	1.460
Sold maize	0.029	0.017	0.084	0.003
Received credit	-0.093	0.039	0.017	-0.010
Received emergency seed	-			-
Used other marketed inputs	-0.153	0.032	<.0001	-0.016
Received extension service	-0.286	0.029	<.0001	-0.030
Worked for money	0.688	0.016	<.0001	0.073
other income sources (Ganho–Ganho)	-0.304	0.018	<.0001	-0.032
<i>Fit statistics</i>				
<i>Adjusted Estrela Pseudo R²</i>	0.77			
<i>Veall Zimermann Pseudo R²</i>	0.61			
<i>Percent of correct predictions</i>	60.0			