Adoption of Drought Tolerant Maize Varieties in Mozambique

CIMMYT MR

International Maize and Wheat Improvement Center

The International Maize and Wheat Improvement Center, known by its Spanish acronym, CIMMYT, is the global leader on publicly funded maize and wheat research and related farming systems. Headquartered near Mexico City, Mexico, CIMMYT works with hundreds of partners throughout the developing world to sustainably increase the productivity of maize and wheat cropping systems, thus improving global food security and reducing poverty. CIMMYT is a member of the CGIAR Consortium and leads the CGIAR Research Programs on MAIZE and WHEAT. The Center receives support from national governments, foundations, development banks and other public and private agencies.

The Drought Tolerant Maize for Africa (DTMA) Project is jointly being implemented by CIMMYT and the International Institute of Tropical Agriculture (IITA). Initial funding for DTMA came from the Bill & Melinda Gates Foundation, the Howard G. Buffett Foundation, the U.S. Agency for International Development, and the U.K. Department for International Development. The 2012–2015 phase is funded by the Bill & Melinda Gates Foundation

The project is part of a broad partnership also involving national agricultural research and extension systems, seed companies, non-governmental organizations (NGOs), community-based organizations (CBOs), and advanced research institutes, together known as the DTMA Initiative. Its activities build on longer-term support by other donors, including the Swiss Agency for Development and Cooperation (SDC), the German Federal Ministry for Economic Cooperation and Development (BMZ), the International Fund for Agricultural Development (IFAD), and the Eiselen Foundation. The project aims to develop and disseminate drought tolerant, high-yielding, locally-adapted maize varieties and to reach 30–40 million people in sub-Saharan Africa with these varieties in 10 years.

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Country Report – DT Maize Adoption Monitoring Survey- Mozambique

Drought Tolerant Maize for Africa (DTMA) Project

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List of Acronyms

BMZ	German Federal Ministry for Economic Cooperation and Development
CBOS	community-based organizations
CIMMYT	International Maize and Wheat Improvement Center
DT	Drought Tolerant
DTMA	Drought Tolerant Maize for Africa
GDP	Gross Domestic Product
IFAD	International Fund for Agricultural Development
IIAM	Agricultural Research Institute of Mozambique
IITA	International Institute of Tropical Agriculture
KG	Kilogram
OPV	Open Pollinated Variety
SDC	Swiss Agency for Development and Cooperation

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1.0 Introduction

The agricultural sector is the main driver for socio-economic development in Mozambique. It employs 80% of the working population and contributes 90% of Gross Domestic Product (GDP). Majority of the farmers are subsistence smallholders who practice their farming under rain-fed conditions with low use of improved technologies and experience low productivity. These smallholder farms account for nearly 90 percent of domestic food supplies. Farmers grow cassava and maize as their main crops, with millet, rice and beans as extra food crops. Mozambique's major cash crops are cashew nuts, cotton, copra, sugar, tea, and cassava.

Maize is the main staple food and is grown throughout the country. The total area used to cultivate maize is about 1.4 million hectares and the yield seldom exceeds 1.0 t/ha. Most households still grow local maize varieties. Uaiene et al (2011) found that 91% of the rural households still grow local maize varieties while 32 percent and 14% grew open-pollinated variety (OPV) and hybrid varieties, respectively. This contributes greatly to low yields. Other constraints affecting maize production in Mozambique includes low soil fertility, frequent droughts, weeds, pests and crop diseases (IFDC, 2011). Drought episodes have intensified in the recent years affecting the already low maize yield levels. This is affecting livelihoods of many rural households. Apart from the effects of climate change causing droughts in Mozambique, the island of Madagascar and the Comoros lie to the east of Mozambique. These act as a natural weather barrier, preventing southern Mozambique from experiencing the full force of tropical storms resulting in many parts of the country receiving low annual rainfall.

In a bid to help smallholder farmers overcome the negative impact of drought in Mozambique and many other countries in sub-Saharan Africa, the Drought Tolerant Maize for Africa (DTMA) project, funded by Bill & Melinda Gates Foundation and jointly implemented by for the International Maize and Wheat Improvement Center (CIMMYT) and International Institute of Tropical Agriculture (IITA) in collaboration with national agricultural research organizations and 13 sub Saharan Africa countries,[1] have developed several Drought Tolerant (DT) maize varieties. [2] These varieties have been released in several countries including Mozambique since 2007. The first step of the variety release made several strides particularly in southern Africa where a number of varieties have been released. In Mozambique, nine improved varieties have been released since 2000.

1 The DTMA program aims at increasing maize yields by at least one ton per hectare under moderate drought and with a 20 to 30% increase over farmers' current yields, benefiting 30-40 million people in 13 African countries of Nigeria, Benin Ghana, Mali, Ethiopia, Uganda, Kenya, Tanzania, Malawi, Zambia, Mozambique, Angola and Zimbabwe

2 A DT maize variety is a maize variety that can produce about 30% of its potential yield roughly (1-3 t/ha) after suffering water stress of 6 weeks before and during flowering and grain-filling (Magorongosho et al 2009).

Table 1: Drought tolerant maize varieties released under DTMA in Mozambique (2007 -13)

No.	Release name	Release year	Hybrid/ OPV	Maturity range	Suitable agro-ecologies	Grain Yield	Additional traits/remarks
1	Hluvukani	2008	Hybrid	Medium	Low- to mid-altitudes	Medium	Semi-flint, downy mildew resist and, MSV resistant
2	Olipa	2008	Hybrid	Medium-late	Stable across different agro-ecologies	High	Semi-dent, downy mildew resistant, MSV resistant
3	ZM309	2013	OPV	Extra early	Dry mid-altitudes	Low-medium	Flinty, MSV resistant
4	ZM523	2011	OPV	Early	Dry mid-altitudes	Medium	MSV resistant
5	Dimba	2011	OPV	Extra-early	Low altitudes	Low-medium	Flint, downy mildew resistant, MSV resistant
6	Gema	2011	OPV	Extra-early	Low altitudes	Low-medium	Orange, flint, downy mildew resistant
7	Molocue	2011	Hybrid	Medium	Mid-altitudes	Medium	MSV resistant
8	Pris 601	2013	Hybrid	Medium	Mid-altitudes	Medium	MSV resistant
9	SP-1	2013	Hybrid	Medium	Mid-altitudes	Medium	MSV resistant

However, the second step of farmers adopting the DT varieties faces a number of challenges. In 2006/07 season Uaiene et al, found that in Mozambique remote location, age of household head extension services and proportion of land were the important factors influencing adoption of improved maize varieties. After seven years of the DTMA work it is imperative to evaluate the progress made in terms of the number of farmers that have adopted the DT maize varieties and assess the constraints they are facing. This report then gives an analysis of farmers' maize production, livestock, technology use, maize varieties grown, awareness and adoption of DT varieties in Mozambique. The report is based on the adoption monitoring survey data collected in Angonia, Manica, Mossurize, Sussundenga, and Tsangano districts in central Mozambique.

2.0 Methods and description of the study area

2.1 Description of study area

The study was conducted in five districts of Manica and Tete provinces in Mozambique. The five districts namely are: Angonia and Tsangano in Tete province, Manica, Mossurize, and Sussundenga in Manica province. Angonia district is located in the northern part of Tete province in the central region of Mozambique covering 3,277 square kilometers with a population of 330,378 inhabitants (Ministerio de Administracao Estatal, MAE, 2005). It is comprised of two administrative posts: Ulongue and Domue. Tsangano district covers 3,828 square kilometers in the northern part of Tete province as well, with an estimated population of 142,025 inhabitants distributed in two administrative posts: Ntengo-wa-Mbalame and Tsangano Sede (Ministerio de Administracao Estatal, MAE, 2005). Sussundenga district is located in the central part of Manica province. It has a population of 9,2622 persons and an area 7,057 square kilometers. It comprises of four administrative posts: Sussundenga-sede, Dombe, Muoha, and Rotanda (Ministerio de Administracao Estatal, MAE, 2005). Manica district is located in Manica province. It has a smaller area and population than Sussundenga (4,594 square kilometers and 199,117 inhabibantas respectively. It is divided into three administrative posts: Machipanda, Messica, and Mavonde (Ministerio de Administracao Estatal, MAE, 2005). Mossurize is located in the sourthern part of Manica province and divided into three administrative posts: Espungabera, Dacata, and Chiurairue. It covers a larger area than Manica (5,038 square kilometers) and has a smaller estimated population size (158,070 inhabitants) compared to Manica district (Ministerio de Administracao Estatal, MAE, 2005). Almost all households in the surveyed districts practice subsistence agriculture with maize as the main crop (Ministerio de Administracao Estatal, MAE, 2005).

