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Drought Tolerant Maize for Africa (DTMA) Project

Characterization of Maize Production Sub-Systems in Mossourize and Sussungenga Districts, Manica, Mozambique

Uaine Rafael, Feliciano Mazuze, Wilfred Mwangi, Augustine Langyintuo and Girma Tesfahun Kassie

CIMMYT MR
International Maize and Wheat Improvement Center

The International Maize and Wheat Improvement Center, known by its Spanish acronym, CIMMYT® (www.cimmyt.org), is an international, not-for-profit research and training organization. With partners in over 100countries, 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.

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DTMA

The Drought Tolerant Maize for Africa (DTMA) Project is jointly being implemented by CIMMYT and the International Institute of Tropical Agriculture (IITA), and is funded by the Bill & Melinda Gates Foundation and the Howard G. Buffett 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, known as the Drought Tolerant Maize for Africa (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), the United States Agency for International Development (USAID), 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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Drought Tolerant Maize for Africa (DTMA) Project

Country Report – Household Survey

Characterization of Maize Production Sub-Systems in Mossourize and Sussungenga Districts, Manica, Mozambique

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DTMA Country Report – Mozambique

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Foreword and acknowledgements

Maize is life to more than 300 million of Africa's most vulnerable population. It is Africa's most important cereal food crop. When recurrent droughts in sub-Saharan Africa (SSA) ruin harvests, lives and livelihoods are threatened, even destroyed. Drought has an overwhelming importance to SSA, affecting people's livelihoods, food security and economic development. Effective approaches to combat current impacts of drought are of uttermost importance, especially as the situation is set to worsen as climate change progresses.

The Drought Tolerant Maize for Africa (DTMA) initiative aims to address this challenge. It joins the efforts of people, organizations and projects supporting the development and dissemination of drought tolerant maize in 13 countries in SSA. The Bill & Melinda Gates Foundation and Howard G. Buffett Foundation support this initiative. For further information about the initiative, refer to the project website (http://dtma.cimmyt.org).

Developing, distributing and cultivating drought tolerant maize varieties is a highly relevant intervention to reduce vulnerability, food insecurity and the damage to local markets accompanying food aid in SSA. However, for this to succeed, it needs to be embedded in the local reality. For this purpose, each of the participating countries was supported to conduct community level assessment and farm household level surveys in the target areas. This report presents the findings of the household survey with the aim of serving as a baseline and characterization of the maize producing households in Sussundenga and Mossurize districts of Mozambique.

This country study received financial support from the DTMA project. The views expressed in this report are those of individual scientists and do not necessarily reflect the views of the donor, the DTMA project or the authors' institutions. During the course of the study, the authors benefitted from constructive contributions from Augustine Langyintuo, Wilfred Mwangi, Girma Tesfahun Kassie and Olaf Erenstein. The authors are responsible for any remaining errors and inferences.

Contents

List of Tables

List of Figures

Acronyms and abbreviations

CIMMYT	International Maize and Wheat Improvement Center
°C	Degree Celsius
DTMA	Drought Tolerant Maize for Africa
FGD	Focus Group Discussion
GDP	Gross Domestic Product
Ha or ha	Hectare
HH or hh	Household
IIAM	Institute of Agricultural Research in Mozambique
M	Meter
Mm	Millimeter
MTn	Meticas
NGO	Non-governmental organization
OPV	Open-pollinated variety
pa	Per annum
PCA	Principal Component Analysis
US$	United States Dollar

Executive summary

A household survey was carried out in July and August 2007 in Sussundenga and Mossurize districts of Manica Province in Mozambique under the auspices of the Drought Tolerant Maize for Africa (DTMA) Project of the International Maize and Wheat Improvement Center (CIMMYT). The insights presented in this report are based on 350 households randomly selected among the communities in both districts and information cordially provided by the extension officials and representatives of the Administration Office, Services for Economic Activities, Health and Education Directorates at district level.

This diagnostic study focused on collecting baseline data on farm households to construct indicators that could be used to measure the impact of the adoption of improved maize varieties in Mozambique. The study was conducted on respondents composed of 60% males and 40% females. Most (67.5%) of the respondents are household heads and 40% of the respondents are female. Nonetheless, 85.1% of the sample households are male headed. Average family size of the sample households was found to be slightly more than 7 persons with the average number of female family members a bit higher than that of males.

The land size owned by sample households ranges from zero to 84 hectares, with mean of 7.9 and standard deviation of 7.35 hectares. Irrigation is not that common and on average only 0.93% of the farm land holding of the sample households is irrigated. Most of the farmland is allocated to annual crops – specifically maize. Of the different maize varieties, most of the land is allotted to local maize varieties.

The study communities have limited access to extension services. For instance, in the 2006/7 season, of those surveyed only 12%, 10.9%, 8.9%, and 15.1% have attended field days, demonstration plot visits, maize related discussions, and made interactions with extension service providers, respectively. This level of access is much lower than comparable communities at least in DTMA project countries. The average number of public-extension-organized field days attended was 0.30 per household. The number of field demonstrations hosted by agricultural extension averaged 0.29 and ranged from no demonstrations to a maximum of 24 demonstrations.

Different maize varieties are being produced by the sample households. The varieties with high frequencies are either local or old improved varieties. Matuba, NdauouChindau, SC 513, and Pannar varieties are grown by many households in the study area. One third of the maize planted in the two districts was an open pollinated variety, Matuba. The second most popular maize variety was SC513.

The sample households generate about 70% of their income from paid employment, crop sales, livestock and livestock product sales, and petty trading. On average, 60% of the members of the sample households are engaged in off-farm activities. The main expenditure item for the sample populations in the study areas is food. Food items claim 48% of the annual expenditure of the sample households. The data generated also show that clothing is the second important expenditure item.

The most important challenge in the study communities is low productivity of the agricultural sector. One crucial component of improving livelihoods is therefore improving the productivity of agriculture. Discussions with sample households have revealed that increasing area under cultivation

is considered to be the most feasible way to increase agricultural production. This must have emanated from the fact that the average land holding is high and the extent of fallowing shows that there is still a lot of land that can be cultivated if the need arises. Increasing cultivated area was followed by application of manure and the use of improved seeds.

The low productivity and production of agriculture has a direct bearing on the food economy of the households. The sample households have indicated different coping mechanisms to mitigate the food shortages they face now and then. The coping strategies include increased engagement in off-farm activities, selling small animals, reducing other expenditures, reduced frequency of food intake, selling other assets, selling cattle, withdrawing children from school, working for food, and receiving food aid.

Particularly, drought, frost or hail, land slide, livestock death, and flood or excess rain were mentioned to be the five most important livelihood shocks the community is facing. Drought is particularly an important agricultural risk in Sussundenga and Mossourize districts. About 60% of the respondents indicated drought as the most serious shock in the past 10 years. The 2001/2 and 2005/6 cropping seasons were indicated to be the driest over the last 10 years. Maize was heavily affected by drought. More than 90% of respondents indicated that maize was negatively affected by drought.

All kinds of maize varieties - local, improved open-pollinated, and hybrid - , were reported to be very risky in terms of yield variability compared to all other crops. The wide ranging coping strategies include all activities farmers consider relevant given their resources, expectations, and understanding of the risk they are facing. In the study districts, sample households emphasized the importance of, among others, agricultural diversification, agricultural intensification, asset accumulation, and program participation.

The riskiness of maize was also emphasized in terms of the price variability in the market. Once again, all kinds of maize were reported to embody higher market risk than other crops produced by the farming community. Asset accumulation, program participation, contract farming, informal insurance, and other activities comprise the price risk management activities of the farming communities in the study areas.

Location, age of household head, maize related extension services, and proportion of land allocated to maize were found to be important factors influencing adoption of improved maize varieties. The extent or intensity of adoption of improved maize varieties in these two rural districts of Mozambique was found to be influenced by location, average literacy level of the household, proportion of land allocated to maize, and fertilizer use.

1 Introduction

Agriculture in Mozambique is almost entirely dominated by smallholders. The agricultural economy is a major source of livelihood and food - representing about two thirds of total consumption - especially among the rural poor. An estimated 68% of Mozambicans live in rural areas. Rural households are predominantly smallholders who provide about 95 % of agricultural Gross Domestic Product (GDP) with the balance from a small number of medium and large commercial farmers. In 2003, there were an estimated 3.2 million farm families cultivating some 4.5 million hectares (World Bank 2005; UNDP. 2011). Two-thirds of agricultural production is for home consumption and only 5 % is generated by large-scale agriculture. Most of the agricultural land area for small (less than 10 hectares) and medium farms (10-50 hectares) is cultivated for basic food crops. By contrast, large farm enterprises (more than 50 hectares) produce mostly cash-crops.

