Adoption of Drought Tolerant Maize Varieties in Angola

CIMMYT MR
International Maize and Wheat Improvement Center

This report is presented without a thorough peer review with the main purpose of making data and information rapidly available to research teams and partners in the Drought Tolerant Maize for Africa (DTMA) project and for use in developing future, peer-reviewed publications. Readers are invited to send comments directly to the corresponding author(s). The views expressed in this report are those of the authors and do not necessarily reflect opinions of CIMMYT, other partners, or donors.

The International Maize and Wheat Improvement Center (known by its Spanish acronym, CIMMYT), is an international, not-for-profit research and training organization. With partners in over 100 countries, the center works to sustainably increase the productivity of maize and wheat systems to ensure global food security and reduce poverty. The center's outputs and services include improved maize and wheat varieties and cropping systems, the conservation of maize and wheat genetic resources, and capacity building. CIMMYT belongs to and is funded by the Consultative Group on International Agricultural Research (CGIAR) and also receives support from national governments, foundations, development banks, and other public and private agencies. CIMMYT is particularly grateful for the generous, unrestricted funding that has kept the center strong and effective over many years.

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The project is part of a broader partnership with 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 long-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 to reach 30–40 million people in sub-Saharan Africa in 10 years.

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SOCIO-ECONOMICS

Country Report – DT Maize Adoption Monitoring Survey- Angola

Drought Tolerant Maize for Africa (DTMA) Project

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Acronym and abbreviation

PNIC	Programa Nacional de Investigação de Cereais"
Ha	Hectare
TLU	Tropical Livestock Unit
PAN	"Projecto Aldeia Nova"
AEZ	Agroecological Zones
DT	Drought Tolerant
IMV	Improved Maize Varieties
DTMA	Drought Tolerant Maize for Africa
CIMMYT	International Maize and Wheat Center
IITA	International Institute of Tropical Agriculture
MINADERP	Ministério de Agricultura, Desenvolvimento Rural e Pescas
GDP	Gross Domestic Product
OPV	Open Pollinated Variety
sd	Standard Deviation
n	Sample size
%	Percentage
hh	Household
N	"Norte"/North
S	"Sul"/South
pers	Person
#	Number

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Executive summary

Angola has an economy heavily dominated by crude oil export. On the other hand agriculture, which is dominated by smallholder farming, directly contributes only 6-10% of Angola's gross domestic product (GDP). However, it is estimated that 70% of the country's population is involved in agricultural activities. This makes the agricultural sector very important as it supports livelihood of the majority of the population. Among the many crops grown by smallholder farmers in Angola, maize is the most important agricultural commodity although production often falls below requirements due to various factors, of which erratic and below normal rains recorded across much of the country stand out as the most important factors. The adoption of drought tolerant (DT) maize variaties is one opportunity currently available for the farmers to avoid the potential threats of the erratic rains and frequent dry spell during the rain season.

Under severe drought stress, drought tolerant hybrids have a 40%yield advantage compared to commercially available hybrids in farmers' fields. These new DT varieties possess genes that can reduce yield loss during the flowering and grain-filling periods under drought conditions. They are also tolerant to low-Nitrogen helping farmers reduce the instability of maize yields. This study provides information on maize production in six provinces of Angola, including improved maize varieties grown, preferred traits by farmer households, and factors that can enhance adoption of improved DT maize varieties.

The mean total farm size was about 2.4 hectares per household. Sample households in Kwanza Norte, Lunda Norte and Malange provinces own farm sizes less than the sample average and hence allocate less than 0.50 hectares of land to maize. About 32.3% of the sample households applied fertilizer on their plots for crop production. Only 14.2% of the sample households reported to have access to irrigation. Both management practices are less used in "Planalto de Malange" provinces. The maize grain yield harvested in 2011/12 agricultural season was comparable to that in 2012/13. The average grain yield harvested per household in 2011/12 and 2012/13 seasons was 405 kg and 420 kg, respectively. About 65% of households did not have enough maize from the 2011/12 harvest season. On average, each household runs short of maize for the household for two months.

Adoption and use of improved maize varieties was found to be very low (13.8%) in the study areas. About 38% of the sample households reported to have been using recycled seed. The inquiry about the exposure to drought revealed that 93% of the sample households reported to have experienced drought twice or less over the last 10 years. Local maize varieties are the most commonly planted in the study areas. Hybrids maize varieties are known only by farm households of Bié, Huambo and Kwanza Sul provinces. Recycled seeds are the main source of maize varieties followed by local market purchased varieties. Only 33% of households received information on new maize varieties from various sources mainly in Bié, Huambo and Kwanza Sul. Government extension services were reported as nearly the sole information source in "Palnalto de Malange" provinces.

Key factors that positively influenced adoption of new improved hybrid maize varieties included age of the head of household, literacy level of the head of household, members of household engaged in agricultural activities, total maize area planted and frequence of drought experienced . Whereas number of household members engaged in agricultural activities and

drought experience have positive influence on intensity of adoption of improved maize varieties. 35% of the sample households indicated that they were aware of DT maize varieties. No farm household reported awareness of DT maize in Kwanza Norte, Lunda Norte and Malange. Farmers consider some of the varieties they are growing as drought tolerant. 5.3% of 72 farmers reported that they were first exposed to DT maize in 1963. DT maize varieties currently being grown in the study areas are Catete, Branco Redondo, Amarelo, Vermelho, ZM521 and SAM3.

DT maize varieties grown in Bié province were Vermelho (14.1%), ZM521 (7.1%), SAM3 (5.9%) and Amarelo (5.2%). DT maize varieties identified in Huambo were Vermelho (12.5%), Branco Redondo (6.3%) and Amarelo (6.3%). Those identified in Kwanza Sul were Catete (25.9%), Amarelo (8.6%) and Branco Redondo (3.4%). Early maturity (43% households) was the most frequently mentioned characteristic of drought tolerant maize as perceived by farmers followed by ability to tolerate dry spells. Farm households learned about DT maize varieties mainly through self experience (57%), from fellow farmers (33%), and government extension services (32%).

Lack of access to seed (92.5%, n=600) mainly in Planalto de Malange was mentioned as the key reason for not trying to grow DT maize varieties. Other reasons mentioned were high levels of fertilizer required to grow the maize and the expected low yield as perceived by farmers.

Interestingly, despite this lack of awareness, all sample households were willing to try DT maize varieties. The results from a linear regression showed that as the number of exposures to drought over the last 10 years increases, households with more income were less willing to pay for OPV DT maize varieties. Farmers in Bié and Huambo provinces are less willing to pay for OPV DT maize seeds compared to Kwanza Sul. This is contrary to farmers in Kwanza Norte, Lunda Norte and Malange who solely depend on government extension services.

Key recommendations

- Access to agricultural extension services is quite limited in terms of alternative sources as the government extension service is the main and in most cases the only source of information for farmers. The government extension service should be context-specific based on the challenges and opportunities that prevail in the respective municipalities.
- Adoption of improved maize varieties is very low in the study areas. This is in fact in line with the national scenario where very few farmers access and grow improved maize varieties. Deliberate interventions are needed in the production, marketing and dissemination of improved seed varieties in the rural parts of Angola.
- Rural commercialization policy must be implemented to increase farmers' market participation andallow farmers to fetch better prices and hence higher income from agricultural activities.
- Access to credit is highly unlikely in the drought prone study areas. The formal credit system needs to address the lack of credit faced by farmer households, especially the bureaucratic procedures for obtaining it.

Chapter 1.0 Introduction

Angola has a population of 20.7 million inhabitants and a land surface area of 1.25 million square kilometres. It is estimated that 70% of the population is involved in agricultural activities (World Bank, 2010). The country has three agro-ecological zones: (a) the tropical humid with extensive forest in the northeast; (b) the less warm and sub-humid central highlands; and (c) the semi-arid and arid areas in the west coast, south and southeast. Maize is predominantly grown in the central provinces: Huambo, Huila, Kwanza Sul, Benguela and Bie, which represent about 69% of the total cultivated area. The remaining areas being distributed equally between the northern provinces: Uige, Malange, Kwanza Norte, Luanda, Zaire, Lunda Norte, Lunda Sul, Bengo, Moxico and Cabinda; and southern provinces: Kuandu Kubangu, Namibe and Kunene (MINADERP, 2010).