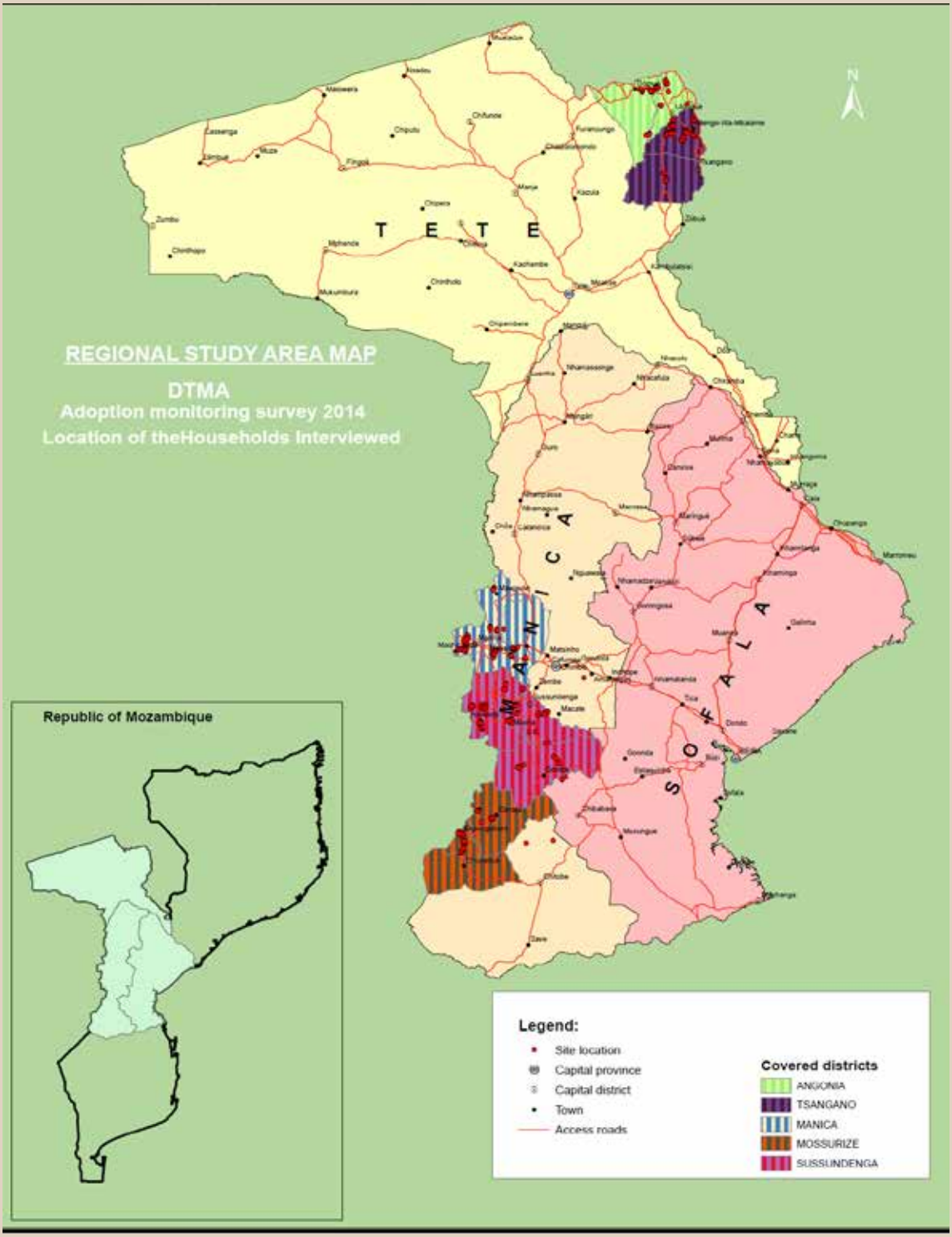

Figure 1: Survey sites

2.2 Sampling and data collection

An adoption monitoring survey was administered to households in Central Mozambique between May and June 2014. The survey was conducted by the Agricultural Research Institute of Mozambique (IIAM) and in collaboration with CIMMYT under the DTMA project.

Five districts were selected using a combination of survey methods i) the DTMA baseline survey was carried in Sussundenga and Mossurize districts. Districts that are part of SIMLESA project (Sussundenga, Manica, and Angónia). The districts under SIMLESA have benefited from DT varieties promoted among farmers.

In Manica, Sussundenga, and Mossurize districts, three administrative posts were selected, and in Angonia and Tsangano two administrative posts. In each administrative post, one to two localidades were randomly selected, from which two villages were randomly selected, and in each village ten or fifteen households were randomly selected and interviewed. Table 2 provides information on the five districts. The total sample comprises of 626 households interviewed in the 48 villages in the five districts. Access to the households and data collection was possible with the assistance of extension agents, village leaders and village guides.

The data was collected using a structured questionnaire, which included both closed and open ended questions. Trained enumerators conducted face-to-face interviews. The survey enabled to collect information on demographic and socio-economic profiles of the households, agriculture and agricultural landholdings, maize varieties grown and awareness, access, and demand for DT varieties.

Table 2: Survey sites

Province	District	Administrative post	Households
Manica	Sussudenga	Sussundenga-sede	37
		Muoha	18
		Rotanda	44
	Mossurize	Espungabera	54
		Dacata	26
		Chiurairue	24
	Manica	Machipanda	40
		Mavonde	20
		Messica	42
Tete	Angonia	Ulongue	57
		Domue	102
	Tsangano	Ntengo-wa-mbalame	130
		Tsangano-sede	32
Total			626

3.0 Household demographic and socioeconomic characteristics

3.1 Demographic statistics

Table 3 provides demographic and socio-economic characteristics for the full sample and by districts. The results indicate that the majority of the surveyed households (86%) are male-headed households, while a small proportion (14%) are female-headed households. Mossurize district have the highest proportion (24%) of female-headed households and Tsangano the lowest proportion (7%). The majority (65%) of the respondents are household heads. The average age of the household heads range from 46 to 50 years. The average age in Tsangano is 46 and in both Manica and Mossurize is 50 years. The average household size is six members per household. Sussundenga district presents a relatively higher household size of seven, while Angonia reported the lowest household size (five). The average number of members involved in agriculture is 3.5. The average number of years of schooling is four. Mossurize have the lowest number of years of schooling education (3.9 years), while Manica has the highest level of schooling (5.3 years) of schooling.

Table 3: Households demographic and socio-economic characteristics

	Total	Angónia	Manica	Mossurize	Sussundenga	Tsangano
N	626	159	102	104	99	162
%Male headed	85.8	83.0	86.3	75.9	91.0	92.6
%female headed	13.9	16.9	13.7	24.0	9.1	7.4
% HH head respondents	65.3	66.0	59.8	63.5	69.7	66.7
Age (years)	47.8	47.9	50.0	46.6	50.0	45.7
HH size	6.2	5.1	7.2	6.2	7.4	5.8
HH members involved in agriculture	3.5	3.1	3.97	3.43	4.2	3.2
Mean schooling years	4.1	3.8	5.3	3.9	4.1	3.9

3.2 Assets owned and input use

3.2.1 Livestock ownership

Table 4 presents the average number of animals owned across districts. The results show that the mean cattle owned by household are 1.9. Manica district had the largest cattle (4) while Mossurize had the lowest number of cattle (1). The average number of goats/ships owned by household is two. Sussundenga district has an average of three goats/ships per household, the highest among the districts. The average number of poultry is 20.

Table 4: Mean livestock numbers

District	Cattle	Sheep and goats	Poultry
Angonia	1.6 (4.5)	1.9 (2.5)	5.8 (7.8)
Manica	3.7 (5.3)	2.3 (3.0)	10.3 (25.8)
Mossurize	0.6 (1.9)	2.9 (4.1)	12.8 (30.2)
Sussundenga	3.2 (4.9)	3.2 (3.3)	14.3 (11.3)
Tsangano	1.2 (2.4)	1.7 (2.5)	8.1 (18.0)
Total	**1.9 (4.1)**	**2.3 (3.1)**	**9.6 (19.7)**

3.2.2 Irrigation and fertilizers use

Figure 2 presents the proportion of households that used fertilizers and irrigation on maize in the 2013/14 growing season. The results indicate that 33% of the surveyed households used fertilizers in maize production. Angonia district presented the highest proportion of households using fertilizers (62%), followed by Tsangano (41%). Mossurize district reported the lowest proportion (2%) of use of fertilizers.