The smallholder sector in Mozambique is characterized by holdings of multiple small plots, multiple crops, low input use, and low productivity. Average crop yields are about one half of the regional average. Smallholders have limited access to capital, little schooling, are at the mercy of highly variable rainfall, and suffer seasonal price risks. Farms typically use manual cultivation techniques and little or no purchased agricultural inputs. In 2003, only about 4 % of farmers used chemical fertilizers and only about 5 % used pesticides. The use of chemical inputs is generally concentrated among cash crop growers. The overall agricultural sector is also characterized by the dominance of maize and maize based production systems. Although maize production in Mozambique has increased rapidly since the early 1990s as a result of increased maize cultivated area, maize yields have decreased slightly since 2006 as illustrated in Figure 1.

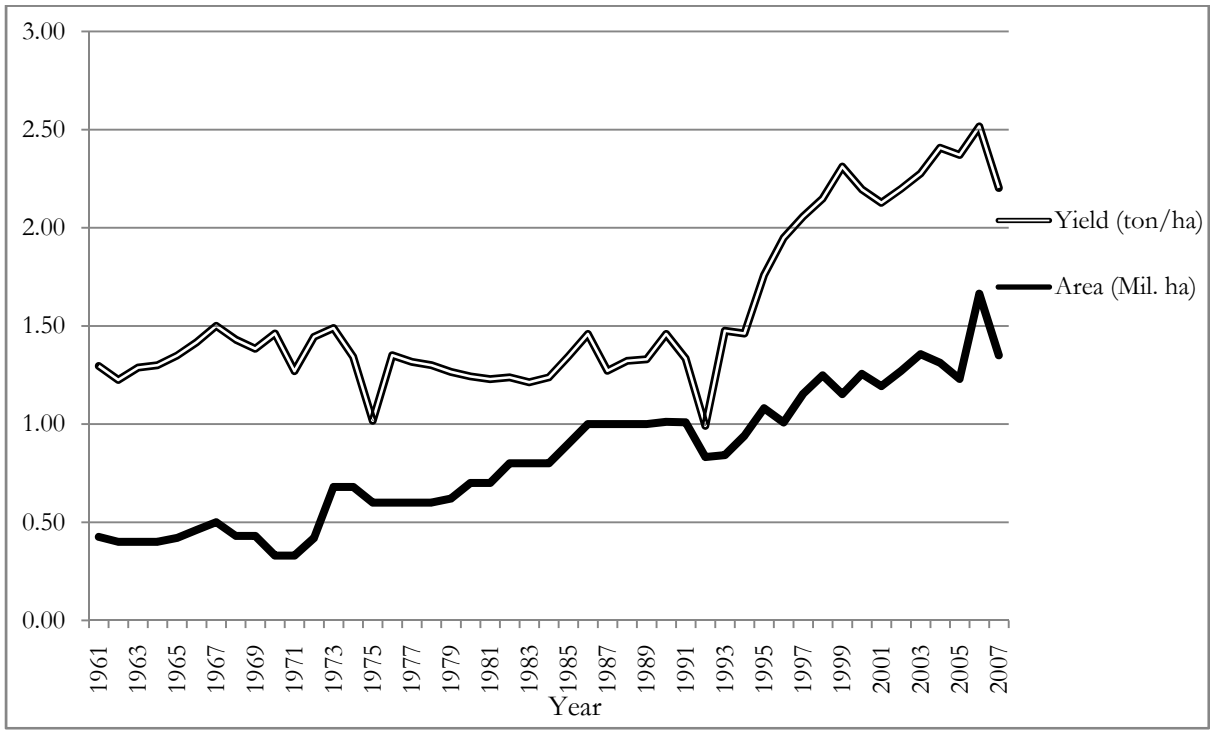

Figure 1. Production and yield of maize in Mozambique (1961-2007)
Source: FAOSTAT 2010.

Actual intercropped maize yields range from approximately 0.4 to 1.3 tons/hectare which is considerably lower than the estimated potential yields of between 5 and 6.5 tons/hectare. In order to increase the agricultural sector's contribution to the Mozambican economy it is crucial to increase on-farm productivity through improved varieties adapted for local growing agro-climatic conditions and better crop management. However, productivity benefits will not be realized unless substantial and adequate improvements are made in seed production and distribution, output market systems and adoption rates of improved varieties. According to agricultural census data, at the country level, the use of improved crop seed varieties is estimated at 5 – 10% of total crop areas.

The Drought Tolerant Maize for Africa (DTMA) project of the International Maize and Wheat Improvement Center (CIMMYT) is an intervention aimed at developing and disseminating drought tolerant, high-yielding, locally adapted maize varieties and reaching 30–40 million people in sub-Saharan Africa with these varieties in 10 years. Designing and implementing efficient and effective research and extension interventions requires, among others, proper understanding of the existing circumstances to identify the crucial livelihood challenges and to prioritize the best-bet interventions. This household level survey is part of a series of biological and socioeconomic activities of the project. This diagnostic study in particular focused on collecting baseline data on farm households to construct indicators that could be used to measure the impact of the adoption of improved maize varieties in Mozambique.

This report presents the details of the characteristics of the study communities. Section 2 presents the materials and methods followed in the study while Section 3 presents the characteristics of the study areas and the sample households. The different livelihood capitals of the sample households, and crop livestock based livelihood strategies are presented in section 5. Section 6 presents a detailed account of the sources of income and items of expenditure, risk and shock management strategies of households and the use of improved maize technologies – particularly improved maize varieties. Finally, Section 6 presents conclusions based on the key observations made in this study.

2 Materials and methods

2.1 Sampling and data collection

A household survey was carried out in July and August 2007 in Sussundenga and Mossurize districts of Manica Province in Mozambique under the auspices of DTMA. The insights presented in this report are based on a semi-structured questionnaire based survey conducted on 350 households. The households were randomly selected within two districts that fell into the 20-40% probability of failed season (PFS) that DTMA has planned to address most through the drought tolerant maize germplasm the project will produce. PFS implies the probability of growing season failure as a result of insufficient soil water availability (either a too-short growing season, or a too-severe level of water stress within the growing period) (Thornton et al, 2006).

Data and information were also generated from relevant institutions that actively operate within the agricultural sector. We have generated data and information from, among others, the administration offices, Services for Economic Activities, and Health and Education offices at district level.

2.2 Data analysis

The data generated were analysed in different ways to explain the different aspects of the livelihoods of the farming communities in the study districts. Mainly descriptive statistics have been employed to characterise the socioeconomic and biophysical features of the households. Principal component analysis (PCA) is also used to generate the wealth indices for each household based on fixed asset and livestock endowments. This asset based method was employed following the rich literature base that highlights the difficulty and irregularities of wealth indicators developed based on reported income and expenditure data. According to Montgomery et al (2000), the collection of accurate income data is quite demanding as it requires extensive resources for household surveys. And in some cases, an indicator of income is difficult use. For example, income information does not capture the fact that people may have income in kind, such as crops which are traded (Cortinovis et al, 1993). Therefore, asset based indicators have become quite common in characterising welfare states of people (Filmer and Prichett, 2001; McKenzie, 2003).

PCA is a statistical procedure used to reduce dimensions of a data set in terms of aggregating variables through orthogonal linear combinations of the variables. Mathematically, from an initial set of n correlated variables, PCA creates orthogonal components, where each component is a linear weighted combination of the initial variables. For n assets and livestock, for instance,

$$\begin{aligned} PC_1 &= a_{11}X_1 + a_{12}X_2 + \ldots + a_{1n}X_n \\ &\vdots \\ PC_m &= a_{m1}X_1 + a_{m2}X_2 + \ldots + a_{mn}X_n \end{aligned} \qquad (1)$$

Where a_{mn} represents the weight for the m^{th} principal component and the n^{th} variable.

The weights for each principal component are given by the eigenvectors of the covariance matrix as we used the original data. The correlation matrix could be used if the data were standardized. Using the scores generated by the first principal component and the mean and standard deviation of the original data set, the wealth indices were computed using the formula:

$$W_j = \sum_i^n [\gamma_i * (x_{ij} - \bar{x}_i) / \delta_i] \qquad (2)$$

where, Wj is the wealth index for each household; γ_i represents the weights (scores) assigned to the n assets and livestock on the first principal component; x_{ij} is the original observation of asset i in household j, $\bar{x}_i$ is the mean holding of asset i in the sample, of each of the n variables; and δ_i the standard deviation of holding of each of the assets in the sample.

The wealth indices were used to categorize the households into three wealth classes. Wealth class one has the poor households and their indices ranged from the negative minimum to the mean of the negative indices, and the rich wealth class included households with indices that are above the

average of the positive wealth indices. Those households with indices between the mean values of the negative and positive wealth indices were classified as middle income.

The data analysis also included econometric modeling of the factors that influence adoption decision and then intensity of adoption. The nature of adoption and intensity of adoption decisions, and hence the factors that influence the decisions, are very much related. In addition, the intensity of adoption will be modeled only for those households who have already adopted making the sample restricted. Accordingly, we have estimated a double hurdle model to identify the factors that determine the interrelated decision of adoption and intensity of adoption.