Figure 1: Map of Angola

Agroecological zones (AEZ) in Angola define five typical production systems:(i) food crop production dominated by cassava and small ruminants; (ii) coffee crop farms in highlands; (iii) sub-urban maize and horticulture systems; (iv) cereal (sorghum and millet) and cattle dominated systems and (v) irrigation based intensive vegetable and fruit production systems in the lowlands.

In an economy heavily dominated by crude oil export, subsistence agriculture mainly by smallholder, directly contributes 6-10% of Angola's gross domestic product (GDP). The range of agricultural commodities includes cereals, beans, roots and tuber crops, horticulture and fruit crops. The staple commodities are maize, cassava, millet, beans, groundnuts, sweet potatoes, fruits and vegetables (Figure 2).

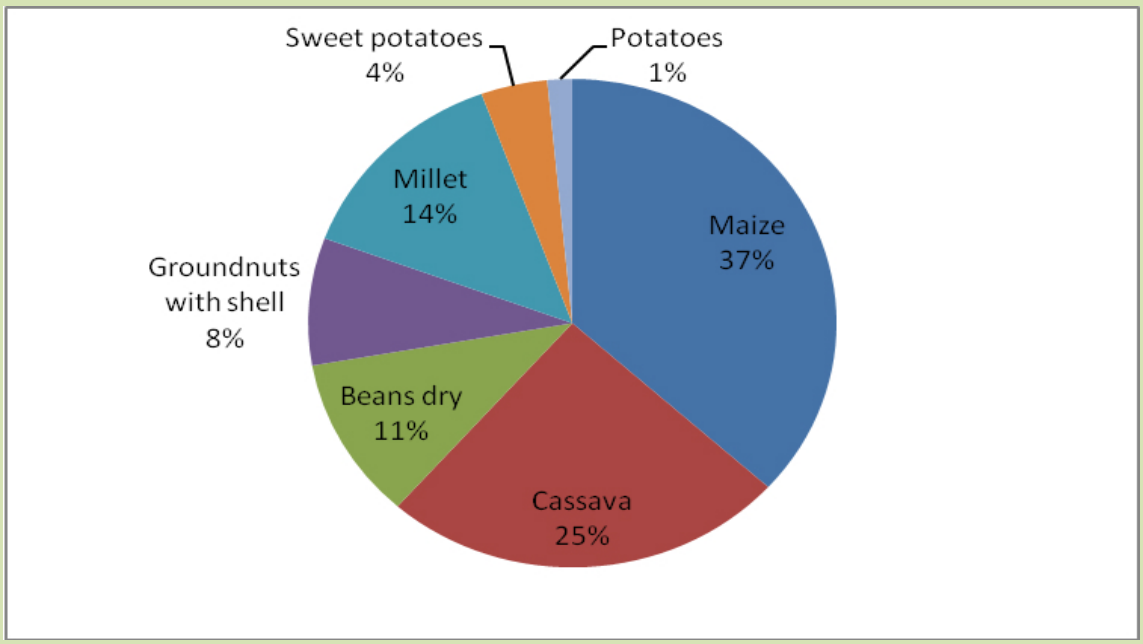


Figure 2: Main crops grown during 2010/2011 season

Angolan agricultural policy focuses on food security, income generation, employment creation and poverty alleviation. Maize is the most important agricultural commodity (Figure 3) although production often falls below potential standards due to various factors, of which erratic and below normal rains recorded across much of the country stand out as the most important factors. Lack of an operational seed sector that necessitates importation of maize seed and milled grain every year also contributes to production failures.

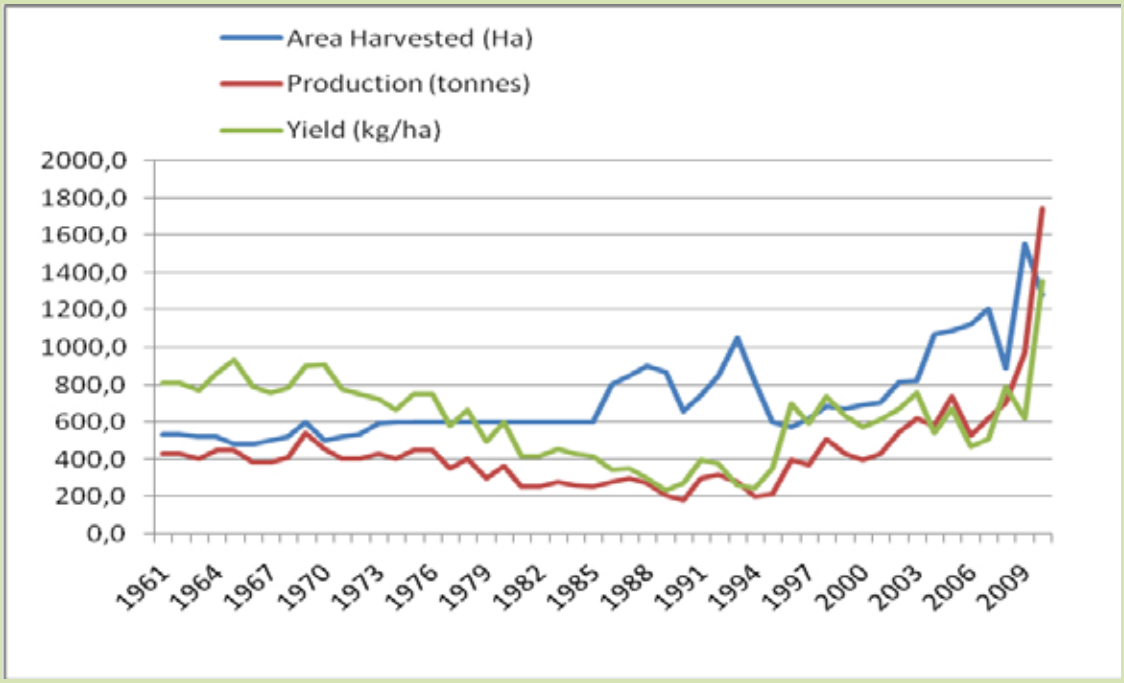


Figure 3: Maize production, area harvested and yield trends

The importance of drought and the production risk from the uncertainity of erratic rainfall cannot be overemphasised. There are a number of global efforts that are addressing drought and other climate change challenges affecting agriculture in sub-saharan Africa. CIMMYT and the International Institute of Tropical Agriculture (IITA), with support from donors and partners have released 11 improved maize varieties in Angola under the Drought Tolerant Maize for Africa (DTMA) initiative since 2006. The overall goal of the initiative is to increase smallholder farmers' access to drought tolerant (DT) maize varieties that yieldmore, to improve household food security hence sustaining their families and strengthening their livelihoods. DT maize varieties have been promoted in the target districts by extension agents and one of the objectives of the initiatives is to enhance impact by identifying and overcoming adoption constraints of new DT maize varieties. Thus, this research, as part of a continental initiative, was designed to meet the following objectives: (i) to measure DT maize penetration and (ii) to describe the key factors associated with farmer uptake of DT maize varieties. The study was conducted in six provinces of Angola involving 600 farmer households of seven municipalities in 60 villages.

Chapter 2.0 Study area and methods

2.1 Study area

The study focuses on the drought prone maize producing areas of Angola. In each province, one municipality (except Huambo with two municipalities) was purposively selected. In each municipality, 10 villages were identified in collaboration with local extension staff. Finally, 10 households were randomly selected from each village. Two teams conducted the survey. The first team had one supervisor and four enumerators. This team visited Bié, Huambo and Kwanza Sul provinces and distributed 450 questionnaires after interviewing 150 households per province. The second team had one supervisor and two enumerators. This team visited Kwanza Norte, Lunda Norte and Malange provinces where they interviewed 150 households (50 respondents per province). The survey was done in a single visit across all study provinces between June and July, 2013.