Farmers were also asked about the use of irrigation. Results show that the proportion of households that used irrigation in the 2013/14 growing season is relatively low. In total, only 6.7% of surveyed households reported using irrigation, indicating that most farmers produce maize under rain-fed conditions. Disaggregation across districts show that Sussundenga have the higher proportion of households using irrigation (26%), followed by Manica district with 10% of households using irrigation, while Tsangano have the least proportion (1%) of use of irrigation.

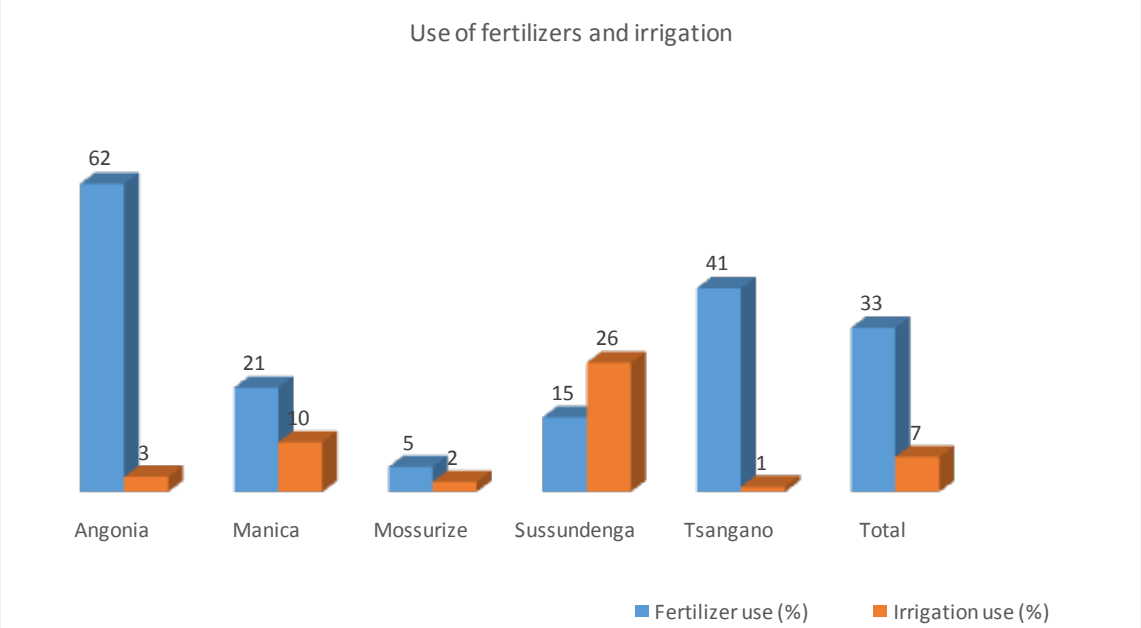

Figure 2: Use of fertilizers and irrigation across districts

3.3 Access to Markets

3.3.1 Mode of transport to market

Figure 3 indicates the mode of transport used by farmers to the market. Results show that the majority (62%) of farmers walk by foot to the market to buy seed, followed by vehicle (20%), and bicycle (17%). Across districts there is a slight variation on the mode of transportation to the market. In Manica district majority (65%) of farmers use bicycle to the market followed by foot (32%), while for both Mossurize and Sussundenga districts, the majority of farmers walk by foot to the market (86% and 78% respectively), followed by vehicle (15% for both).

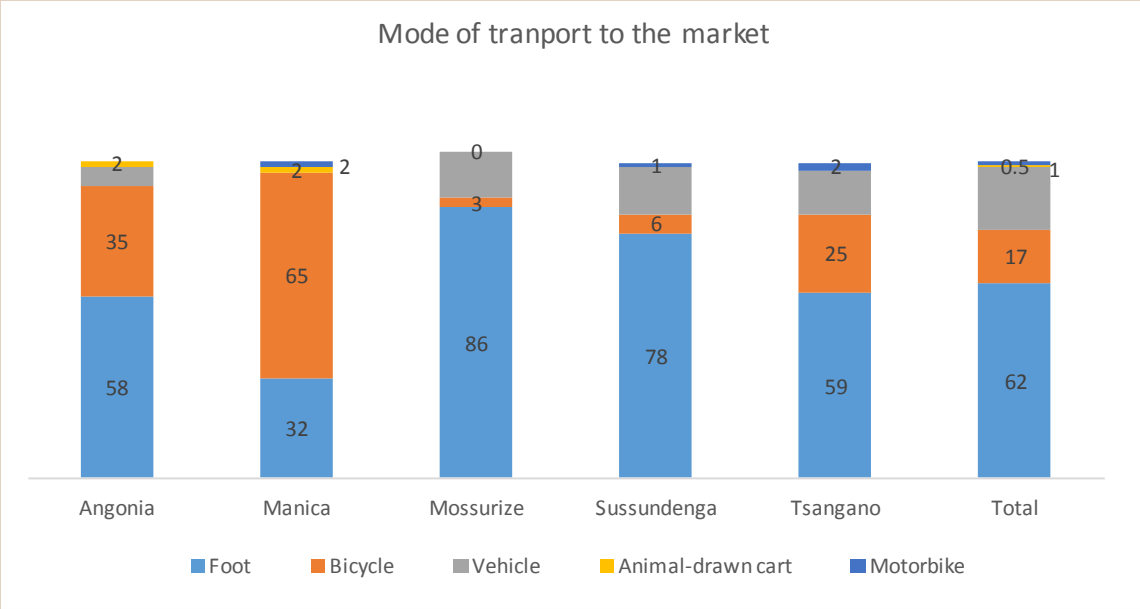

Figure 3: Mode of transport to the market

3.3.2. Walking distance to market to buy seed

On average surveyed households walk in one single trip approximately 60 minutes to the nearest market to buy seed. Across districts, Sussundenga farmers walk more time (80 minutes), while in Mossurize districts farmers walk less (49 minutes) (Table 5)

Table 5: Walking distance to market to buy seed

District	Mean	Std
Angonia	73.1	71.7
Manica	48.7	43.3
Mossurize	45	60
Sussundenga	80.4	68.3
Tsangano	50.9	59.1
Total	**60.1**	**63.5**

3.4 Source of agricultural information

3.4.1 Advice on new maize seed

Results of access to advice on maize seed are presented in figure 4. Sixty two percent the surveyed households reported to have access to advice on new maize seed. In Manica and Sussundenga districts a slightly higher proportion of households have access to advice (76% and 66% respectively).

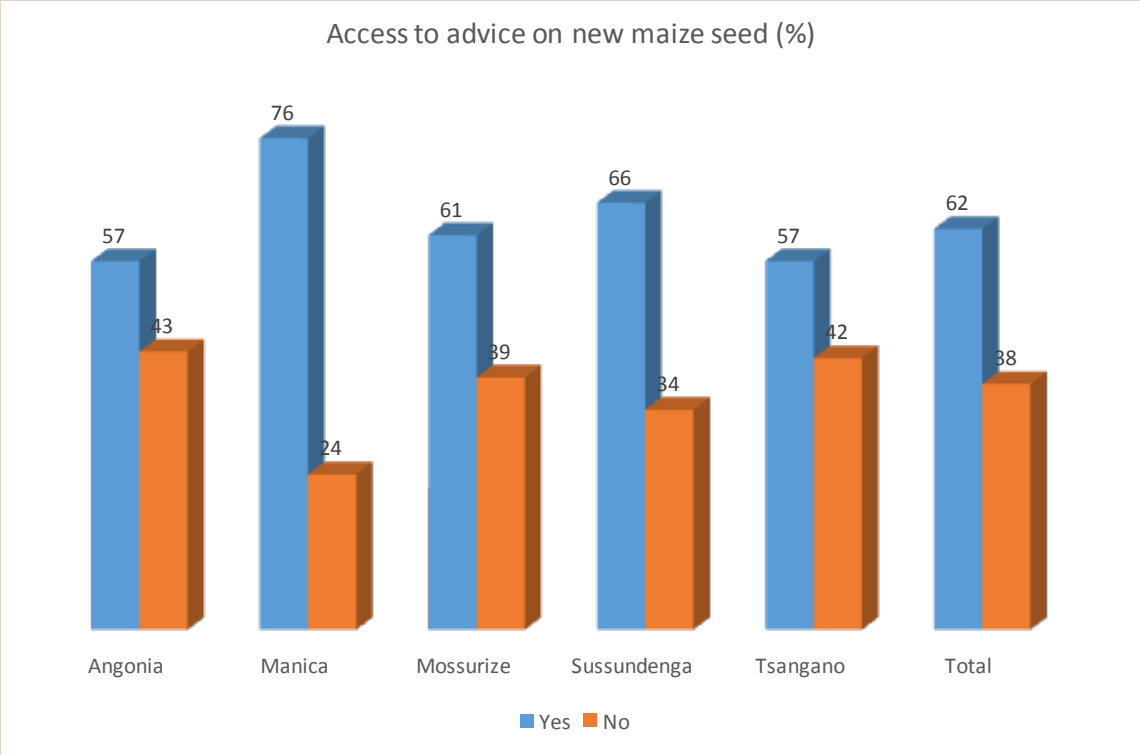

Figure 4: Proportion of households with access to advice on maize seed

3.4.2 Sources of information on maize seed

Table 6 presents the sources of information on new maize across districts. The main sources of information on new maize are other farmers (50%), followed by government extension services (30%), NGOs (8%), electronic media (6%). Across the districts, results show that government extension services were the main sources of information in Manica and Sussundenga districts (47% and 48% respectively), while in Angonia and Tsangano, and Mossurize districts, other farmers (neighbors or friend) were the main sources of information (66%, 52%, and 54% respectively).