Double Hurdle Model

The double-hurdle model is due to Cragg (1971) and is a parametric generalization of the Tobit model whereby two sequential decisions are assumed to follow two separate stochastic processes. In our case, the two decisions are the decision to adopt and the decision on the intensity of adoption.

The first decision variable (D) takes the value 1 for farmers who have grown improved maize variety and takes the value zero otherwise. The expected utility of adopting a technology (D_i^*) is latent, however. Therefore, the first decision (adoption hurdle) of the households is formulated as

$$D_i^* = z_i'\alpha + \varepsilon_i$$
$$D = \begin{cases} 1 \text{ if } D^* > 0 \\ 0 \text{ otherwise} \end{cases} \quad (3)$$

Not all improved maize adopters do grow improved maize at the same level of intensity. Intensity of adoption is measured in terms of the proportion of farm area allocated to improved maize varieties. The intensity of adoption (intensity hurdle) of improved maize varieties is given as in a tobit like function:

$$y_i^* = x_i'\beta + \upsilon_i$$
$$y^{**} = \begin{cases} y^{**} \text{ if } y^* > 0 \\ 0 \text{ otherwise} \end{cases} \quad (4)$$

The observed value of the proportion of land allocated to improved maize is therefore given by:

$$y_i = D_i y_i^* \quad (5)$$

Models of both decisions (hurdles) are assumed to be linear in parameters and the random terms are assumed to be independently and normally distributed:

$$\begin{pmatrix} \varepsilon_i \\ \upsilon_i \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & \sigma^2 \end{pmatrix}\right] \quad (6)$$

The matrices x and z are overlapping sets of explanatory variables for the two decisions. The double-hurdle model is estimated with the maximum likelihood procedure that maximizes the log of the following likelihood function:

$$L = \prod_0 \left(1 - \Phi\left(\frac{x_i\beta}{\sigma_{\varepsilon_1}}\right).1 - \Phi\left(z_i\alpha\right)\right) \prod_+ \left(\Phi\left(z_i\alpha\right)\frac{1}{\sigma_{\varepsilon_1}}\phi\left(\frac{y_i - x_i\beta}{\sigma_{\varepsilon_1}}\right)\right) \quad (7)$$

where $\Phi(.)$ is the standard normal cumulative density function and $\phi(.)$ is the standard normal probability density function. The two processes are non-separable and thus both parts of the likelihood function must be maximized simultaneously.

Given the cross sectional nature of our data and hence the possibility of conditional heteroscedasticity, we estimated the double hurdle model with robust option to generate the Huber-White-Sandwich standard errors (Cameron and Trivedi, 2009).

2.3 Description of the study area

Sussundenga district is located in the central region of Manica whereas Mossurize District is in southern Manica. Mossurize district comprises three (3)"*Postos Administrativos*", namely, Espungabera-Sede, Chiuraírue e Dacata, ten (10) villages (*localidades)* and 188 communities (*povoados*). There are four (4) *PostosAdministrativos*, and twelve (12) villages (*localidades)* and 92 communities *(povoados*) in Sussundenga District. The total land area of Mossurize and Sussundenga Districts is 5,096 km^2 and 7,060 km^2, respectively. The Focal Group Discussions (FGDs) were conducted in 12 communities shown in Figure 2.

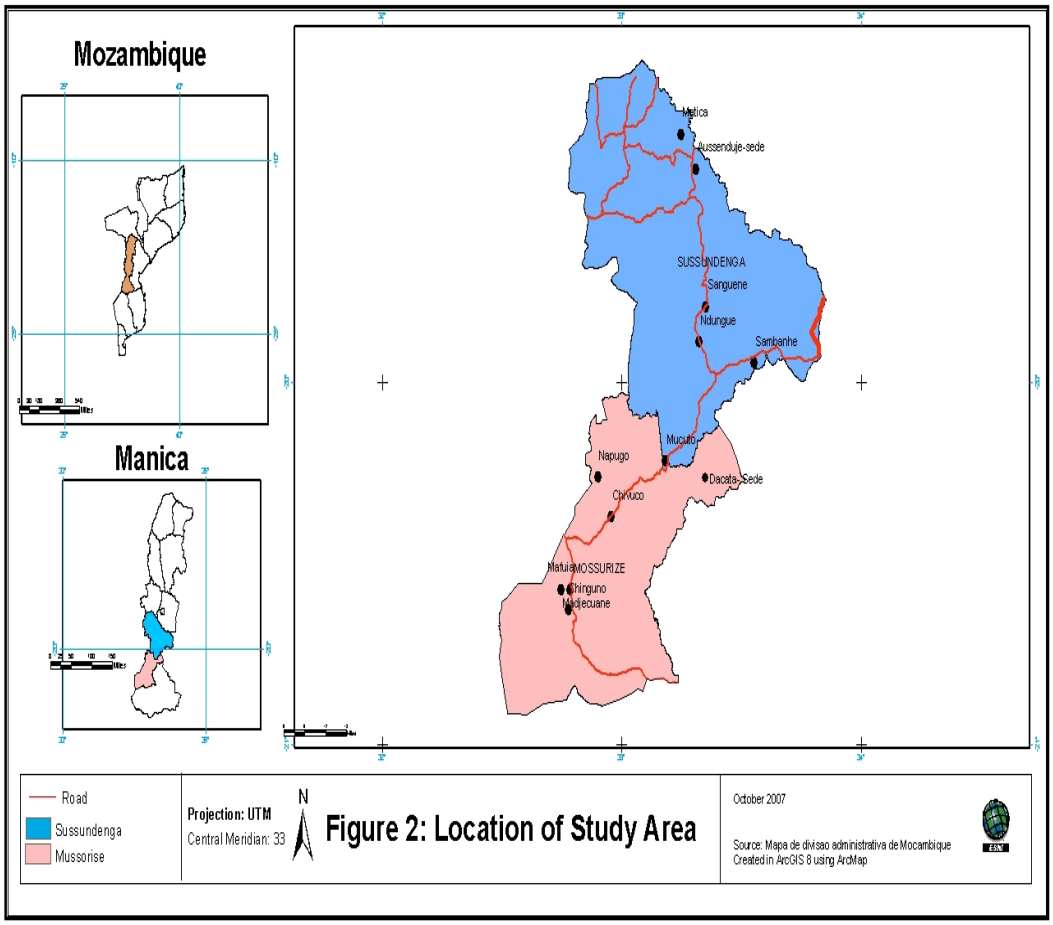

Figure 2. Location of the study area

According to 2007 Population Census, Mossurize District had 195,182 inhabitants of which 44% were men and 56% were women. Sussundenga District had 129,851 inhabitants of which approximately 53% were women and 47% were men (Table 1).

Table 1. Characterization of the study districts

District	PostoAdministrativo	Area (km²)	Population	Localidade	No. of communities
Mossurize	Chiuraírue	2,096	40,215	Chiuraírue-Sede	32
				Chicuecuete	33
				Chirera	21
	Dacata	2,650	55,896	Dacata-Sede	21
				Mave	20
				Bungonhe	7
				Macuvo	26
	Espungabera	350	20,133	Espungabera-Sede	6
				Dibi	19
				Matengane	3
Sussundenga	Sussundenga-Sede	2.411	39,241	Sussundenga-Sede	14
				Matica	8
				Munhinga	14
				Nhaurombe	9
	Muoha	1.178	36,324	Muoha	6
				Mupandea	11
	Rotanda	1,427	9,835	Mussapa	5
				Tse-tsera	2
	Dombe	2,055	7,222	Dárue	8
				Javela	6
				Matakara	4
				Muoco	5

Source: DTMA survey 2007.

The Medium Altitude Region of Central Mozambique covers land between 200 and 1000 meters above sea level (masl) located in the provinces of Manica and Sofala. The average annual rainfall is 1000 -1200 mm concentrated mainly in the rainy season (between November and March). The majority of soils are light, with some occurrences of heavy soils along the major rivers. The average temperature during the crop growing period ranges from 17.5 to 22.5 °C (Table 2). Maize, sorghum, cassava and cowpea are the predominant crops in this agro ecological zone. Sweet potato and rice are cultivated in the soils with residual moisture. There is good potential for cotton and tobacco farming. Cattle are raised by wealthier farmers in regions less affected by tsetse fly. Chicken population has fallen because of frequent outbreaks of Newcastle disease.

Table 2. Agro ecological features of Sussundenga and Mossurize districts

Physical Feature	Unit	District Mossurize	Sussundenga
Minimum level of rainfall registered	Mm	800	600
Maximum level of rainfall registered	Mm	2,070*	1,400*
Average level of rainfall	Mm	1,500	1,155
Average altitude of the district	M	600	500
Minimum level of temperature	°C	15.1	15.3
Maximum level of temperature	°C	25.1	27.2
Total land area	Ha	509,600*	706,000*
Arable land; land potentially available for farming	Ha	339,280‡	531,060‡
Cultivated land	Ha	52,972*	42,882*
Land covered by forests	Ha	229,600+	509,300+
Average cultivated area per household	Ha	1.9*	1.5*

Source: DTMA survey 2007.