The seven municipalities covered in the study are Kuito (Bié), Huambo and Ekunha (Huambo) and Cela (Kwanza Sul) in "Planalto Central"; Lukala (Kwanza Norte), Xa Muteba (Lunda Norte) and Malange (Malange) in "Planalto de Malange". The municipalities have a total population of 2.87 million inhabitants living in an area of 20,000 km² (Table 1) (Wikipedia, 2013). Farmer households in "Planalto Central" have maize as predominant crop while those of "Planalto de Malange" have cassava as main staple.

Table 1: Sample municipalities and their characteristics

Municipalities	Kuito	Huambo/ Ekunha	Lukala	Cela	Xa-Muteba	Malange
Sample size (# hh)	150	60/90	50	150	50	50
[1]Area (km²)	4,818	2,609	1,718	5,525	-	2,422
[1]Population (10^3inhab.)	447	1,204	42	148	157	288
[1]Pop. density(inh./km²)	99	461/55	54	27	-	119
[1]Latitude	S12°23′	S12°46′	-	S11°21′30″	S9°16′	S9°32′29″
[1]Longitude	E16°56′	E15°44′	-	E15°07′10″	E18°00′	E16°20′27″

Source: [1] http://pt.wikipedia.org/wiki (accessed August 2013).

Chapter 3.0 Descriptive results

3.1 Socio-economic characteristics of the sample population

80% of the respondents were household heads (except in Bié and Huambo where only 72% and 77%, respectively, were household heads). On average, 11% of the sample households were female-headed although the proportion is much lower in Bié, Kwanza Sul and Lunda Norte (Table 2). Sample households are typically male-headed. In 20% of the cases where respondents were not household heads, it was emphasized that mostly household heads were temporarily unavailable. The family size of the surveyed households averages at 6.6 people, the maximum being 7.81 in Kwanza Sul and the minimum being 5.5 in Malange. The average age was about 47.6 years with 4.26 years of schooling. Malange standing out with only 2.72 years of completed school. In terms of agricultural labor supply, 3.33 members were engaged in agriculture on average. Kwanza Norte (2.06 members), Malange (2.12 persons), and Lunda Norte (2.26 persons) were found to be having the least number of people engaged in agriculture (Table 2).

Table 2: characteristics of sample households

		Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Sample mean (sd)
Relationship to household head (% of hh).	Head	72	77	84	82	86	92	80
	Spouse	27	21	16	17	14	8	19
	Other	.7	2	0	1.3	0	0	1
Gender of the household head (% of hh)	Female	7	16	10	6	8	32	11
	Male	93	84	90	94	92	68	89
Age of household head (years)		47.32	47.5	42	49.78	45.78	49.52	47.6(14.91)
Literacy distribution of household head (# of schooling ye ars)		4.32	4.05	4.13	5.4	3	2.72	4.26(2.95)
Family size distribution of household (# of pe rs.)		6.23	6.74	5.69	7.81	6.16	5.5	6.64(2.92)
Household level agricultural labor supply, (# of pers.)		3.63	3.54	2.06	4	2.26	2.12	3.33(2.01)

Source: Adoption Monitoring Survey/Angola, June 2013.

3.1.1 Income level of households

A qualitative approach of measuring income was employed in this study. The income level was measured against its sufficiency to cover all expenses of the household. Making savings in the drought prone study areas was still a challenge. The current income for 71.9% of household was not sufficient to meet their expenses. Households therefore needed to use savings, borrow money, aid or assistance to meet their expenses. The three municipalities in "Planalto Central" provinces; i.e., Bié, Huambo and Kwanza Sul, were worse compared to others. Only 22% of the respondents have the minimum required to just meet their expenses, where Huambo with 14% of households and Kwanza Sul with 14.7% of respondents have the smallest proportion (Table 3).

Table 3: Status of household current income (% of hh)

Income level	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Sample mean
Allows to build savings	0.7	0	2	0.7	0	0	.5
Allows to save a little	3.3	7.3	0	10.7	2	2	5.7
Allows just to meet expenses	24	14	28	14.7	24	52	22
Not sufficient, so needs to use savings	6	3.3	34	7.3	50	30	13.7
Not really sufficient, so needs to borrow	17.3	24	16	16.7	20	8	18.2
Not really sufficient, so needs assistance	48.7	50.7	20	50	4	8	40

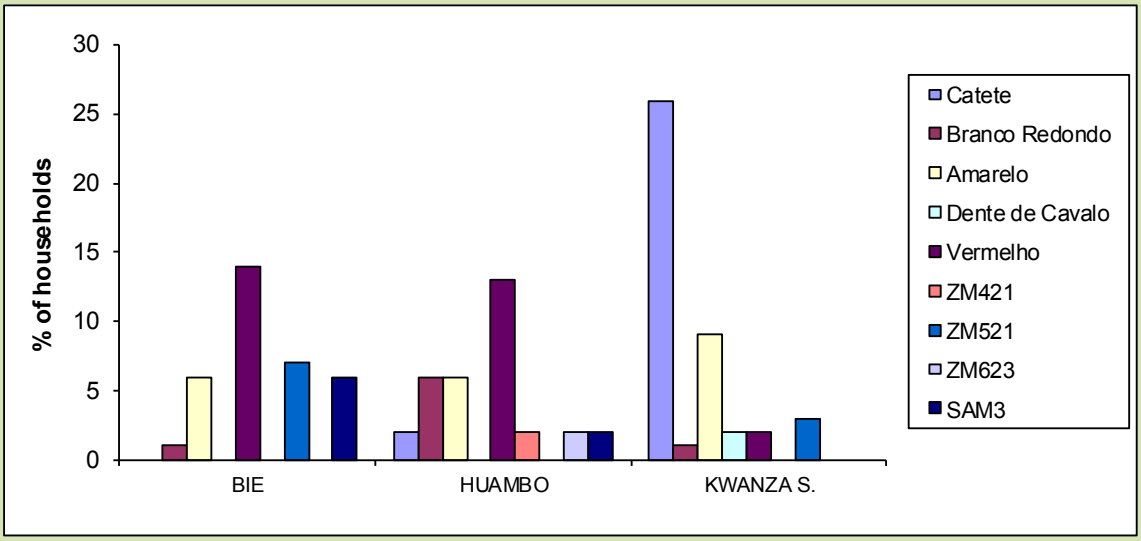
Source: Adoption Monitoring Survey/Angola, June 2013.

i) Frequency of DT maize awareness by district

About 35% of the sample households indicated that they were aware of DT maize varieties. The awareness was much higher particularly in three provinces of "Palnalto Central", namely Bié (56.7%), Huambo (44.7%) and Kwanza Sul (38.7%). No farm household reported awareness of DT maize in Kwanza Norte, Lunda Norte and Malange.

ii) Frequency of DT maize varieties mentioned by farmers

Figure 5 shows that Five DT maize varieties are grown in Bié province, the dominant varieties being Vermelho (14.1%), ZM521 (7.1%), SAM3 (5.9%) and Amarelo (5.2%). Similarly, Seven DT maize varieties were identified in Huambo whereby Vermelho (12.5%), Branco Redondo (6.3%) and Amarelo (6.3%) are the most dominant. In Kwanza Sul, Six DT maize varieties were identified and again the list is dominated by Catete (25.9%), Amarelo (8.6%) and Branco Redondo (3.4%).



Source: Adoption Monitoring Survey/Angola, June 2013.

Figure 4: DT maize varieties mentioned by farmers (% of hh)

iii) Characteristics of DT maize varieties as described by farmers

Early maturity (43%) was the most frequently mentioned characteristic of DT maize prefered by farmers. In Bié (54.1%) and Huambo (40.9%) in particular, early maturity dominated all other traits as major characteristic of DT maize. Ability to tolerate dry spells was the second most frequently mentioned (34.9%) trait of DT maize in the study areas where farmers were found to be aware of DT maize. Both characteristics (short duration and ability to tolerate dry spells) were mentioned by 15.8% of the sample households (Table 24).

Table 24: Characteristics of DT maize varieties being grown (% of hh)

	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Sample mean
Short duration	54.1	40.9	0	29.3	0	0	43.1
Able to toleate dry spells	30.6	37.9	0	37.9	0	0	34.9
Both	11.8	16.7	0	20.7	0	0	15.8
Other	3.5	4.5	0	12.1	0	0	6.2

Source: Adoption Monitoring Survey/Angola, June 2013.