Table 6: Sources of information on maize seed

Source	Angonia	Manica	Mossurize	Sussundenga	Tsangano	Total
Govt. agric.ext.svc	10.6	46.8	36.5	48.5	20.4	30.5
Private agric. Ext.svc		1.3	-	2.5	-	0.5
NGO	11.7	9.1	-	4.6	9.7	7.6
Agric. Ext.course	1.1	-	-	-	-	0.25
Agric.coop/farmer's group	7.4	-	-	-	1.1	2.0
Other farmer (neighbor or friend	65.9	28.6	54	45	51.6	49.8
Electronic media	1.1	6.5	6.4	-	12.9	5.6
Input shop	2.13	7.8	3.2	-	4.3	3.56

3.5 Access to credit

The likelihood of households to access credit is presented in table 7. About 38% of the surveyed households reported that it is extremely difficult to access credit, compared to 12% that reported that is extremely likely to access credit.

Table 7: Access to credit (%)

Likelihood access credit	Angonia	Manica	Mossurize	Sussundenga	Tsangano	Total
Extremely likely (100%)	18.9	7.8	3.8	3	14.8	11.8
Quite likely (75%)	13.4	11.8	5.8	10	9.9	10.4
Neither likely or unlikely (50%)	11.6	21.6	11.5	22	16.7	16.1
Quite unlikely (25%)	15.2	25.5	32.7	34	22.8	24.7
Extremely unlikely (0%)	40.8	33.3	46.2	31	35.8	37.7

Disaggregating by gender, results show a slight difference between gender with higher proportion of female-headed households (79%) reporting unlikelihood of accessing credit compared to 60% of male-headed households (Figure 5).

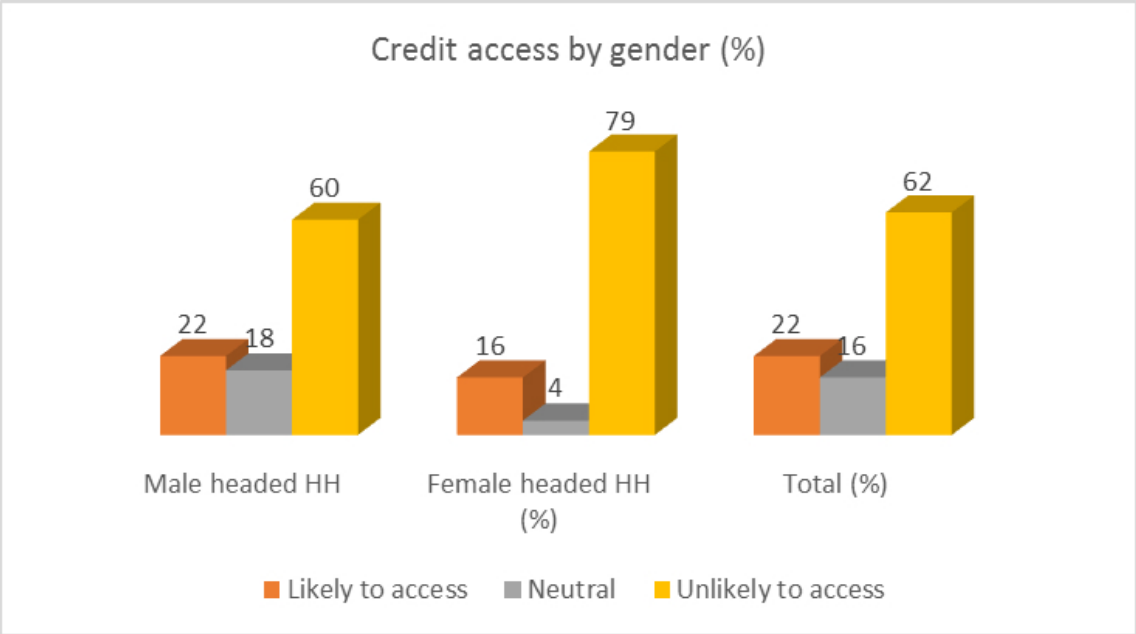

Figure 5: Likelihood to access credit by gender

3.6 Household drought riskiness

Farmers were asked to indicate if they were affected by drought in the last 10 years. Table 8 presents the results across districts indicating that the majority (93%) of households were negatively affected by drought in the last 10 years. Across districts there was no significant variation on the proportion of households affected.

Table 8: Proportion of households affected and not affected by drought in the last 10 years

District	Yes (%)	No (%)
Angonia	90	10
Manica	95	5
Mossurize	97	3
Sussundenga	93	8
Tsangano	91	8
Total	93	7

The average number of years affected by drought in the past 10 years is presented in table 9. On average, households were affected fortwo years by drought in the past 10 years. There was a slight difference across districts, with Mossurize reporting a higher average (2 years) compared to other districts.

Table 9: Years affected by drought in the last 10 years

District	Mean	Std	Min	Max
Angonia	1.74	0.9	0	5
Manica	1.97	1.1	0	6
Mossurize	2.25	1.4	0	7
Sussundenga	1.8	1	0	5
Tsangano	1.7	1	0	5
Total	1.86	1.1	0	7

3.7 Household current income

The majority of surveyed households (53%) reported that their current income only just meet expenses while 16% reported that their income is not sufficient and need to use savings to meet expenses (table 10).

Table 10: Household current income (Proportion)

	Angonia	Manica	Mossurize	Sussundenga	Tsangano	Total
Allows to build savings	15.8	26.5	5.7	15.8	12.9	15.2
Allows to save a little	4.9	15.7	15.4	9.9	11.7	10.9
Only just meets expenses	59.2	45.1	53.8	53.5	52.3	53.4
Is not sufficient, so need to use savings to meet expenses	16.5	10.8	18.3	20.8	14.2	15.9
Is really not sufficient, so need to borrow to meet expenses	3.7	1.9	6.7		8.6	4.58

Current income by gender presented in table 11 shows that a relatively higher proportion (22%) of female-headed households reported that the current income is not sufficient compared to 15% of male-headed households. However, a higher proportion of male-headed households (17%) reported that the current income allows building savings compared to 4% of female-headed households.

Table 11: Household current income by gender

	Male headed HH (%)	Female headed HH (%)	Total (%)
Allows to build savings	16.9	4.4	15.2
Allows to save a little	11.4	7.8	10.9
Only just meets expenses	53.2	54.4	53.4
Is not sufficient, so need to use savings to meet expenses	14.9	22.2	15.9
Is really not sufficient, so need to borrow to meet expenses	3.5	11.1	4.6

4. Maize production and consumption

4.1 Total and maize area and maize production

Table 12 presents the total area of all plots cultivated, area under maize, and maize production by district. An average total area of all plots cultivated by household was about 3.8 hectares and the average area under maize was about 2.7 hectares. Households in Sussundenga district reported a bigger average total area cultivates (4 hectares) and area under maize (2.7 hectares).

The average maize harvested in the 2013/14 growing season was 1350 kg. Analyzing total maize harvested by district, results indicate that farmers in Manica district harvested on average the highest quantity of maize (1932 kg) compared to Mossurize with the lowest maize harvest (886kg).