3 Household characteristics

3.1 Categorization of households based on non-monetary measure of wellbeing

Principal component analysis – asset wealth endowment

Principal component analysis (PCA) was run to generate the indices by way of reducing the dimension of the various indicators of wellbeing in such a way that most of the variation and contribution of each of the assets is captured. Following Filmer and Prichett (2001) we included all asset and non-asset variables that have strong correlation with the expenditure data we have (Table 3). In cases where monetary income and expenditure data are limited it is common to use other related variables to measure the relative wellbeing (Cortinovis et al 1993). It is also suggested that whenever PCA is used to measure wellbeing, it is important to include variables of different dimensions (demographic, physical asset, natural asset, etc) to capture the wide spectrum of livelihood status of the household (Filmer and Prichett 2001; McKenzie 2003). Accordingly, the

variables used in the PCA include age, sex of head of the household, literacy level, ownership of physical assets, number poultry owned, and access to off-farm income.

Table 3. Variables included in PCA based poverty index computation

	Mean	Std. Deviation
Age of household head (years)	48.53	13.126
Female headed household (yes =1)	.15	.353
Family size	7.23	3.834
No. of illiterate members	3.37	2.834
Number of motor vehicles owned	.02	.130
Number of draft animals owned	.01	.106
Number of mobile phones owned	.06	.359
Number of heads poultry (chicken, duck, fowl, pigeon)	14.31	14.628
HH sold assets because of drought (yes = 1)	.39	.484
Number interactions with extension staff	.51	1.994
Proportion of HH members with off-farm income	14.49	16.763
Literacy of HH head (in years of schooling)	4.91	3.551

Source: DTMA survey 2007.

The wealth classification can be formed into ways. The first option is to divide the households as poor and rich based on whether indices are less or greater than zero, respectively. The second option is to calculate the mean of the negative indices and the mean of the positive indices to classify the sample into three. The households will be poor, middle or rich if the index value is less than the mean of the negative indices, between the two means, or higher than the mean of the positive indices. We have adopted both options as discussed below.

Using the first approach, 57% of the households do have negative welfare index and hence can be considered as poor households, whereas the remaining 43% can be considered as better off (Figure 3). This clear cut classification is hardly useful as wellbeing is a relative socioeconomic concept. Accordingly, using the second approach we can classify the households as 23.7% poor, 62.6% middle, and 13.7% rich.

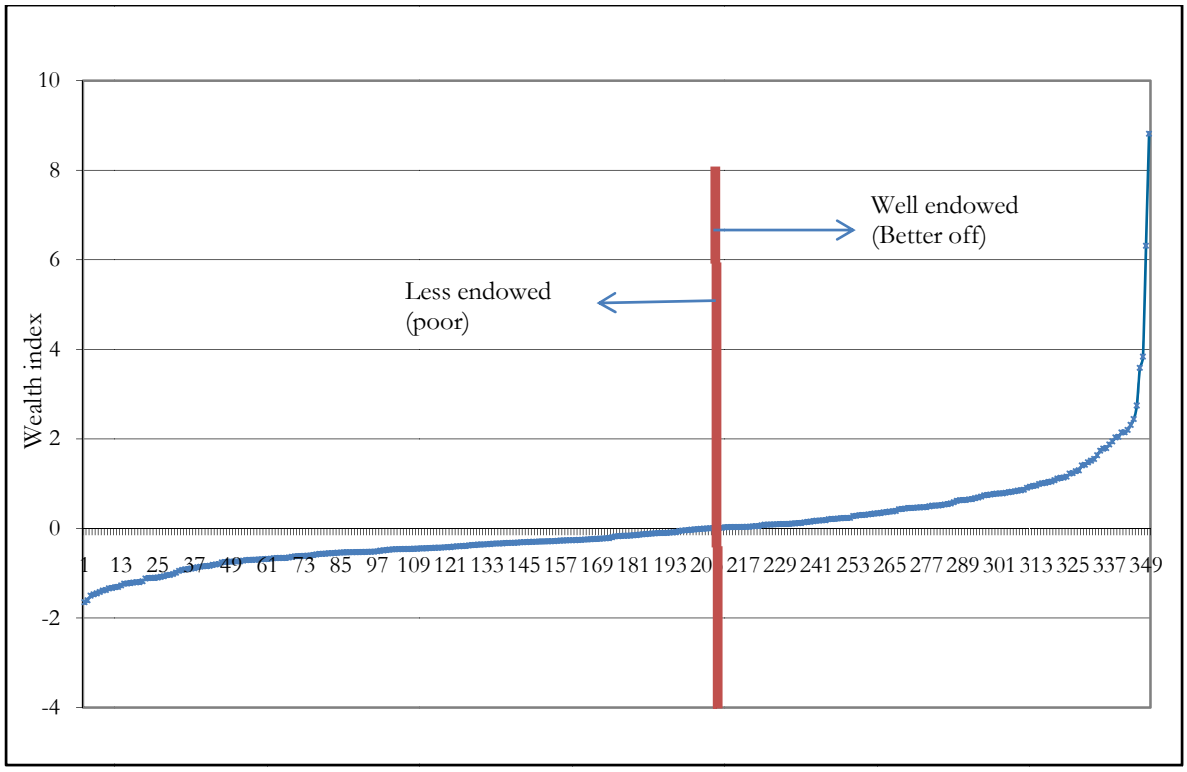

Figure 3. Distribution of the wealth index computed using PCA

3.2 Demographic characteristics of sample households

3.2.1 Human capital

The survey was conducted on respondents composed of 60% males and 40% females. Most (67.5%) of the respondents are household heads and 40% of the respondents are female. Nonetheless, 85.1% of the sample households are male headed (Table 4). Majority of the respondents have not attended school or have primary level education at best. Only 10% of the respondents have attended secondary school or higher. It was found out that 26.3% of the household heads are illiterate and 64% of the household heads have attended only primary or adult education (Table 4). The average education level in the sample households was also found to be only 3.73 years (Kassie et al. 2011).

Among the 103 respondents, 60.2% reported that main household decisions are made by the head of the household and in about 38% of the cases, the spouse makes the decisions. More than 68% of the respondents are married whereas the rest are single, divorced, or widowed.

Table 4. Characteristics of respondents and household heads

	Frequency	Valid %
Respondent (N=350)		
Is household head (yes)	235	67.5
Is female (yes)	140	40.1
Household head (N=350)		
Is female (yes)	51	14.9
Marital status		
Married	239	68.3
Single	60	17.1
Divorced	4	1.1
Separated	3	0.9
Widowed	44	12.6
Literacy		
Illiterate	92	26.3
Adult education	15	4.3
Primary school	208	59.4
Secondary school	34	9.7
Post-secondary school	1	0.3
Decision maker (N=103)		
Household head	62	60.2
Spouse	39	37.9
Children	2	1.9

Source: DTMA survey 2007.

The average age of the respondents was computed to be 44 years ranging from 15 to 99 years. Similarly, the average age of household heads was found to be 48.5 years with a narrower range of 20 to 95 years. Average family size of the sample households was found to be slightly more than 7 persons with the average number of female family members a bit higher than that of males. The man equivalent of the households was computed to be on average 4.6, ranging from 0.7 to 17.8. This shows that high variability in terms of family labor availability. Average dependency ratio was computed to be 1.34 implying that there are about 13 people depending on 10 economically active people in the sample households (Table 5).

Table 5. Demographic description of the sample households

	Mean	Minimum	Maximum	Std. Deviation
Age of respondent (years)	44.12	15.00	99.00	14.96
Age of household head (years)	48.53	20.00	95.00	13.28
Family size	7.23	1.00	23.00	3.84
No. of male family members	3.52	0.00	12.00	2.07
No. of female family members	3.71	0.00	15.00	2.41
Man equivalent units	4.59	0.70	17.80	2.53
Dependency ratio	1.34	0.00	9.00	1.16

Source: DTMA survey 2007.

The most important source of agricultural labor is the family. The average family size of the sample households was found to be about 7 persons with the proportion of female family members slightly higher than that of males. In terms of man-days equivalent, the sample households have on average a labor power supply of 4.6 man-day equivalent per days. Similarly, a summary of the sex and age of the household members available for farm activities showed that an average household has a supply of labor 44.5 months of agricultural work (Table 6).

Table 6. Household labor availability

	Mean	Mini-mum	Maxi-mum	Std. Devia-tion
Family size	7.23	1	23	3.84
Number of male household members	3.52	0	12	2.07
Number of female household members	3.71	0	15	2.41
Man equivalents units per household	4.59	.70	17.80	2.53
Number of household months pa available for farm work	44.50	0	252	31.81

Source: DTMA survey 2007.