3.1.2 Livestock ownership

Livestock is an important component of the livelihood portfolio of the interviewed farm households as a source of food and income, asset accumulation, diversification/ insurance and services (e.g., transport of firewood and charcoal). Chicken are the most commonly kept livestock in the study areas with an average holding of about 14 chicken per household. The average holding of goats/sheep per household was found to be 1.3. The number of pigs is about 1 per household. Livestock ownership is always higher than the sample average in Kwanza Sul province where "Projecto Aldeia Nova" supplied poultry and pigs to enhance small ruminant rearing. Despite the efforts made by "Projecto Aldeia Nova", in Kwanza Sul province, pronouncements were made during the survey about a plague that killed a considerable number of poultry and pigs (Table 4). On the contrary, average holdings of all kinds of livestock in Kwanza Norte were less than the sample average. In terms of tropical livestock units (TLU), the average holding was estimated to be 1.5 units per household.

Table 4: Livestock ownership in the study areas (mean number of animals).

	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Mean (sd)
Cattle	.15	.71	.36	.80	.04	.18	.46 (1.67)
Horses/donkey	0	.02	0	.06	0	0	.02 (.39)
Goats/sheep	1.29	1.15	.56	1.89	.72	.84	1.26 (3.86)
Poultry	5.36	3.73	1.6	44.4	3.68	4.04	14.2(96.26)
Pigs	.79	.49	.54	1.4	.84	.56	.83 (2.11)

Source: Adoption Monitoring Survey/Angola, June 2013.

3.1.3 Household access to information and rural credit

3.1.3.1 Access to agricultural extension on new maize varieties

Social capital provides households with important additional entitlements. Inquiry was made in the study on access to agricultural extension on improved maize varieties. The inquiry revealed that about one third of the sample households have received extension information on improved maize varieties. The least access to agricultural extension information was reported by households in Lunda Norte where only 6% of the sample households had access to such information (Table 10).

Table 10: Access to agricultural extension on new maize varieties (% of hh)

Accessed	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Sample mean
No	43.3	72	78	71.3	94	68	66.7
Yes	56.7	28	22	28.7	6	32	33.3

Source: Adoption Monitoring Survey/Angola, June 2013

3.1. 3.2 Sources of information on new maize varieties

About half of the surveyed farm households reported government extension service as the main source of information on new maize varieties followed by farm group association and other farmers. Government's extension service was found to be the only source of information for farm households in Kwanza Norte, Lunda Norte and Malange (Table 11).

Table 11: Sources of information on new varieties in the study areas (% of hh)

	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Sample mean
Government agr. extension	60	19	100	32.6	100	93.8	51
NGO	1.2	9.5	0	2.3	0	0	3
Farmers' association	7.1	7.1	0	34.9	0	0	12
Other farmers	12.9	31	0	20.9	0	6.3	17
Electronic media	7.1	14.3	0	2.3	0	0	6.5
Other	10.6	9.5	0	7	0	0	8
Lead farmer	1.2	2.4	0	0	0	0	1
Farmer field days	0	2.4	0	0	0	0	0.5
Input shop/supplier	0	4.8	0	0	0	0	1

Source: Adoption Monitoring Survey/Angola, June 2013.

3.1.3.3 Subjective likelihood of access to credit

Lack of funds that is apparent in rural Angola is another manifestation of poverty among rural households. Credit facilities can help alleviate cash shortage, but access to rural financing seems to be very limited with only 11% of the sample households reported to have accessed. The main sources of rural credit are friends, family or neighbors. The effort to elicit the subjective likelihood of access to rural credit showed that about 70% of the sample households claim it is difficult to borrow money for agricultural purposes. 3.7% of the households reported that they do not want to borrow money, due to the difficulty in repaying due to crop failures and low maize grain prices (Table 12).

Table 12: Likelihood of access to credit in the study areas, (% of hh)

	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Mean
Extremely likely	3.3	3.3	0	2.7	0	4	2.7
Quite likely	5.3	12.0	0	11.3	12	2	8.3
Neither likely/ unlikely	14.7	17.3	10	23.3	2	12	15.8
Quite unlikely	12	30	26	27.3	34	32	25
Extremely unlikely	52.7	37.3	64	32.7	52	50	44.5
No need	12	0	0	2.7	0	0	3.7

Source: Adoption Monitoring Survey/Angola, June 2013.

3.1.4 Drought risk

3.1.4.1 Intensity of drought

Drought intensity can be described in terms of extent of agricultural water scarcity in a given season and the number of times such scarcity happens in a given period of time. We have inquired about the frequency of drought experienced by the sample households over the last 10 years. On average, sample households have faced nearly two drought episodes over the last 10 years. This exposure to drought ranged from 0 to 10 times.

3.1.4.2 Vulnerability to drought risk in the study areas

There were 589 households who reported exposure to drought over the last 10 years. Four (0.68%) farmers said that they have faced drought in each of the last 10 seasons. 21 (3.6%) farmers indicated that they have not experienced any drought over the last 10 years. While 73% of farmers were affected at least once by drought during the last 10 years (Table 13).

Table 13: Vulnerability to drought risk in the study areas

Number of years drought affected household	Sample size	% of household
Not affected	21	3.6
One	221	37.5
Two	211	35.8
Three	97	16.5
Four	26	4.4
Five	7	1.2
Six	2	0.3
Ten	4	0.7

Source: Adoption Monitoring Survey/Angola, June 2013.

3.2 Maize production and consumption in the study areas

3.2.1 Inputs

3.2.1.1 Total farm owned and proportion of land allocated to maize

Land is the main natural asset of the farm households and the average holding was found to be 2.4 hectares per household (Table 5). Sample households in Huambo, Kwanza Norte, Lunda Norte and Malange provinces had less farmland holdings than the sample average. The total farm land allocated to maize crop was about 865 hectares of which 32% were under improved maize varieties in the study areas (Bié: 129 hectares; Huambo: 63 hectares; and Kwanza Sul: 85 hectares). Sample households in Kwanza Norte, Lunda Norte and Malange provinces own farm sizes less than the sample average and hence

allocate less than 0.50 hectares of land to maize. In these provinces maize is intercropped with other crops mainly cassava, which is the principal staple food crop in the region.

Table 5: Total land owned and land allocated to maize in the study areas.

	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Sample mean (sd)
1.Total farm owned (ha)						(n=600)	
	2.49	2.03	1.39	3.63	1.42	1.68	2.41(2.04)
2. Total maize area planted(ha)						(n=599)	
	2.04	1.36	.37	1.97	.45	.55	1.46(1.32)

Source: Adoption Monitoring Survey/Angola, June 2013.

3.2.1.2 Fertilizer use frequency and access to irrigation

Only 32% of the sample households were found to be using chemical fertilizers in crop production. In Malange as well, only 4% of households (out of 50) reported using chemical fertilizer (Table 6). In Kwanza Norte and Lunda Norte, no chemical fertilizer use was reported by the sample households.

Access to irrigation was limited. Only 14% of the sample households indicated having access to irrigation. Some considerable proportion of farmers had access to irrigation in Huambo, Bie, and Kwanza Sul. It is however nearly non-existent in the other municipalities as irrigation is uncommon in the "Planalto de Malange" provinces.

Table 6: Use of chemical fertilizer and access to irrigation (% of hh)

	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Sample mean
Use of chemical fertilizers							
No	75.3	39.9	100	57.3	100	96	67.7
Yes	24.7	60.1	0	42.7	0	4	32.3
Use of irrigation							
No	83.3	78	98	83.3	100	98	85.8
Yes	16.7	22	2	16.7	0	2	14.2

Source: Adoption Monitoring Survey/Angola, June 2013.