Table 12: Maize production in the 2013/14 growing season

District	Total plots area (ha)	Area under maize (ha)	Maize harvested (2013/14) (t/ha)
Angonia	3.7 (2.2)	2.6 (1.6)	1.45 (1.34)
Manica	3.4 (2.9)	2.3 (1.6)	1.93 (5.04)
Mossurize	3.2 (1.8)	2.3 (1.4)	0.89 (1.14)
Sussundenga	4.3 (4.1)	2.7 (1.9)	1.78 (2.91)
Tsangano	4.1 (2.6)	3.2 (1.9)	1.62 (1.77)
Total	3.8 (2.8)	2.7 (1.8)	1.35 (2.65)

4.2 Maize self-sufficiency

Households were asked to report if they were self-sufficient in maize from the 2012/13 growing season. Figure 6 presents the results indicating that 63% of all surveyed households were self-sufficient in maize. Analyzing the results by district, Manica district showed a higher proportion (72%) of households self-sufficient in maize compared to Sussundenga with 55% of self-sufficient households.

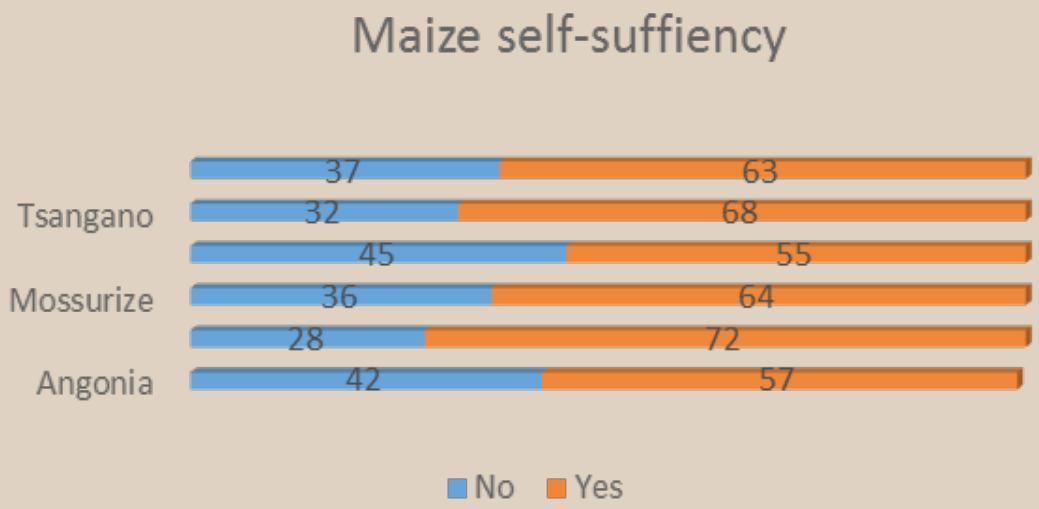

Figure 6: Maize self-sufficiency

On average, the majority of households (20%) ran out of maize for 3 months, followed by 2 months (20%), 4 months (16%), 1 month (12%). Disaggregating by gender, a higher proportion of male-headed households (22%) runned out of maize compared to 14% of female-headed households.

Table 13: Average number of months running out of maize

Nr of months	% HH run out of food	% Male headed HH	% Female headed HH
1	11.6	10.8	16.7
2	20.2	21.7	13.9
3	25.8	26.1	25
4	15.5	13.9	22
5	7.3	7.7	5.4
6	8.6	10.3	0
7	3.0	2.1	8.3
8	3.0	2.6	5.6
9	1.2	1.6	0
10	1.2	1.6	0
11	0.8	0.5	2.8
12	1.29	1.6	0

4.3 Maize varieties grown

Farmers were asked to indicate maize varieties grown in the 2013/14 growing season. Table 14 indicates that the most commonly grown varieties include: *PAN 67* (19%), *Cagolo* (12%), *Matuba* (12%), *Chimanhica* (10%), *Bantamo* (7%), *Chindau* and *PAN53* (6% each).

Table 14: Most commonly grown maize varieties

Variety	Percent
PAN 67	19.3
Cagolo	12.5
Matuba	11.9
Chimanhica	9.9
Bantamo	7.1
Chindau	6.2
PAN 53	6.2
SC513	4.9
Candjere	3.6
Raposta	2.4
Nthua	2.4
DK80	1.8
Chitonga	1.2
Others	11.2

4.4 Type of maize varieties

Analysis of maize types revealed that the majority of households (47%) use local varieties, 35% of surveyed households use hybrid varieties, 17% used OPV varieties and only 1% used recycled maize seed in the 2013/2014 season. Disaggregating by district, results show that Angonia district have a higher proportion of farmers using hybrid varieties (45%) compared to Manica district with 23% of households using hybrid seed. Sussundenga district presents a higher proportion of households using OPV varieties (25%) compared to Angonia with 9%. The results are presented in table 15.

Table 15: Type of maize varieties grown

Variety type	Angonia (%)	Manica (%)	Mossurize (%)	Sussundenga (%)	Tsangano (%)	Total (%)
Local	46.0	54.1	42.1	40.4	50.5	46.9
OPV	9.2	20.2	21.6	25.2	13.9	17.1
Hybrid	44.6	23.5	36.3	33.8	34.5	35.4
Recycled hybrid	-	2.2	-	0.5	1.0	0.7

4.5 Sources of maize seed

Surveyed households obtain maize seed from a variety of sources. The majority of farmers (36%) obtain maize seed from previous season, followed by private trader (20%), relatives (14%), local market (10%), relatives (9%), input shop (6%), and agro-dealers (6%). A small proportion of farmers obtained maize seed from neighbor or friend (5%), NGO (3%), government (2%), and from other countries including Malawi and Zimbabwe (1%). Across the districts, previous season and private trader were the main source of maize seed. In Mossurize district, agro-dealers were relatively a significant source of maize seed (12%) compared to other districts. (Table 16).

Table 16: Sources of maize seed

Source of maize seed	Angonia (%)	Manica (%)	Mossurize (%)	Sussundenga (%)	Tsangano (%)	Total (%)
Previous season	37.9	47.8	35.9	34.6	29.9	36.1
Private trader	28.9	13.8	17.5	17.3	19.1	20.2
Local market	7.9	13.8	4.2	10.3	13.9	10.2
Relatives	9.7	5.7	10.6	8.6	9.9	9.2
Shop	4.5	1.9	10.0	4.9	8.3	6.2
Agro-dealers	2.4	2.5	12.2	5.9	5.6	5.5
Neighbor/friend	1.4	10.1	1.1	8.6	4.9	4.7
NGO	2.1	3.1	1.6	4.9	4.0	3.1
Government	2.1	-	2.6	3.8	3.4	2.5
Seed company	0.7	1.3	1.6	1.1	0.3	0.9
Malawi	2.4	-	-	-	-	0.6
MLT	-	-	-	-	0.3	0.09
Zimbabwe	-	-	3.2	-	-	0.5

Table 17 presents the quantity of maize seed in the 2013/14 growing season. On average, farmers used about 20 kg of maize seed. Looking at the districts, Tsangano used a slightly higher amount of maize seed compared to other districts. This is in line with the average area under maize, which was slightly higher than the other districts.

Table 17: Quantity of maize seed used in 2013/14 (in kgs)

District	Mean (kg)	Std
Angonia	17.3	14.5
Manica	18.2	16.3
Mossurize	16.6	16.5
Sussundenga	21.2	18.9
Tsangano	23.5	17.9
Total	19.5	17.0

4.6 Maize seed recycling

Farmers were asked to report how long they have recycled seed. The results are presented in table 18 showing that on average maize seed was recycled for 11 years. Majority of the farmers were growing local varieties and this may explain the number of years recycling maize seed. Analyzing the results across districts, Sussundenga with 7 years recycled maize seed the least compared to other districts. This is in line with the type of variety grown, with Sussundenga reporting the lowest proportion of use of local varieties compared to other districts. The most common recycled maize types were the local and OPV varieties, however, some farmers reported recycling some hybrid varieties. The varieties commonly recycled were *candjere*, *chimanhica*, *cagolo*, *PAN67*, *raposta, chindau*, and *matuba.* A small proportion of farmers reported recycling other hybrid varieties including SC513 and PAN53.

Table 18: Numbers of years recycling maize seed

	Mean (years)	Std
Angonia	14.4	11.5
Manica	9.6	11.0
Mossurize	12.4	9.5
Sussundenga	7.4	7.3
Tsangano	12.0	9.6
Total	11.3	10.2

5.0 Farmer maize trait preferences

5.1 Maize characteristics and farmers preferences when selecting varieties

Table 19 presents the positive traits for maize varieties grown. The results show that the main positive traits include storage pest resistance, drought tolerance, early maturity, cob size and grain yield. Grain size, disease resistance, poundability, cobs per plant, bread/ porridge quality, and fertilizer requirements were among the positive traits also pointed out by the farmers. The results show that storage pest resistance and poundability were positive traits exhibited by local varieties.