3.2.2 Natural capital

Land ownership and allocation

The land size owned by sample households ranges from zero to 84 hectares, with mean of 7.9 and standard deviation of 7.35 hectares. Irrigation is not that common and on average only 0.93% of the farm land holding of the sample households is irrigated. Land transactions in terms of renting in and renting out do also exist to a limited extent (Table 7). Most of the farmland is allocated to annual crops – specifically maize. Of the different maize varieties, most of the land is allotted to local maize varieties. Considerable amount of land is allotted to legumes and fallowing. Fallowing is an important activity practiced by 86% of the sample households to maintain soil fertility. The farmland is plowed on average for about 4.61 years before left to fallow and the fallowing is on average for 3.21 years.

Table 7. Land ownership and allocation (in hectares)

	Mean	Minimum	Maximum	Std. Deviation
Farm size	7.88	0.00	84.00	7.35
Irrigated area	0.04	0.00	4.15	0.30
Area rented out	0.10	0.00	10.00	0.80
Area rented in	0.01	0.00	3.00	0.19
% farm size irrigated	0.93	0.00	100.00	7.02
Maize local area	2.20	0.00	12.00	1.93
Maize improved OPV area	0.76	0.00	10.00	1.54
Maize hybrid area	0.36	0.00	21.00	1.48
Other cereal area	0.98	0.00	21.00	1.77
Legume area	1.10	0.00	21.00	2.23
Roots & tubers area	0.72	0.00	21.00	1.65
Perennial crop area	0.01	0.00	3.00	0.16
Fallow/pasture area	1.06	0.00	12.00	1.80
Other crops area	0.69	0.00	40.00	2.51
Annual crop area	6.81	0.00	84.00	7.18

Source: DTMA survey 2007.

It is clear that land is an important resource to the farming communities and hence it is useful to see how correlated are the indicators of wellbeing and farm land ownership. We formed four artificial classes of farmland size owned; i.e., less than 5 hectares (35.4% of the observations), 5 to 10 hectares (39.7%), 10 to 15 hectares (13.7%), and more than 15 hectares (11.1%). As expected most of the poor and middle economic classes own less than 10 hectares of land whereas the rich households possess more than 10 hectares of farm land (Table 8). This clearly shows the strong correlation between the wealth status of households and their land holding.

Table 8. Land ownership patterns across wealth groups

Farm size class		Poor (N=83)	Middle (N=219)	Rich (N=48)	Total
0 to 4.99 ha	Frequency	48	71	5	124
	Valid %	57.80%	32.40%	10.40%	35.40%
5 to 9.99 ha	Frequency	30	96	13	139
	Valid %	36.10%	43.80%	27.10%	39.70%
10 to 14.99 ha	Frequency	4	35	9	48
	Valid %	4.80%	16.00%	18.80%	13.70%
above 15 ha	Frequency	1	17	21	39
	Valid %	1.20%	7.80%	43.80%	11.10%

Source: DTMA survey 2007.

Determinants of cultivated farm size

In allocating their most important resource; i.e., land, farmers look at different issues. Sample farmers indicated that they consider among others, food requirement, expected family labor availability, seed availability, financial capability to hire labor and purchase other inputs, expected market price, and current market price in deciding the size of land to be cultivated (Table 9). The most important were however indicated in order to be food requirement, expected family labor availability, availability of seed, and financial capability to hire labor.

Table 9. The three most important factors that determine the size of cultivated land in a season

	First rank		**Second rank**		**Third rank**	
	Frequency	Valid %	Frequency	Valid %	Frequency	Valid %
Food requirement	184.0	53.5	70.0	20.5	41.0	12.1
Expected family labor	81.0	23.5	106.0	31.0	91.0	26.8
Other	25.0	7.3	3.0	0.9	3.0	0.9
Availability of seed	24.0	7.0	80.0	23.4	56.0	16.5
Financial capability to hire	15.0	4.4	37.0	10.8	50.0	14.7
Cash availability to purchase	10.0	2.9	23.0	6.7	44.0	13.0
Expected grain price after	3.0	0.9	11.0	3.2	30.0	8.8
Current grain prices	2.0	0.6	12.0	3.5	24.0	7.1
Total (N)	344	100	342	100	339	100

Source: DTMA survey 2007.

Patterns of land allocation to maize over seasons

Discussions on the pattern of land allocation to maize as compared to the 2005/6 season showed that majority (54.5%) of the farmers have allocated less land to maize mainly because of poor rainfall and field pests and diseases (Table 10). On the other hand, 40.4% of the respondents have increased the land allocated to maize compared to the previous season and the main reason was good rainfall. This clearly shows the importance of the level of rainfall in farmland management in the sample community.

Table 10. Land allocation pattern to maize and reasons over two (2005/6 & 2006/7) seasons

Land allocated to maize compared to previous season	Reasons	Frequency	Valid %
Smaller	Inadequate seed	1	0.29
	Lack of labor force	2	0.58
	Shortage of land	4	1.15
	Poor rainfall	128	36.89
	Floods	6	1.73
	Pest and diseases	31	8.93
	Other	17	4.90
	Sub-total	**189**	**54.47**
Same	No variability in rainfall	7	2.02
	Yield related reasons	1	0.29
	No change in farm land size owned	2	0.58
	Not interested in expanding	1	0.29
	Other	5	1.44
	Sub-total	18	5.19
Larger	Had enough seed	16	4.61
	Had enough labor	11	3.17
	Had enough land to expand	11	3.17
	Interested in expanding	10	2.88
	Better rainfall	84	24.21
	Other	8	2.31
	Sub-total	**140**	**40.35**
	Total (N)	347	100

Source: DTMA survey 2007.

3.2.3 Physical capital

Rural Mozambique is doted by mud huts with grass thatch roofs all along its length and width. The study areas appear to be representative of the whole country at least in this regard. Nearly, 70% of the sample households live in mud huts of mainly grass thatch roofs. Far second (27%) is brick houses with either thatch or asbestos roofing (Table 11). This by itself is an important indicator of the poverty in which the communities in these districts are living in.

Table 11. Type of dwelling

	Frequency	Valid %
Mud hut with grass thatch roof	219	62.6
Mud hut with asbestos/iron roof	23	6.6
Brick house with grass thatch roof	27	7.7
Brick house with asbestos/iron roof	56	20.0
Block house with grass thatch roof	1	.3
Block house with asbestos/iron roof	14	4.0
Pole and dagga with grass thatch	7	2.0
Pole and dagger with iron roof	3	.9
Total	350	100.0

Source: DTMA survey 2007.

The basic asset ownership by sample households is also very minimal at least as compared to neighboring countries (Kassie et al 2011). Only radio and bicycle seem to be relatively well spread within the sample population as 34% and 26% of the households reported owning at least one, respectively. Otherwise, all assets – including plowing animals and tools – are owned by very few and even for those who own the numbers are very few (Table 12).

Table 12. Asset ownership of sample households

	Mean	Minimum	Maximum	Std. Deviation	Proportion
Car	0.02	0.00	1.00	0.13	1.70
Motor Cycle	0.03	0.00	5.00	0.32	1.10
Bicycle	0.43	0.00	6.00	0.98	25.70
Tractor	0.00	0.00	1.00	0.05	0.30
Tractor	0.01	0.00	1.00	0.75	0.60
Draft	0.01	0.00	1.00	0.11	1.10
Draft animal	0.01	0.00	2.00	0.16	1.40
Television	0.03	0.00	5.00	0.30	2.30
Radio	0.51	0.00	6.00	1.00	34.00
Private	0.01	0.00	3.00	0.18	0.90
Mobile	0.06	0.00	5.00	0.36	3.70

Source: DTMA survey 2007.

3.2.4 Financial resources

It is clear that credit plays a crucial role in lubricating the rural livelihood system through improved access to liquid capital for rather poor communities thereby increasing their propensity to purchase and utilize, among others, agricultural technologies. Most (96.3%) of the respondents have reported that they have shortage of funds to settle the basic costs of life. Access to credit is however very limited in the studied sample communities that only 3% of the households received credit.

3.3 Institutional issues and social capital

As indicated above, food requirement is the most important factor that determines the extent of agricultural activities undertaken by households. This implies that the households primarily aim at producing sufficient food for the family in designing their agricultural activities. It can therefore be easily said that as agriculture goes so goes the food economy of the households. The query about food insufficiency in a season indicated that 26% of the households did not have enough food in the last year (Table 13).

In the two districts there are several non-governmental organizations (NGOs) operating in the field of agriculture. Respondents indicated that Sassakawa Global 2000 (SG2000), Africare, the World Food Program (WFP) of the United Nations are some of the organizations present in Sussundenga and or Mossourize. Very few respondents benefited from those organizations. However, institutional support for food insufficient households does not seem to be available as only 1% of the households reported to have received any food relief. In fact, such interventions are so limited that only 2.3% of the respondents indicated to have benefitted from any kind of development program by governmental and non-governmental organizations (Table 13).