3.2.2 Outputs

Maize yield distribution over 2011/12 and 2012/13 seasons

Maize yield was very low in the study areas. Maize harvested in the 2011/12 agricultural season (on average 405 kg/ha) is roughly equal to the harvest in 2012/13 (on average 420 kg/ha). There was a 6% reported increase in yield (Table 7). 4% of households in 2011/12 season and 17% in 2012/13 did not harvest any maize. The highest amount of yield harvested in 2011/12 and 2012/13 was 6,750 kg and 7,000 kg per household,

respectively. Households in Kwanza Norte, Lunda Norte and Malange reported maize yields well below the sample average

Table 7: Maize yield distribution over 2011/12 and 2012/13 seasons (in 50 kg bag)

	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Sample mean (sd)
Total maize harvested in 2012/13 season							(n=599)
	8.37	7.91	.31	16.59	.89	1.08	8.4 (13.54)
Total maize harvested in 2011/12 season							(n=592)
	6.81	7.62	1.92	15.86	2.39	1.77	8.07(12.42)

Source: Adoption Monitoring Survey/Angola, June 2013.

3.2.3 Maize subsistence consumption

As a consequence of low maize harvest in the study areas, 64.4% of the sample households had insufficient maize for consumption from their own production in the 2011/12 season (Table 8). On average, each household runs short of maize for two months. Maize self-sufficiency is much lower among households in Kwanza Norte, Lunda Norte and Malange provinces. Note that in these provinces maize is consumed fresh as dessert or breakfast.

Table 8: Self-sufficiency in maize from own production (% of hh)

Self-sufficient	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Sample mean
No	66.4	65.3	84	40	94	80	64.4
Yes	33.6	34.7	16	60	6	20	35.6

Source: Adoption Monitoring Survey/Angola, June 2013.

3.2.4 Maize marketing

3.2.4.1 Proportion of maize production marketed and distance walked to buy maize seeds

Maize markets in the study areas are not developed. Maize production has primarily a dual purpose to meet household food needs and for income through marketable surplus. An average of 63 kg (1.26 bags) of maize grain per farming household was reported to have been sold. Households in Kwanza Norte, Lunda Norte and Malange reported much less figures than the average. A total of 38,600 kg was sold of which 46% was sold by farmers who planted improved maize varieties continuously over the last five years. In terms of distance, households in the study areas walked an average of 61 minutes from maize seeds market. Households in the drought prone areas face upto 18 months without food from own production (Table 9).

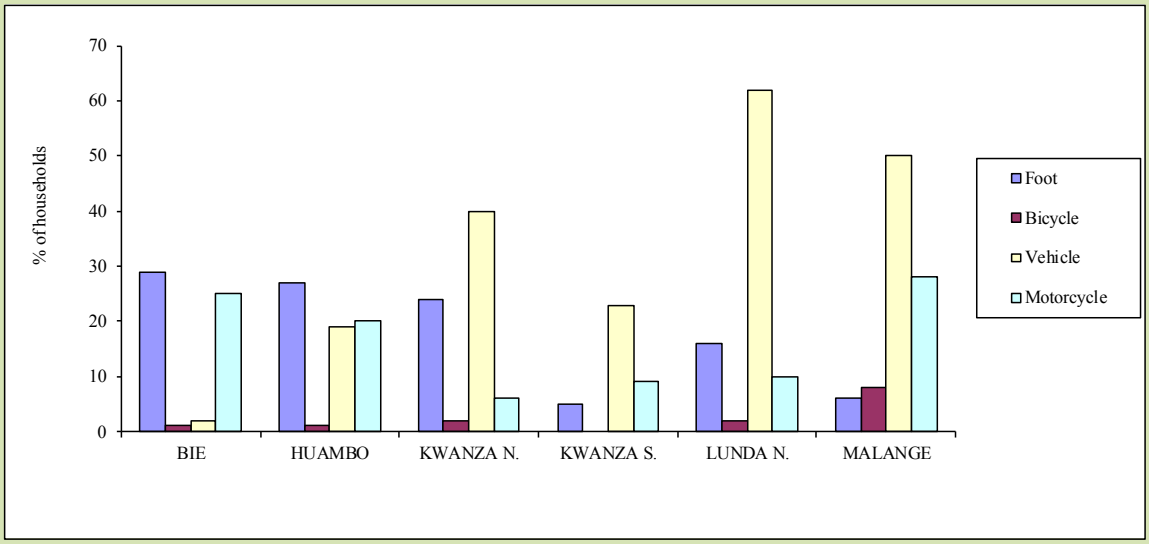
Table 9: Maize marketing and self-sufficiency

	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Sample mean (sd)
Maize sold (50 kg bag)							(n=598)
	1.05	1.41	.16	2.39	.22	.23	1.26(5.29)
Distance walked to buy maize seeds (minutes)						(n-=171)	
	90.71	60.99	26.11	48.22	68.71	42.50	60.58(59.47)
Run out of maize from its own production (months)						(n=600)	
	1.74	1.86	2.42	.91	2.3	3.32	1.8(2.69)

Source: Adoption Monitoring Survey/Angola, June 2013.

3.2.4.2 Mode of transportation from maize seeds market

The common mode of transportation to maize seed sources used in Kwanza Norte, Kwanza Sul, Lunda Norte and Malange was vehicle (Figure 4). In fact, sample households were not interested to travel to points where they can purchase maize seeds because they had seeds reserved from last season (e.g., about 38% of the sample households did not buy maize seeds in the 2012/13 season because they used saved/recycled seed). Motorcycle and walking on foot were found to be common modes of transportation as reported by 19.2% and 17.2% of the sample households, respectively. Animal drawn carts were used for firewood and charcoal transportation in Huambo province only.



Source: Adoption Monitoring Survey/Angola, June 2013.

Figure 5: Mode of transport used to maize seed market (% of hh)

4.0 Adoption of improved maize varieties

4.1 Maize varieties being grown

Different varieties of maize are being grown in the study areas. A total of 36 maize varieties were identified in the survey and the dominant varieties in terms of proportion of households growing them are Branco Redondo (40.4%), Amarelo (14.86%), Catete (9.35%), Nanhala (8.01%) and Vermelho (5.51%). Other open-pollinated varieties (OPVs) and hybrid maize were also identified including ZM521 (1.34%), SAM3 (1%), ZM623 (0.17%), Sintetico (0.33%), Chianga (0.33%), 3 meses (0.33%) and hybrid (1.67%) (Table 14).

Table 14: Types of maize varieties being grown in the study areas.

Varieties	% of hh	Varieties	% of hh	Varieties	% of hh
Catete	9.35	Cassenha	.17	Epungu	.33
Branco Redondo	40.4	Kalagi	1.50	Amarelo	14.86
Kapomo	2.5	Dente de Cavalo	.83	Vermelho	5.51
Likusuka	3.67	Nanhala	8.01	Fernando	.33
Granada	.17	ZM521	1.34	Sintetico	.33
Tchilavekela	.67	ZM623	.17	Hungu	.50
Itombo	.17	SAM3	1.0	Kipeso	.17
Limbundu	.17	Mangena	.17	Mbuelo	.17
Nativoyo	.33	Ndende	2.17	Olombirito	.17
Wiya	.17	Don't kwon	.17	3 meses	.33
Napomo	1.34	Decele	.17	Hule	.17
Hybrids	1.67	Kapalandanda	.50	Chianga	.33

Source: Adoption Monitoring Survey/Angola, June 2013.

4.2 Description of the different maize varieties under production

4.2.1 Classification of varieties by farmer households

Local maize varieties are the most common grown maize types planted by 79.3% of the sample households. In Kwanza Norte and Lunda Norte, 64% and 60% of the sample households respectively, reported to have been growing open-pollinated maize varieties. Sampled farmers do not seem to be quite familiar with hybrid maize as only few reported to have ever grown one. (Table 15).

Table 15: Classification of maize varieties being grown in the study areas (% of hh)

	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Mean
Landraces	91.3	87.9	36.0	92	40	62	79.3
OPV	6.7	6.7	64	5.3	60	34	17.9
Hybrid	2	2	0	1.3	0	0	1.3
Rec. Hybrid	0	.7	0	1.3	0	0	.7
Don't know	0	.7	0	1.3	0	4	.8

Source: Adoption Monitoring Survey/Angola, June 2013.