Table 19: Positive traits for maize varieties being grown

Positive trait	**Varieties exhibiting the trait**
Drought tolerance	*PAN67, raposta, SC513, matuba, PAN53*
Storage pest resistance	*Candjere, chimanhica, matuba, chindau, cagolo, bantamo*
Early maturity	*PAN67, PAN53, SC513,matuba, raposta*
Cob size	*PAN67, Candjere, chimanhica, sussuma*
Grain yield	*PAN67, PAN53, SC513, bantamo, cagolo*
Grain size	*Chindau, SC513,*
Poundability	*Candjere, chimanhica, matuba, chindau, cagolo, bantamo*
Cobs per plant	*PAN53, PAN67*

Farmers were also asked to indicate the negative traits of the maize varieties being grown. Table 20 presents the results showing that drought tolerance was a negative trait exhibited by local varieties. Storage pest resistance was another negative trait exhibited by improved varieties. A negative trait exhibited by *matuba* variety was the grain size that is very small.

Table 20: Negative traits for maize varieties grown

Negative trait	Varieties exhibiting the trait
Drought tolerance	*Candjere, bantamo, cagolo, chimanhica*
Storage pest resistance	*PAN67, SC513, Sussuma, DK80*
Fertilize requirements	*PAN53, DK80, cagolo, bantamo*
Early maturity	*Candjere, bantamo, cagolo, chimanhica*
Grain yield	*Cagolo, chimanhica*
Grain size	*matuba*

5.2 Maize characteristics and farmers preferences when selecting maize varieties

Farmers were asked to list the three most important characteristics they consider when selecting maize varieties to plant. Table 21 presents the first most important characteristic and the households' proportion. The results indicate that overall, drought tolerance was the most important maize trait when selecting maize varieties with 28% , followed by grain yield (13%), storage pest resistance (11%), early maturity (9%). Cob size, bread/porridge quality, grain size, and other traits were mentioned as the important characteristics.

Table 21: First most important trait when choosing a variety (proportion of households)

Trait	Angonia (%)	Manica (%)	Mossurize (%)	Sussundenga (%)	Tsangano (%)	Total (%)
Drought tolerance	26.4	34.7	33.6	19.2	25.9	27.6
Grain yield	13.2	14.7	5.8	21.2	11.7	13.1
Storage pest resistance	12.6	6.9	10.6	7.1	16.0	11.3
Bread/porridge quality	10.1	1.9	12.5	1.0	8.6	7.2
Cob size	6.3	13.7	5.8	9.1	3.7	7.2
Early maturity	12.6	7.8	12.5	11.1	2.5	8.9
Grain size	6.3	11.8	4	9.1	1.3	5.4
Fertilizer requirement	6.3	-	0.9	-	6.8	3.5
Cobs per plant	1.9	-	4.8	3.0	5.6	3.2
Disease resistance	1.9	2.9	0.9	7.1	4.9	3.5
Poundability	3.2	0.9	4.8	-	4.3	2.9
Other	13	4.7	3.8	19.2	8.7	6.2

Table 22 presents the second most important trait when selecting maize varieties. Results show that overall, early maturity (20%), storage pest management (12%), and drought tolerance (10%), cob size (9%) were considered the second trait farmers look at when selecting maize varieties.

Table 22: Second most important trait when choosing a variety (proportion of households)

Trait	Angonia	Manica	Mossurize	Sussundenga	Tsangano	Total
Early maturity	23.9	16.8	23.0	16.3	20.4	20.5
Storage pest resistance	11.3	12.9	7.7	9.1	15.4	11.7
Drought tolerance	12.6	5.9	8.6	12.2	8.6	9.8
Cob size	8.2	14.8	9.6	11.0	4.3	8.9
Grain yield	5.0	9.9	9.6	5.1	4.9	6.6
Grain size	6.3	10.9	-	4.1	6.2	6.2
Bread/porridge quality	5.0	3.9	7.7	3.1	8.6	5.9
Disease resistance	3.8	-	4.8	8.2	6.8	4.9
Poundability	8.2	-	3.8	5.1	2.5	4.3
Cob per plant	3.1	5.9	3.8	4.0	7.4	4.9
Fertilizer requirements	3.1	-	-			1.9
Field pest resistance	1.9	1.3	1.9	1.9	2.0	2.5
Others	7.6	17.7	19.5	19.9	12.9	11.9

Table 23 shows the third most important trait when selecting maize variety. The results indicate that, overall, grain size and cob size are the top third most important trait.

Table 23: Third most important trait when choosing a variety (proportion of households)

Trait	Angonia	Manica	Mossurize	Sussundenga	Tsangano	Total
Grain size	12.3	16.3	9.0	10.9	11.6	12.0
Cob size	11.6	15.3	11.0	10.9	11.6	12.0
Drought tolerance	7.5	9.2	8.0	16.5	12.9	10.7
Cob per plant	11.6	8.2	10.0	-	12.9	9.4
Storage pest resistance	6.9	10.2	-	10.9	4.1	7.4
Early maturity	4.1	6.2	8.0	6.6	5.4	5.8
Poundability	7.5	-	9.0	3.3	6.1	5.5
Disease resistance	-	5.1	7.0	5.5	4.8	4.6
Bread/porridge quality	-	4.1	3.0	-	4.8	3.3
Uniform maturity	2.0	-	-	5.5	2.7	2.6
Grain yield	-	-	-	6.6	3.4	-
Other	36.5	24.4	35	23.3	19.7	26.7

6.0 Awareness and adoption of drought tolerant maize varieties

6.1 Level and determinants of likelihood of maize adoption

Farmers were asked about their awareness of maize varieties that perform well even in times of drought and dry sells. Figure 7 presents the proportion of households aware of DT varieties across districts. Overall, the majority of households (93%) were aware of the existence of DT varieties. All the districts had more than 90% of households aware of DT varieties.

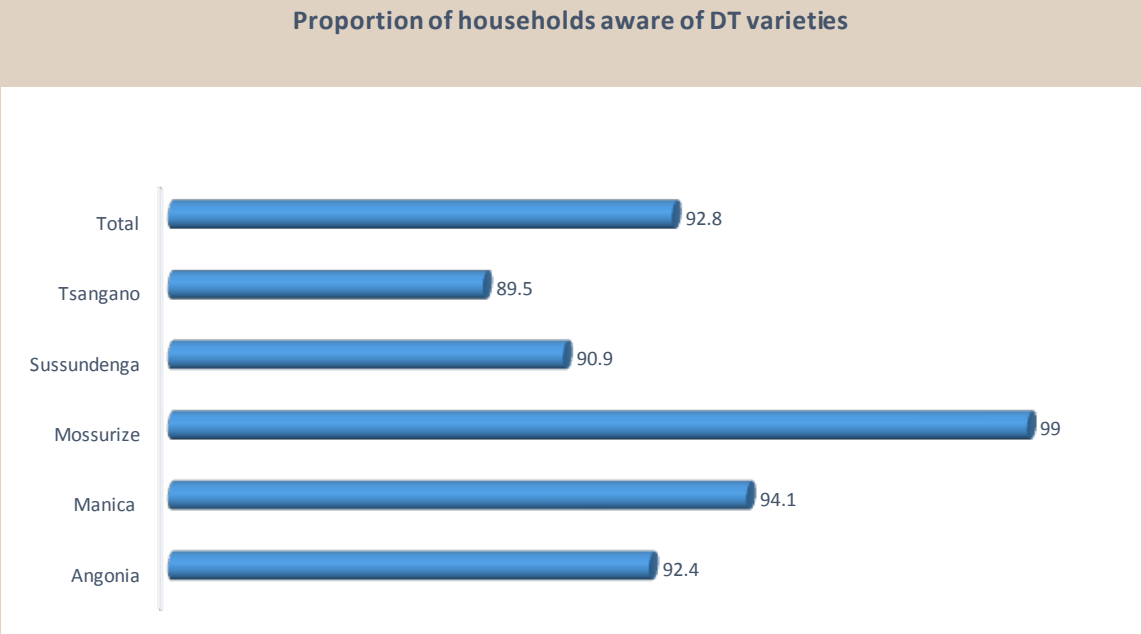

Figure 7: Proportion of households aware of DT varieties

In this study farmers were asked why the maize varieties were able to attain high yields even in times of drought and dry spells. Majority of the households (70%) indicated that DT varieties were maize varieties that had both attributes: short duration and dry spells tolerance. Only 15% and 14% of households thought that drought tolerant maize varieties were able to tolerate dry spells and were of short duration respectively. The results suggest that farmers consider improved varieties that are of short duration as drought tolerant maize varieties. Figure 8 presents what farmers think DT varieties are.