Table13. Fund/food shortage and access to support services

	Frequency	Valid % (/N)
Faced fund shortage at times (yes)	337	96.3
All hh members had enough food last year (yes)	258	74.1
Received credit of any type (yes)	10	2.9
HH benefited from development programs (yes)	8	2.3
HH received food relief	4	1.1
HH received seed relief	5	1.4

Source: DTMA survey 2007.

Access to agricultural extension services

Agricultural extension services need to be available to initiate and facilitate agricultural transformation. The importance these services play has already been well proved and documented. Its absence has also been indicated to be one of the reasons why agricultural production and productivity has been hampered in many rural economies. The study communities in Mozambique have limited access to extension services. For instance, in the 2006/7 season, only 12%, 10.9%, 8.9%, and 15.1% of respondents attended field days, demonstration plot visits, maize related discussions, and made interactions with extension service providers, respectively (Table 14). This level of access is much lower than comparable communities in DTMA project countries (Kassie et al. 2011).

The average number of public-extension-organized field days attended was 0.30 and the number of days attended hosted by extension ranges from zero to 24. The number of field demonstrations hosted by agricultural extension averaged 0.29 and ranged from no demonstrations to a maximum of 24 demonstrations.

The number of times that the interviewed households discussed maize crop production with agricultural extension agents ranged from zero to 24 and with an average of 0.30 times per

household. Agricultural research activities are not common in these two districts. The number of field days agricultural research institutions organized was not greater than 2 for the sampled farmers as indicated in the Table 14. Similarly, the number of field demonstrations organized by agricultural research institute and attended by farmers was not greater than 5. On no occasion did farmers discuss maize crop production with an agricultural research institute officials.

Table 14. Attendance of different extension activities in 2006/7

	Frequency	Valid %	Mean	Min	Max
Field days (Yes)	42	12			
Number of field days attended			.37	0	24
Demonstrations (Yes)	38	10.9			
Number of demonstrations attended			.34	0	24
Maize related discussions (Yes)	31	8.9			
Number of maize related discussions			.40	0	24
Any interactions with extension (Yes)	53	15.1			

Source: DTMA survey 2007.

4 Household livelihood strategies

4.1 Crop production

Agriculture was ranked as the number one livelihood strategy by 55% of the respondents, while 21% ranked it as second and 14% as third. Almost all sample households grow maize. More than 91% of the households grow a local maize variety, whereas 32.3% and 14% of them grow improved OP and hybrid maize varieties, respectively. In sum, 42% of the households grow improved maize varieties (OPV + hybrids). Maize is followed by other important crops such sorghum, potato, cow pea, beans, cassava, sesame, and ground nut (Table 15).

Table 15. Crops grown by the households

	Frequency (yes) (N=350)	%
Maize		
Local maize	320.00	91.40
OPV maize	113.00	32.30
Hybrid	49.00	14.00
Improved (OPV + hybrid)	147.00	42.00
Sorghum	156.00	44.60
Potato	84.00	24.00
Cow pea	81.00	23.10
Bean	68.00	19.40
Cassava	42.00	12.00
Sesame	35.00	10.00
Ground nut	30.00	8.60
Vegetable	17.00	4.90
Yam	11.00	3.10
Cotton	9.00	2.60
Rice	6.00	1.70
Millet	3.00	0.90

Source: DTMA survey 2007.

Different maize varieties are being produced by the sample households. The varieties being grown are indicated in Table 16 below. The varieties with high frequencies are either local or old improved varieties. Matuba, NdauouChindau, SC 513, and Pannar varieties are grown by many households in the study area. One third of the maize planted in the two districts was an open pollinated variety, Matuba. The second most popular maize variety was SC513. The two districts Mossourize and Sussundenga present an unusually high proportion of users of improved varieties (85%) compared to the national average of 7%. The list of varieties shows that farmers are mainly using old improved maize and local varieties. One of the reasons could be lack or unaffordability of seed.

Table 16. Maize varieties under production

Variety	Households growing (%)	Local	Improved
Matuba	24.44		X (old)
NdauouChindau	23.37	X	
SC 513	12.33		X
Pannar 1	7.93		X
Pan 67	7.72		X
Laposta	6.00		X
Sussuma	4.61		X
Chinhamuana	3.22	X	
Pannar 57	2.04		X
Chigogoyo	1.39	X	
Chitonga	0.86	X	
Pannar 3	0.86		X
SC 501	0.86		X
Candjere	0.54	X	
Semoc 501	0.43		X
Chiute	0.32	X	
Manica-SR	0.32		X
Chinaka	0.21		X
Chitombodzi	0.21	X	
Local	0.21	X	
R 201	0.21		X (old)
R 52	0.21		X (old)
Others	1.71	X	X

Source: DTMA survey 2007.

Storage Problem Affecting Maize Grain

Weevils and rats are major storage problems for maize in the surveyed areas. Sixty three % (63%) of the respondents said that weevils were the major post harvest problem while37% identified rats as a problem. The quarter of the year in which storage problems affect maize grain was indicated to be August to December. The problems affecting maize were similar to those affecting other cereals and legume grains. To control the maize grain problem identified above, farmers used several methods. To control rats, cats are used (16%), rodenticide (7%) and mouse-trap or snare (8%). To control weevils, insecticides are used (10%) (Table 17).

Table 17. Farmers' measures against maize grain storage problem

Method of control	Proportion	Std. Err.
Cats to control rats	0.16	0.02
Apply rodenticide	0.07	0.01
Mouse-trap/snare	0.08	0.01
Apply insecticide to control	0.10	0.02
Mixture pepper and tobacco	0.01	0.01
Conserve products in improvised	0.05	0.01
Expose the output to sun	0.02	0.01
Fumigate the agricultural output	0.04	0.01
Pesticide application	0.08	0.02
Eucalypts and leaves	0.03	0.01

Source: DTMA survey 2007.

4.2 Livestock wealth of sample households

Most of the sample households keep poultry – chicken, guinea fowl and ducks – and goats. The average holding per household was found to be 14 birds and about 5 small ruminants (Table 18). Generally, the average livestock holding (which is 1.18 TLU per household) is much less than neighboring countries (Kassie et al., 2011).

Table 18. Livestock wealth of the sample households

	Households owning	Average livestock
Households owning livestock (%)		
Improved cattle	0.3	0.01
Local cattle	18.3	1.32
Small ruminants		4.72
Goat	67.1	
Sheep	1.4	
Pig	8.6	
Poultry	90.3	14.31
TLU		**1.18**

Source: DTMA survey 2007.

5 Income and expenditure

5.1 Source of household income

The sample households generate about 70% of their income from paid employment, crop sales, livestock and livestock product sales, and petty trading (Table 19). On average, 60% of the members of the sample households are engaged in off-farm activities. Petty trading, teaching, masonry or carpentry, arts and crafts are the most important off-farm activities the sample households are engaged in.

Table 19. Household level income sources

	Valid %
Share of sources of income	
Crop sales	19
Fruits & vegetables sales	6
Livestock/fish sales	14
Petty trading	19
Paid employment	20
Self-employment	8
Remittances	5
Other sources	8
Access to off-farm activities (%)	
Petty trade	26.3
Teaching	7.7
Masonry/carpentry	6.3
Nursing	0.6
Art and crafting	5.4
Driving	2
Mechanic	1.1
Working on other farms	3.1
Other activities	20.3
Household members working off-farm (%)	60
Reported Household income - US$ pa	477.18
Per capita income US$ pa	76.02

Source: DTMA survey 2007.

The average reported household income was computed to be US$ 477.18 per annum. Given the family size of about 7 persons, the per capita reported monetary income is only 76.02 USD. Paid employment generates the highest mean income per household - 14,822.12 MTn while the lowest average income is obtained in the fruit and vegetable sales (Table 20).

Table 20. Sources of household income (MTn)

Income source	Obs	Mean	Std. Dev.	Min	Max
Crop sale	172	2577.53	6551.28	20	66000
Fruits and vegetables	54	1992.04	2629.02	50	18000
Livestock and fish	130	2285.15	4145.75	30	30800
Petty trading	101	10083.67	17230.24	11	100000
Employment	85	14822.12	18560.58	200	120000
Self employment	40	12776.25	56539.70	100	360000
Remittances	44	2367.27	4056.91	70	18000
Other sources	48	8051.46	10823.83	60	50400

Source: DTMA survey 2007.

5.2 Expenditure items

The main expenditure item for the sample populations in the study areas is food. Food items claim 48% of the annual expenditure of the sample households. The data generated also show that clothing is the second important expenditure item (Table 21). The average annual reported expenditure per household was found to be US$ 322.32 per annum, whereas the per capita reported monetary expenditure was US$ 51.24 per annum.

Table 21. Expenditure items

Expenditure item	Valid %
Expenditure items (%)	
Food	48
Tobacco/alcohol	6
Education	3
Medication	4
Clothing	27
Fuel	6
Transfers	1
Direct social costs	1
Other items	5
Reported expenditure - US$ pa	322.32
Per capita expenditure - US$ pa	51.24

Source: DTMA survey 2007.