4.2.2 Comparison of farmers and researchers' classifications of DT maize

The researchers of "Programa Nacional de Investigação Agronomica-PNIC" propose that hybrids, ZM521, ZM623, SAM3, and 3 meses are improved maize varieties while Catete, Branco Redondo, Dente de Cavalo, Amarelo, Vermelho, Sintetico, Chianga, Kapomo, Likusuka, Granada, Tchilavekela, Itombo, Limbundu, Nativoyo, Wiya, Napomo, Cassenha, Kalagi, Nanhala, Mangena, Ndende, Decele, Kapalandanda, Epungu, Fernando, Hungu, Kipeso, Mbuelo, Olombirito and Hule are landraces.

4.2.3. Sources of the maize varieties under production

Seeds retained from last season are the main source of maize seed planted in the study areas as reported by 68% of the sample households. Local market is the second source of seed particularly in Kwanza Norte (52% of respondents) and Lunda Norte (40% of interviewed). The government extension local services also provide seed to farm households mainly in Kwanza Norte (18%) and Malange (18%), (Table 16).

Table 16: Sources of maize varieties being grown in the study areas (% of hh)

	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Sample mean
Recycled seeds	82.7	71.7	18	89.3	26	42	67.9
Agro-dealers	2	2.7	0	0	0	4	1.5
Private trader	.7	0	4	0	2	6	1.2
Local market	7.3	15.4	52	8	40	24	17.4
Shop	0	0	0	.7	2	0	.3
Neighbor	0	3.4	8	1.3	16	4	4.2
Relatives	2.7	3.4	8	1.3	16	4	4.2
NGO	0	0	0	0	6	0	0.5
Government	4.7	3.4	18	.7	2	18	5.3
Seed companies	0	.7	0	0	0	0	.2
Other	0	0	0	0	0	2	.2

Source: Adoption Monitoring Survey/Angola, June 2013.

Almost all of the sample households (99.8%) have been growing the same maize variety continuously. Nearly 50.17% of them planted one variety, 42.67% planted two varieties, and 6% planted three varieties.

4.2.4 Maize seed recycling intensity

This study revealed that farm households in rural Angola have been recycling maize seed on average for 17.5 years with the range of 1 to 60 years. The average of maize seed used by the farm households in the study areas is about 28.1 kg with a maximum of 200 kg.

4.2.5 Maize traits and farmers' preferences

The most preferred maize traits in the study areas were grain yield (29.4%), porridge taste (12.4%), cob size (10.7%), early maturity (8.5%), porridge quality (7.8%) and drought tolerance (4.2%). As shown in Table 17, most of the highly preferred traits are linked to productivity (grain size, cob size, and early maturity) and food quality (porridge).

Table 17: Positive traits of maize varieties being grown (% of hh)

	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Sample mean
Grain yield	26.7	22.7	40.0	30.0	44.9	30.0	29.4
Cob size	8.0	3.3	22.0	12.0	6.1	30.0	10.7
Cob per plant	1.3	0.7	6.0	2.0	24.5	2.0	3.7
Drought tolerance	4.7	9.3	0.0	2.7	0.0	0.0	4.2
Early maturity	8.0	13.3	2.0	4.0	8.2	16.0	8.5
Performance under low soil fertility	6.0	3.3	0.0	2.0	0.0	2.0	3.0
Porridge taste	8.0	20.7	4.0	18.0	4.1	0.0	12.4
Green maize taste	3.3	3.3	16.0	0.0	8.2	6.0	4.2
Porridge quality	12.0	8.0	0.0	10.7	0.0	2.0	7.8

Source: Adoption Monitoring Survey/Angola, June 2013.

The traits that were disliked by sample households were susceptibility to drought (15.5%), susceptibility to storage pest (5%) and susceptibility to field pest (9.5%), lack of performance under low fertility (8%) and fertilizer requirements (5.3%). The types and frequencies of the negative traits mentioned clearly show that the maize varieties being grown by farm households of Kwanza Norte, Lunda Norte and Malange are more susceptible to drought than those being grown in Bié, Huambo and Kwanza Sul (Table 18).

Table 18: Negative traits of maize varieties being grown in the study areas (% of hh)

	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Sample mean
Drought tolerance	6.7	12.7	40.0	7.3	26.5	40.0	15.5
Performance under low fertility	12.7	10.0	0.0	8.7	2.0	0.0	8.0
Fertilizer requirements	8.7	8.0	0.0	4.7	0.0	0.0	5.3
Field pest resistence	15.3	6.0	0.0	15.3	0.0	4.0	9.5
Storage pest resistence	3.3	6.0	2.0	9.3	2.0	0.0	5.0
Don't know	24.0	28.0	44.0	28.7	49.0	46.0	31.7

Source: Adoption Monitoring Survey/Angola, June 2013.

When selecting maize varieties to grow (Table 19), sampled households indicated that they consider cob size (25.5%), grain size (15%), grain yield (12.2%), grain color (8.2%), resistance to storage pests (6.2%) and food quality (porridge). Farm households in Kwanza Norte, Lunda Norte, and Malange provinces are interested in yield quantity related traits (e.g., size of cob and grain).

Table 19: Most important traits considered when selecting maize varieties to grow (% of hh)

	Bié	Huambo	Kwanza N.	Kwanza S.	Lunda N.	Malange	Sample mean
Grain yield	2.7	8.1	24.0	10.0	32.0	28.0	12.2
Grain size	15.3	24.8	10.0	13.3	2.0	8.0	15.0
Cob size	31.3	9.4	18.0	44.7	14.0	18.0	25.5
Porridge taste	6.7	5.4	4.0	11.3	0.0	0.0	6.2
Storage pest resistence	10.0	11.4	4.0	2.7	0.0	0.0	6.3
Grain color	10.0	18.8	0.0	3.3	0.0	2.0	8.2

Source: Adoption Monitoring Survey/Angola, June 2013.

4.2.6 Level of adoption of improved maize varieties

4.2.6.1 Proportion of farmers growing improved maize varieties by district

About 65.2% of farm households indicated that they have the experience of growing improved maize varieties, where Bié province stand with 67.1%of respondents, Huambo 59.7% and Kwanza Sul 69%. This proportion is in relation with farmers' classification. According to researchers, adoption level of improved maize varieties (the five varieties listed above) is about 13.8%.

5.0 Regression and results

5.1 Determinants of likelihood of maize adoption

Factors influencing the adoption of new agricultural technologies can be divided into three groups: farm and household characteristics, attributes associated with the technology and farming objective. Factors in the first group include literacy level of household head, age, size of household and farm size. The second group includes type of technology and the third group includes the livelihood strategies of the farm household (Table 20).

Table 20: Descriptive statistics for variables used in adoption model

Variable	Mean	Std. Dev.	Min	Max	Obs.
Ever grown DT maize	.23	.42	0	1	600
Gender of household head	.11	.32	0	1	599
Age of household head	47.6	14.9	15	95	593
Literacy of household head in schooling years	4.2	2.9	0	12	587
Hh members engaged in agricicultural activities	3.3	2.0	1	15	599
Total maize area planted	1.4	1.3	.01	10	599
Member received advices on new variety	.33	.47	0	1	600
Drouhgt affected household over last 10 years	1.9	1.2	0	10	589

Source: Adoption Monitoring Survey/Angola, June 2013.

Result of the probit model for the adoption of maize varieties are presented in Table 21. The probit model was used because the response on adoption of maize varieties was a binary variable (1= if the household has ever grown DT maize varieties and 0 = otherwise). Age of households, literacy level of household head, members of household engaged in agricultural activities, total maize area planted and frequence of drought in the region were found to positively influence adoption.

Table 21: Determinants of likelihood of maize adoption in the study areas

Adoption of improved maize varieties	**Coef.**	**Std. Err.**	**P>|z|**
Gender of household head	.085	.213	.692
Age of household head	.017*	.005	.000
Literacy of household head	.055*	.024	.024
Member engaged in agricultural activities	.095*	.031	.002
Total maize area planted	.120*	.050	.002
Member received advices on new var.	.235	.131	.007
Drought affected household	.156*	.156	.001
Constant	-2.755	.337	.000
Number of obs.=572		Prob>chi^2=.0000	
Chi^2(7)=70.69		Pseudo R^2=.1144	

Source: Adoption Monitoring Survey/Angola, June 2013.