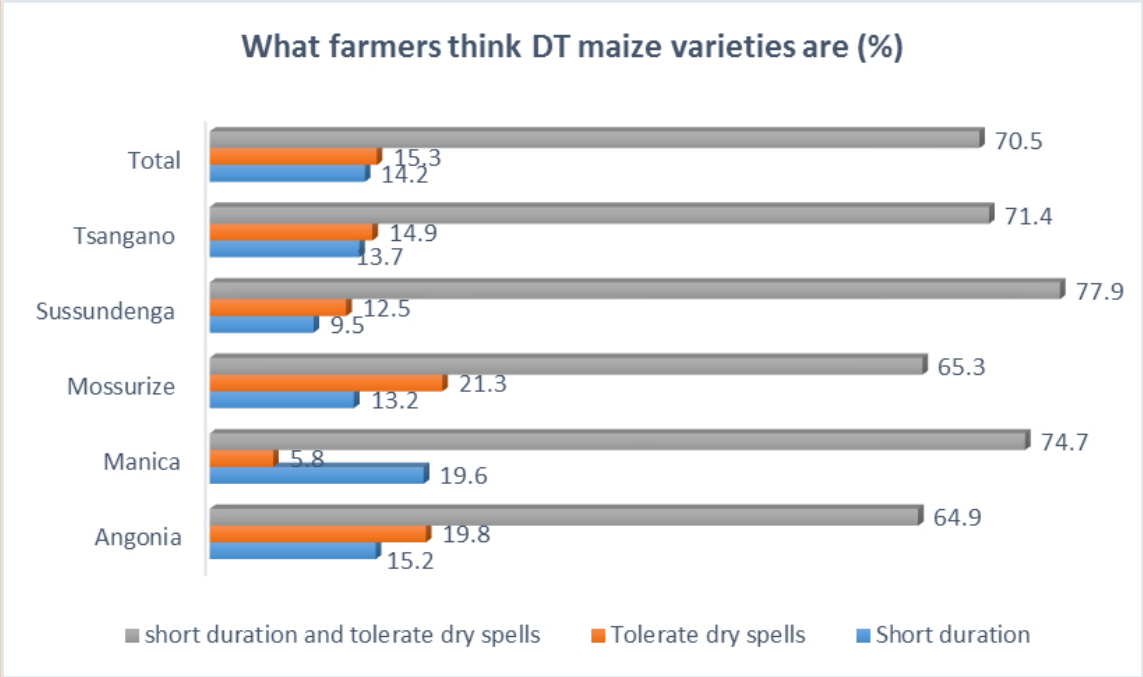

Figure 8: Characterization of DT varieties

6.2 Sources of information on DT varieties

The study examined the different sources of information drought tolerant maize varieties. The results are presented in table 24. Results show that other farmers were the major source of information with 46%. Government extension services (19%), electronic media (17%), and input shop (12%) were other important sources of information on drought tolerant maize varieties. Print media, private agricultural extension service, agricultural extension courses, and farmer field days were sources of information with below 1% of households using these sources.

Disaggregation by districts shows that for all districts, other farmers are the main source of information. More farmers from Sussundenga district (29%) used government extension services as source of information. Input shop was mentioned as an important source of information on DT varieties by a larger proportion of households in Mossurize district. Farmer's groups were an important source of information on DT varieties in Angonia district.

Table 24: Sources of information on DT varieties

Source of information	Angonia (%)	Manica (%)	Mossurize (%)	Sussundenga (%)	Tsangano (%)	Total (%)
Other farmers	56.2	42.3	36.6	47.6	46.5	46.0
Government agricultural extension	9.0	24.4	22.6	29.4	15.4	19.3
Electronic media	15.9	17.9	17.6	7.1	25.3	17.4
Input shop	10.7	10.9	21.3	7.1	11.6	12.5
NGO	3.3	2.9	1.4	4.1	1.2	2.5
Paper media	1.3	-	-	-	-	0.3
Private agricultural extension	-	0.5	-	0.6	-	0.2
Farmer field day	-	-	-	1.2	-	0.2
Agr.ext. course	-	-	-	0.6	-	0.1
Model/lead farmer	-	-	-	0.6	-	0.1
Agr. Coop/farmer group	3.3	1.0	-	1.8	-	1.2

Figure 9 presents the proportion of households that had ever grown DT maize varieties. The results show that the majority of households (80%) had grown DT varieties (including demonstrations and trials). Disaggregating by district Manica and Mossurize reported a higher proportion of households that ever grew DT varieties with 86% each compared to 75% of households in Angonia.

It is interesting to notice that farmer's understanding of drought tolerant maize varieties; they consider DT varieties most of the improved varieties that are of short duration.

The study analyzed the number of years farmers had grown DT varieties. The results show that the majority of households (23%) had started growing DT varieties in 2010, 15% started growing DT varieties in 2009, and 11% in 2012. However, some households in Manica district started to grow DT back in the 1973 and 1979. Comparisons across districts, that 2010 was the most common year farmers started growing drought tolerant maize varieties.

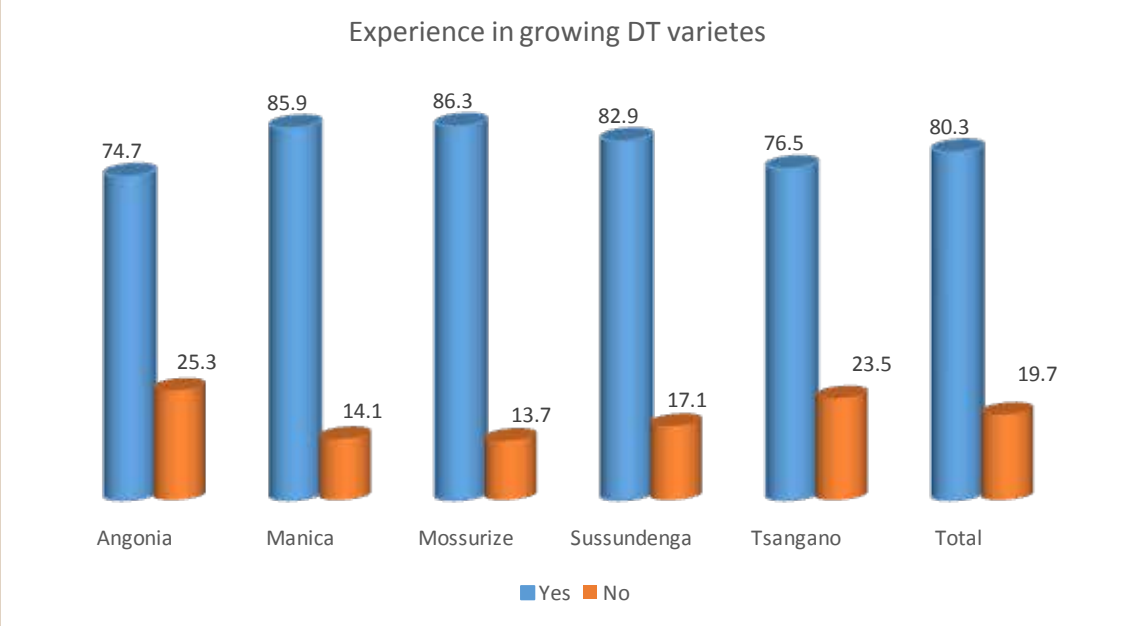

Figure 9: Experience growing DT varieties

Farmers were asked to report the name of DT varieties they had grown prior to 2013. Table 25 presents the results showing that DT varieties[1] that have been released in Mozambique by research organizations such as IIAM were not among the most frequently mentioned varieties by farmers. Matuba, PAN67, and SC513 were the most common varieties grown by farmers. Among the DT varieties in Mozambique, only ZM523 was reported being grown by 7% of households in Tsangano district.