5.3 Outlook of livelihoods

The most important challenge in the study communities is in general low productivity of the agricultural sector. One crucial component of improving livelihoods is therefore improving the productivity of agriculture. Discussions with sample households have revealed that increasing area under cultivation is considered to be the most feasible way to increase agricultural production. This must have emanated from the fact that the average land holding is high and the extent of fallowing shows that there is still a lot of land that can be cultivated if the need arises. Increasing cultivated area was followed by application of manure and the use of improved seeds.

5.3.1 Coping strategies against food shortage

The low productivity and production of agriculture has a direct bearing on the food economy of the households. The sample households have indicated different coping mechanisms to mitigate the food shortages they face now and then. The coping strategies include increased engagement in off-farm activities, selling small animals, reducing other expenditures, reduced frequency of food intake, selling other assets, selling cattle, withdrawing children from school, working for food, and receiving food aid (Table 22). Most of the households attach higher importance to working off-farm and selling small animals to generate cash and subsidize their food economy before opting for food aid and other measures.

Table 22. Food shortage coping mechanisms

Coping Mechanism 1 (N= 340)	Frequency	Valid %
Working more off-farm	108	31.8
Selling small animals	86	25.3
Reducing other expenditure	75	22.1
Reduced frequency of food intake	26	7.6
Selling other assets	14	4.1
Selling cattle	11	3.2
Withdrawing children from school	7	2.1
Working at Food-For-Work	7	2.1
Receiving food aid	1	.3
Other	5	1.5
Coping Mechanism 2 (N= 194)		
Working more off-farm	88	45.4
Receiving food aid	29	14.9
Selling small animals	22	11.3
Reducing other expenditure	16	8.2
Selling other assets	16	8.2
Working at Food-For-Work	10	5.2
Selling cattle	4	2.1
Withdrawing children from school	3	1.5
Selling farm equipment	3	1.5
Other	3	1.5
Coping Mechanism 3 (N=71)		
Working more off-farm	23	32.4
Receiving food aid	15	21.1
Working at Food-For-Work	13	18.3
Selling other assets	7	9.9
Selling small animals	5	7.0
Reducing other expenditure	2	2.8
Selling cattle	2	2.8
Reduced frequency of food intake	1	1.4
Other	3	4.2

Source: DTMA survey 2007.

5.4 Livelihood shocks experienced by sample households

Farmers in the study areas face a number of natural (drought, flooding), human (illness, conflict), and market risks (price hikes or drops). The natural risks were indicated to be the most important challenges households are living with. Particularly, drought, frost or hail, land slide, livestock death, and flood or excess rain were mentioned to be the five most important livelihood shocks the community is facing (Table 23).

Drought is an important agricultural risk in Sussundenga and Mossourize districts. About 60% of the respondents ranked drought as the most serious shock of the past 10 years. The 2001/2 and 2005/6 cropping seasons were indicated to be the driest over the last 10 years. Maize was heavily affected by drought. More than 90% of respondents indicated that maize was negatively affected by drought.

Flood was another risk factor. The risk perception of flood was not as high as the drought risk. When floods did occur, they affected maize in 85% of the cases. Frost was also important and it did affect maize production in 18% of the households interviewed. Land slide occurred once in the past ten years. Land slide was reported in 2000 and 2006. Maize was not heavily affected by land slide. Only 20% of the cases did affect maize production. Plant pests and diseases were important for maize producers. This risk affected 90% of the maize producers. Livestock diseases were particularly acute in 2005 and 2006 but did not affect directly maize production. Few farmers reported destruction of crops by animals as a serious shock in the past 10 years. Among input users, only 14% reported that large input price increase did affect maize directly. Large drop in maize grain price affected only 21% of the respondents. The largest output price drop was said to have occurred in 2006.

The death of a breadwinner or wife was a serious risk in the last 10 years. The largest number of deaths occurred between 2005 and 2007. The death of a member of a household, especially adults affected maize production in 27% of the cases. Illness or disability of a breadwinner affected maize production. The highest number of reported cases of illness occurred between 2005 and 2007. Burning of property did affect maize production in 16% of the cases when this shock was observed. Fire on property was reported in 20% of the sample.

Table 23. Livelihood shock reported by sample households

Shock	Frequency	Valid %
Drought	295	84.5
Frost/hail	209	59.9
Land slide	167	47.9
Livestock death	145	41.5
Flood/excess rain	140	40.1
Death of breadwinner	89	25.5
Illness/disability breadwinner/wife	70	20.1
Input price	67	19.2
Fire	63	18.1
Livestock diseases	51	14.6
Plant pests/diseases	49	14.0
Animal damage to crops	39	11.2
Family breakdown	35	10.0
Weeds	29	8.3
Maize price	25	7.2
Land loss	19	5.4
Birds	13	3.7
Conflict	13	3.7
Erratic rain	7	2.0
Other crops' price	7	2.1
Theft	6	1.7

Source: DTMA survey 2007.

5.4.1 Relative production and market riskiness of crops and coping strategies

A detailed look into the risk embedded in the crop production sub-system shows that production/yield risk (in terms of variability of yield over time) is considered to be highest in maize production. All kinds of maize; i.e., local, improved OP, and hybrid varieties, were reported to be very risky compared to all other crops (Figure 4). Sorghum and millet follow as second and third risky crops in terms of yield variability. Sweet potato and cassava were reported to be the least risky crops in terms of yield variability.

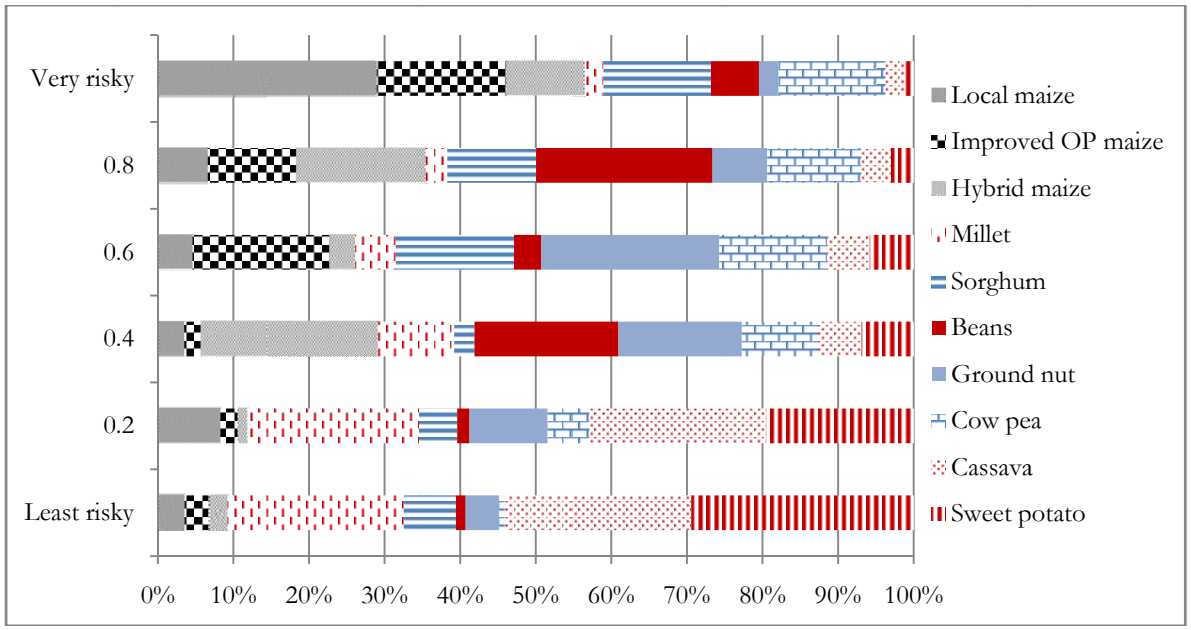

Figure 4. Relative yield riskiness of the crops under production in the study area

Farmers do have their own age-old management of the different types of agricultural risk they face (Hardaker et al., 2004; Tesfahun et al., 2006). The risk management activities of farmers can be both off-farm and on-farm. Therefore, the wide-ranging coping strategies t include all kinds of activities farmers consider relevant given their resources, expectations, and understanding of the risk they are facing. In the study districts, sample households emphasized that the importance of agricultural diversification, agricultural intensification, asset accumulation, program participation, and others (Table 24). Relevant information that is used to design production risk management activities is generated from other farmers, extension services, media, NGOs, and field days organized by different institutions.

Table 24. Coping strategies against crop yield risk and source of relevant information

Coping strategies	**Frequency**	**Valid %**
Agricultural diversification	300	86.0
Agricultural intensification	298	85.1
Asset accumulation	265	75.9
Program participation	219	62.8
Other activities	151	43.3
Source of information on yield risk reduction		
Extension	211	60.5
Other farmers	289	82.8
NGOs	169	48.4
Radio/Newspaper	195	55.9
Field days	103	29.5

Source: DTMA survey 2007.