5.2 Intensity of adoption improved maize varieties

Variables selected to determine the intensity of adoption of improved maize varieties are gender of the household head, age of the household head, literacy of the household head, number of household members engaged in agricultural activities in 2012/2013 season and number of times the household was affected by drought over last 10 years (Table 22).

Table 22: Descriptive statistics of variables used in the Tobit model

Variable	Mean	Std. Dev.	Min	Max	Obs.
Proportion of land allocated to maize	65.4	30.19	1	100	598
Gender of household head	.89	.32	0	1	597
Age of household head	47.6	14.9	15	95	597
Literacy of household head in schooling years	4.2	2.9	0	12	585
Hh members engaged in agricultural activities	3.3	2.0	1	15	597
Drought affected household over last 10 years	1.9	1.2	0	10	587

Source: Adoption Monitoring Survey/Angola, June 2013.

The results from theTobit model on the intensity of adoption of improved maize varieties are presented in Table 23. The Tobit model was used because the dependent variable is a contunuous variable but truncated between 0 and 1. Significant variables were number of household members engaged in agricultural activities and drought risk in the location of residence. Both variables were positively influencing the intensity of adoption of improved maize varieties in the study areas.

Table 23: Intensity of adoption of improved maize varieties

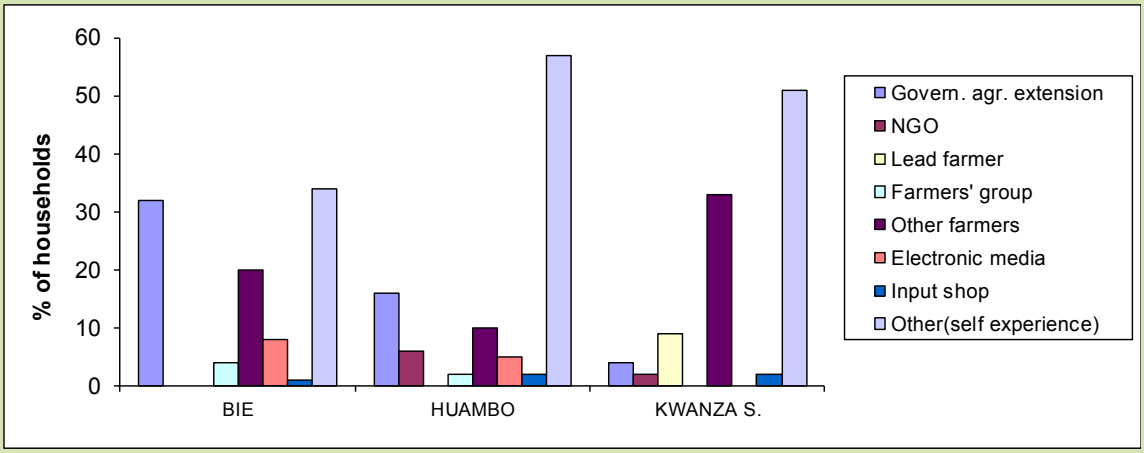
Intensity of improved maize varieties	Coef.	Robust Std. Err.	P>|z|
Age of household head	.020	.140	0.888
Literacy of household head	.416	.666	0.533
Member engaged in agricultural activities	2.208*	.991	0.026
Drought affected household	4.078*	1.570	0.010
Constant	55.346	8.768	0.000
Number of obs.=572		Prob>F=.0081	
F (4, 568)=3.48		Pseudo R^2=.0034	

Source: Adoption Monitoring Survey/Angola, June 2013.

5.3 Drought tolerant maize varieties - awareness and adoption

5.3.1 Sources of information on DT maize varieties

All provinces in the survey areas are covered by government extension services. Farm households learned about DT maize varieties mainly through self experience (57%), other farmers (33%), and government extension services (32%). Lead farmer in the region and NGO were also mentioned as sources of information in the study areas (Figure 6).



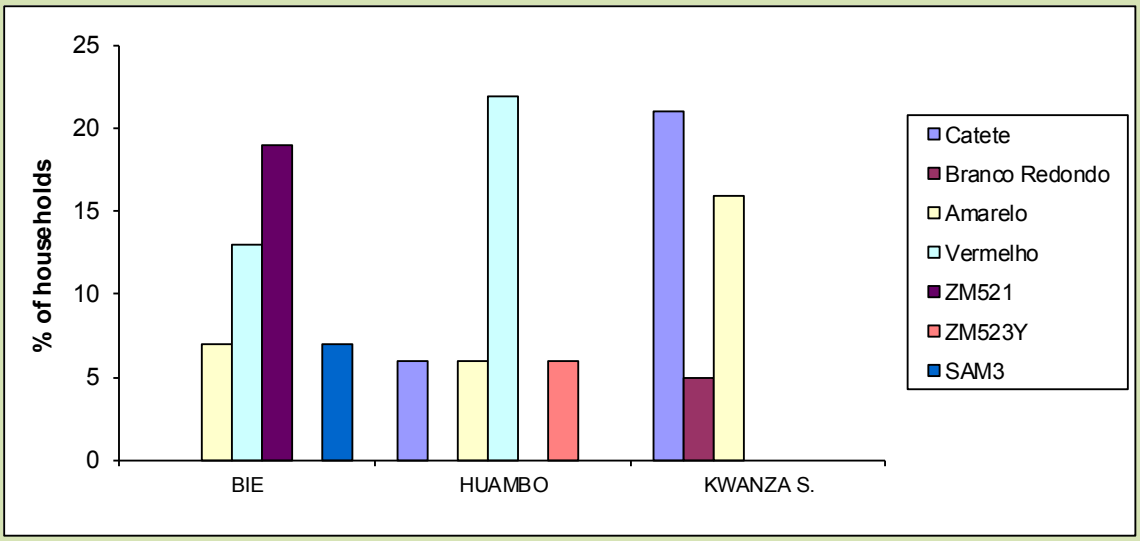
Source: Adoption Monitoring Survey/Angola, June 2013.

Figure 6: Sources of information on DT varieties in the study areas (% of hh)

5.3.2 Experience in DT maize production

Farmers consider some of the varieties they are growing as drought tolerant. DT maize varieties currently grown in the study areas are Catete in Huambo (2.7%) and Kwanza Sul (15.6%), Branco Redondo in Huambo (8.1%) and Kwanza Sul (3.1%), Amarelo in Bié (12.7%), Huambo (8.1%) and Kwanza Sul (15.6%), Vermelho in Bié (21.8%), Huambo (24.3%) and Kwanza Sul (3.1%), ZM521 in Kwanza Sul (6.3%), and SAM3 in Bié (3.6%) and Huambo (2.7%).

Nine DT maize varieties were indicated to have been grown in the past. The most frequent being Catete in Kwanza Sul, Vermelho and Amarelo in Huambo, and Amarelo, Vermelho, ZM521, SAM3 in Bié (Figure 7).



Source: Adoption Monitoring Survey/Angola, June 2013.