Table 25: DT varieties grown prior to 2013

	Angonia (%)	Manica (%)	Mossurize (%)	Sussundenga (%)	Tsangano (%)	Total (%)
Matuba	16.0	28.6	29.7	20.4	18.5	23.7
PAN67	20.0	19.6	27.0	32.6	22.2	24.7
SC513	12.0	30.4	18.9	16.3	-	18.0
Sussuma	4.0	12.5	10.8	12.2	-	9.3
SC501	4.0	1.2	-	10.2	-	3.6
Zebra	-	1.8	10.8	2.0	-	3.1
Njovu	16.0	-	-	-	3.7	2.6
MH18	4.0	-	-	-	14.8	2.6
PAN53	4.0	-	2.7	2.0	3.7	2.1
DK80	4.0	-	-	-	11.1	0.5
MC17	-	-	-	-	3.7	1.0
ZM303	-	-	-	-	3.7	0.5
ZM421	-	-	-	-	3.7	0.5
ZM523	-	-	-	-	7.4	1.0

[1] *The list of DT maize varieties that have been released in Mozambique since 2008 include: Hluvukani, Olipa, ZM309, ZM523, Dimba, Gema, Molocue, Pris 601, and SP-1.*

6.3 Reasons for not growing DT varieties

Analysis of reasons why farmers have not yet tried growing a drought tolerant maize variety are presented in table 26. The results show that lack of cash was the main reason given by most farmers (35%), followed by lack of fertilizers (23%), lack of seed (10%).

Comparison across the districts show that lack of cash is the main reason for not trying DT maize varieties. Sussundenga district presented a higher proportion of households who have not tried growing DT maize varieties because they do not know the DT maize varieties.

Table 26: Reasons for not growing DT varieties

	Angonia (%)	Manica (%)	Mossurize (%)	Sussundenga (%)	Tsangano (%)	Total (%)
Lack cash	37.5	24.1	62.9	22.5	33.9	35.3
Lack fertilizers	24.1	17.2	7.4	2.5	33.0	22.6
Lack seed	13.4	10.3	11.1	10.0	6.9	10.0
Fertilizer requirements	12.5	-	-	-	6.9	6.8
Storage pest	1.8	-	-	-	8.7	3.7
Don't know variety	2.7	17.2	-	20.0	3.5	5.5
Expensive seed	-	1.4	7.4	-	-	0.9
Used to local varieties	-	10.3		-	-	0.9

Across all districts, almost all households were willing to try the drought tolerant maize varieties.

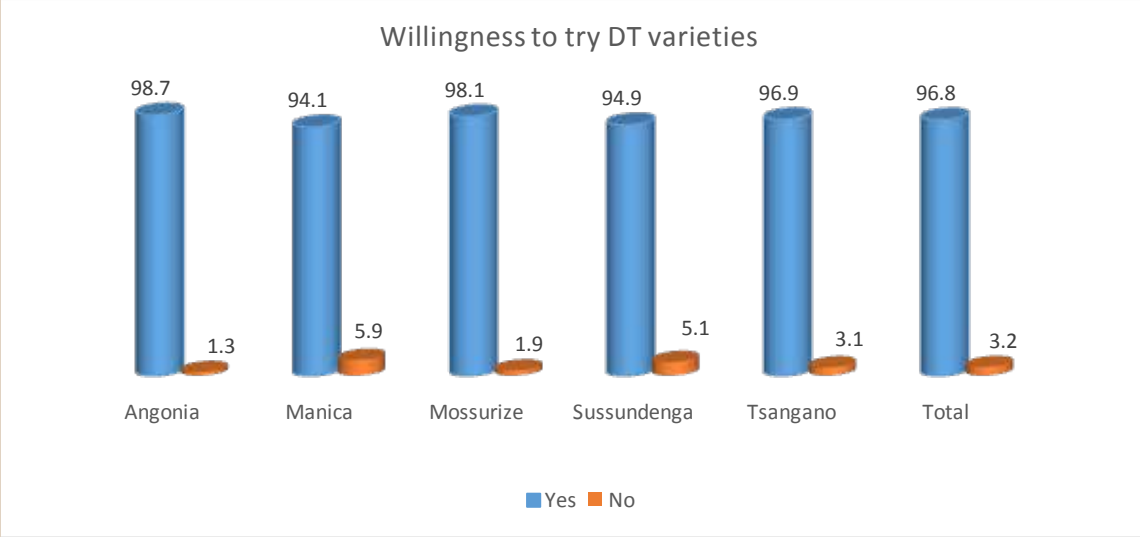

Figure 10: Willingness to try DT varieties

6.4 Reasons for interest growing DT maize varieties

The main reason for farmer's willingness to try DT varieties is the ability to tolerate drought with 26%. Good production or yield (21%), early maturity, and cob size (12%) are among other reasons for trying DT maize varieties (Table 27).

Table 27: Reasons for the willingness to try DT maize varieties

	Angonia (%)	Manica (%)	Mossurize (%)	Sussundenga (%)	Tsangano (%)	Total (%)
Drought tolerance	21.2	24.3	34.3	31.3	24.1	26.5
Early maturity	17.8	18.0	28.4	18.8	19.5	18.8
Good production	21.7	17.4	17.0	12.0	23.7	20.6
Cob size	14.0	7.9	11.6	4.5	15.4	11.5
Grain size	5.1	5.9	5.3	8.3	4.1	5.5
Cobs per plant	4.7	6.9	1.0	6.0	5.4	4.8

6.5 Willingness to pay for hybrid and OPV varieties

Farmers were asked how much they were willing to pay for a kilogram of hybrid or OPV seed of drought tolerant maize. Results show that, overall, farmers are willing to pay on average 25 Mt for a kilogram of hybrid maize seed and 19 Mt for a kilogram of OPV maize seed. The amount ranges from 22 Mt/kg of hybrid in Mossurize to 26Mt/kg of hybrid in Angonia and Sussundenga districts. While for the OPV seed, the cost ranges from 17Mt/kg of OPV in Mossurize and Tsangano districts to 23Mt/kg of OPV in Manica district (Table 28). This suggests that farmers were willing to pay more for hybrid seed than for OPV seed. However, the average price farmers were willing to pay was lower than the current cost of improved seed in Mozambique.

Table 28: Mean price of hybrid and OPV farmers are willing to pay (Mt/kg)

District	Variety	Mean (Mt)	std	Min (Mt)	Max (Mt)
Angonia	Hybrid	26.4	10.5	10	80
	OPV	18.7	7.3	6	40
Manica	Hybrid	27.6	15.0	10	120
	OPV	22.7	11.2	5	100
Mossurize	Hybrid	21.6	6.7	7.5	45
	OPV	17.2	8.4	3	60
Sussundenga	Hybrid	26.4	11.8	5	70
	OPV	19.8	11.4	2	65
Tsangano	Hybrid	22.5	9.1	7	50
	OPV	17.2	12.9	4	155
Total	Hybrid	24.8	10.9	5	120
	OPV	18.8	10.6	2	155

7.0 Conclusion and recommendation

Results from the study show that maize is produced under rain-fed conditions with some level of irrigation in Sussundenga district. The use of chemical fertilizers is low except for Angonia and Tsangano districts, which had a relatively high use of fertilizers. The productivity of maize is relatively low and yet more than 50% of households are maize self-sufficient. Seed markets are distant and the main mode of transport is foot and bicycle. The main source of new maize varieties is the government agricultural extension services. Households grow different types of maize varieties including local, OPV, and hybrid. Most of the farmers indicated they had experience growing DT maize varieties, however, the varieties mentioned are not all drought tolerant. Majority of farmers indicated 2010 as the year when they started growing DT maize varieties. Lack of cash, fertilizers, and seed were the main reasons for farmers not growing DT maize varieties. Most of the farmers were willing to try DT maize varieties because of their traits. The reasons for willingness include tolerance to drought, early maturity, and good production of the DT maize varieties.

Results from the modelling of likelihood of adoption of DT maize varieties indicate that the number of household members involved in agriculture and walking distance to seed market were important factors in the decision to adopt DT maize varieties. Households with more members involved in agriculture were more likely to adopt DT maize varieties. Furthermore, an increase in the distance to seed market reduced the likelihood of adoption of DT maize varieties.

Results indicate that farmers are interested in growing DT varieties however there is a knowledge gap on DT varieties available in the market. Among the DT maize varieties grown by farmers, the released DT varieties were mentioned by a small proportion of farmers, which implies that farmers are not yet using the rereleased DT varieties. Therefore, it is important to increase the dissemination and availability of the varieties. Increasing access to information may include access to extension services, promotion of demonstration plots, field days and radio programs to inform a larger number of farmers about the DT maize varieties at the same time.

The results also suggest that farmers had to walk long distances for long time to get to the seed market. There is a potential for business programs to bring seed closer to the farmers and selling DT varieties at the local market. Results indicate lack of cash, fertilizers, and seed as the reasons for not growing DT maize varieties. There is a need for increasing access to credit and inputs locally.

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