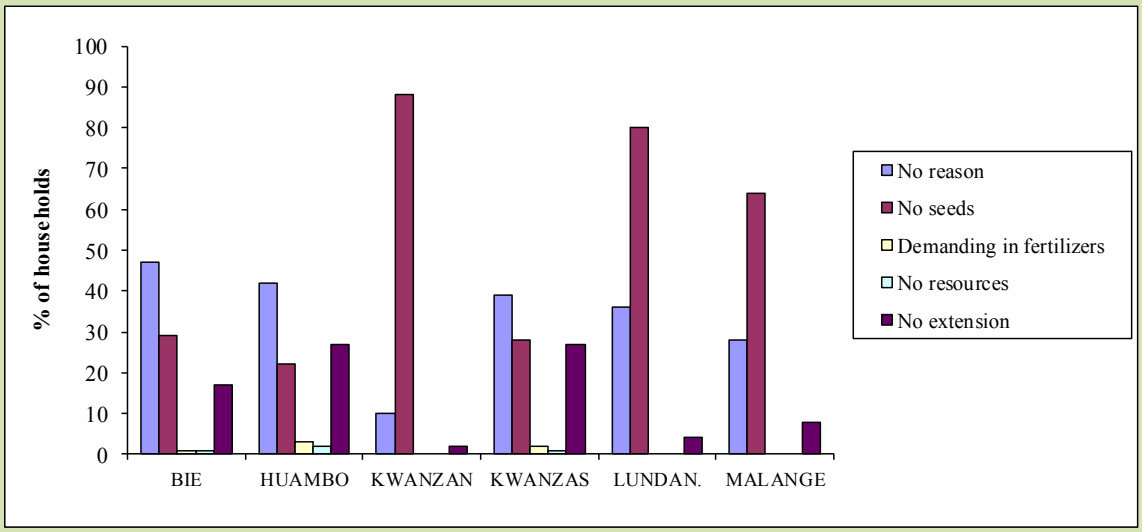
Figure 7: DT maize varieties grown in the past in the study areas (% of hh)

5.3.3 Distribution of DT maize growing experience in years

There were 32, 21 and 19 farmers who reported that they have grown DT maize varieties in Bié, Huambo, and Kwanza Sul provinces, respectively. In total 72 farmers reported the time of their first exposure to DT maize in the study areas. Out of these 72 farmers, 56.9% indicated that they got exposed to DT maize between 2007 and 2012, with 68.7% of the 32 in Bie, 28.5% of those in Huambo, and 68.5% of those in Kwanza Sul. Of the 19 DT growing farmers in Kwanza Sul, 5.3% indicated that they first experienced DT maize varieties in 1963.

5.3.4 Reasons for not trying DT maize varieties

Sample households mentioned lack of access to seed (92.5%, n=600) mainly in "Planalto de Malange" provinces as the key reason for not trying to grow DT maize varieties. The other reasons mentioned were DT varieties' fertilizer requirement, and the low yield from DT maize as perceived by farmers (Figure 8). This simply shows the need for clear and precise information on DT maize varieties.



Source: Adoption Monitoring Survey/Angola, June 2013.

Figure 8: Reasons for not trying DT maize varieties in the study areas (% of hh)

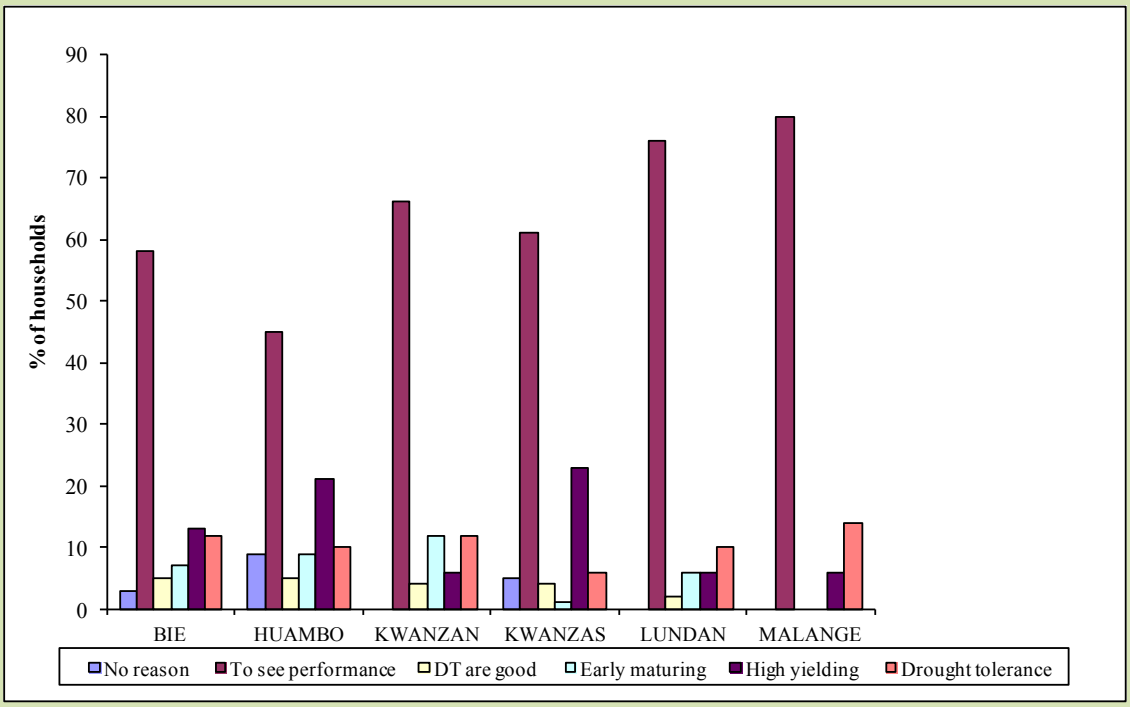
5.3.5 Willingness to grow DT maize varieties

About 97.2% of the sample households mentioned willingness to try DT maize varieties mainly in Bié (99.3%), Huambo (94%), and Kwanza Sul (95.3%). Interestingly, despite the lack of awarness about DT maize varieties, all sample households were found to be willing to try DT maize varieties.

5.3.6 Interest in DT maize

As mentioned above, all sampled households showed interest in growing DT maize varieties even if they are not certain what DT maize means. This is especially in Kwanza

Norte, Lunda Norte and Malange provinces. The reasons why they want to grow DT maize varieties are mainly 'to see performance', 'early maturity', 'high yielding', 'drought tolerance' and 'good seeds' (Figure 9).



Source: Adoption Monitoring Survey/Angola, June 2013.

Figure 9: Reasons for the interest in DT maize varieties in the study areas (% of hh)

5.3.7 Willingness to pay for OPV DT maize and its determinants

Sampled households were willing to pay a mean value of 481.76 AKZ (equivalent to 4.8 USD)[1] per 10 kg of OPV DT maize seed. The willingness to pay value ranged from 100.00 AKZ (1.0 USD) in Bié and Kwanza Sul provinces to 2,000.00 AKZ (20.0 USD) in Lunda Norte and Malange provinces.Results of the linear regression of willingness to pay for OPV DT maize varieties are presented in Table 25.

1 AKZ is Angolan Kwanzas. The official exchange rate in September 2013 was: 1USD= 100 AKZs.

Conclusion

The results show that as farmers experienced more droughts over the last 10 years, households were found to be less willing to pay for OPV DT maize varieties. This sounds counter-intuitive and yet given the fact that the level of awareness of DT maize is very low and that the varieties are yet to be widely available, it is expected that farmers might be less interested in OPV DT maize varieties. The model result also showed that compared to households that reported to be generating just sufficient income for the household, those who have to borrow to supplement their income were found to be more willing to pay for OPV DT. This could be due to the lower price charged for OPV maize varieties and the recycling advantage.

On the other hand, as farm size increases, the willingness to pay for OPV DT maize increases. This is expected as farmer households can afford to try new technologies and pay for them compared to those who own less land - in a livelihood system where land highly valued as household wealth. Farmers in Bié and Huambo provinces are less willing to pay for OPV DT maize seeds because they have a lot of sources of information about new maize varieties compared to Kwanza Sul contrary to farmers in Kwanza Norte, Lunda Norte and Malange who are depending only on government extension services. The access to different sources of information might have at least made them aware that there are other options – such as hybrid maize and hence less interested in OPV DT maize (Table 25).

Table 25: Factors influencing willingness to pay for 10 kg of OPV DT maize seed

Variable	Coefficient (β/t)
Age of household head	-0.001
	-0.72
Literacy level of the household head	-0.005
	-0.86
Household size	0.001
	0.16
Drought affected household	-0.023
	-1.71
Hoseholds with more income	0.012
	0.34
Households savers	-0.038
	-0.96
Households borrowers	0.059
	1.86
Households assisted	-0.026
	-1.00
Cattle owned	0.000
	0.00
Goats/sheep owned	0.004
	1.32
Pigs owned	0.011

	1.49
Total farm area	0.020
	2.47
Bie	-0.325
	-10.59
Huambo	-0.320
	-9.61
Kwaza N.	0.281
	6.31
Lunda N.	0.473
	9.13
Malange	0.284
	4.39
Constant	1.858
	23.73
N	565,000
Ll	-185.58
Aic	407.16
Bic	485.22

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