The riskiness of maize was also emphasized in terms of the price variability in the market. Once again, all kinds of maize were reported to embody higher market risk than other crops produced by the farming community. For more than 50% of the respondents, maize is the most market-risk crop followed by sorghum, cow pea, and sweet potato (Figure 5). Millet, ground nut and cassava were reported to be the least market-risk crops in the study areas.

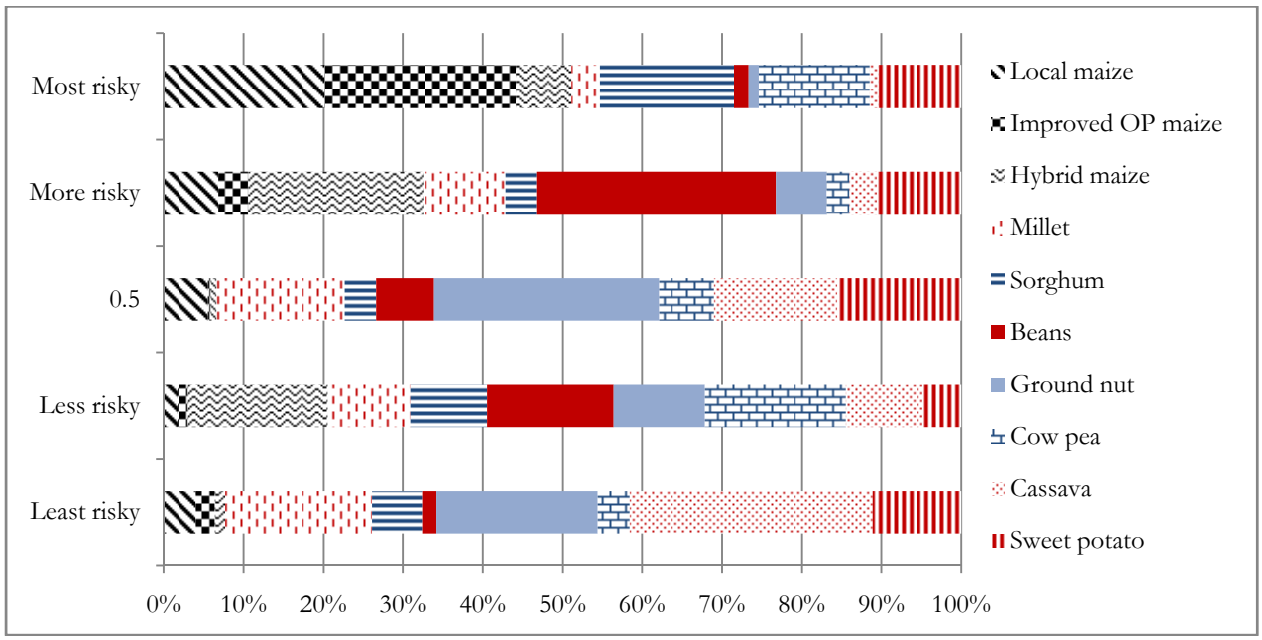

Figure 5. Relative price riskiness of the crops under production in the study area

Asset accumulation, program participation, contract farming, informal insurance, and other activities comprise the price risk management activities of the farming communities in the study areas (Table 25). Once again, information that helps farmers plan and execute their price risk coping strategies is generated from other farmers, extension services, radio, newspapers, and NGOs (Table 26).

Table 25. Coping strategies against grain price risk and source of relevant information

	Frequency	Valid %
Coping strategy		
Asset accumulation	332	95.1
Program participation	254	72.8
Contract farming	196	56.2
Informal insurance	252	72.2
Others	138	39.5
Sources of information		
Extension	258	73.9
Other farmer	271	77.7
NGO	90	25.8
Radio	214	61.3
Newspaper	192	55.0

Source: DTMA survey 2007.

5.5 Adoption of improved maize varieties

5.5.1 Maize seed sources and utilization

The adoption of an agricultural technology starts from access to the information that a technology exists and what that technology is all about. Improved maize varieties can be broadly categorized into open pollinated and hybrid varieties and they have very distinct characteristics (Agarwal et al. 1998). The adoption of improved maize varieties therefore starts with, among others, an understanding of the difference between these two broad classes of improved varieties. In the study communities, however, only (1.6%) of the respondents know the difference between open pollinated varieties and hybrids. This shall be related to the low level of improved maize adoption reported. Over the last five years (2001/2 – 2006/7), only 19% of the households have grown improved maize variety.

It was indicated by the respondents that most of them (54%) have purchased seed in the 2006/7 season and yet only 20% of the seed used was improved. Most of the farmers (73.5%) have also indicated that the seed they purchased is of improved maize (Table 26). The most important source of seed is still the market and farmers buy either directly from shops in the market or agro-dealers. Retaining and concomitantly recycling of maize seed is common (21.6%) and free seed provisions are sources of seed for 8.7% of the sample households. On average, each household interviewed used 15 kg of the most preferred seed variety. The amount used varied from 250 grams to 280 kg of seeds. Most seed is purchased in September (39%); October (29%) and November (16%). This means that 84% of seeds are purchased between September and November.

Table 26. Improved maize seed sources and use

	Mozambique
Purchased maize seed (% yes)	**54**
Major season (% yes)	53.4
Minor season (% yes)	16.9
Type of seed purchased	
Local seed	12.2
Improved seed	73.5
Local and improved seed	14.3
Proportion of seed type (% maize seed used)	
Local seed	80.1
Improved seed	19.9
Sources of Seed	
Retained from last season	21.6
Purchased seed (major or minor seasons)	68
Purchased from another farmer	1.4
Purchased from market	42.7
Purchased from seed company	6.9
Purchased from NGO	
Purchased from an agro-dealer	17
Purchased from Ministry of Agriculture	
Purchased at a seed fair	
Free seed and others	**8.7**
Free seed from neighbor	3.2
Free seed from government	2.3
Free seed from NGO	1.4
Other	1.8

Source: DTMA survey 2007.

5.5.2 Determinants of adoption of improved maize variety

In cases where the adoption level of improved technologies is low, the question of what determines the decision to adopt and then the intensity of adoption has an important research, development and policy implication. Accordingly, we have estimated a double-hurdle model to identify the different factors that dictate adoption and intensity of adoption of improved maize varieties.

Double-hurdle model results

Location, age of household head, maize related extension services, and proportion of land allocated to maize were found to be important factors influencing adoption of improved maize varieties

(Table 27). Sussundenga district receives significantly less precipitation and higher temperature as compared to Mossurize. This might be among the reasons why farmers in Sussundenga are less likely to adopt improved maize as compared to those in Mossurize.

The likelihood of adopting improved maize varieties declines as age of the household head increases. This is in line with other reported observations that as farmers get older, they tend to be more risk averse and hence less likely to venture into trying new technologies – including improved varieties. In fact, the older generation of rural Mozambique has been through so many ups and downs that it hardly managed to accumulate any buffer stock to take any chances with any unfamiliar technologies. Accordingly, it is expected that only the younger generation will have the will and the means to try new technologies in the agricultural arena.

Expectedly, involvement of farmers in maize technology-related demonstrations, field days and focused discussions with extension officers increases the likelihood of adoption of improved maize varieties. Similarly, the higher the proportion of household members engaged in off-farm income generating activities, the higher the likelihood of adoption of improved maize varieties. This association is likely due to the additional purchasing power generated from the income acquired from the off-farm activities. Given the lack of alternative sources for rural finance, the role off-farm employment plays in enhancing the propensity to adopt farm technologies is very high.

Increase in the proportion of land allocated to maize increases the likelihood of adoption of improved maize varieties. Land is the most important input for the farming communities and the proportion of land allocated to any crop is an important indicator of the significance of the enterprise at household level. Accordingly, the proportion of land allocated to maize shows how important maize is for the household and concomitantly the willingness to allocate resources to it.

The extent or intensity of adoption of improved maize varieties in these two rural districts of Mozambique was found to be influenced by location, average literacy level of the household, proportion of land allocated to maize, and fertilizer use. Location (1= Sussundenga) is related negatively to intensity of adoption, whereas proportion of land allocated to maize and proportion of household members in off-farm activities affect intensity of adoption positively. The nature and pattern of their influence shall be similar to their relationship to the adoption decision.

Average education level of the household members was also found to be positively related to intensity of adoption of improved maize. The role education plays in increasing access and consumption of information is obvious. Higher education enables the rural households to identify the different options they have to address the different challenges they are facing. Low farm productivity characterizes farming communities in rural Mozambique and it is expected that families with higher education level tend to use more high yielding technologies.

On the other hand, households that use fertilizer tend to grow less improved maize varieties as compared to non-fertilizer users. Fertilizer is an expensive input as compared to seed and farmers who are using fertilizer might have already realized the importance of growing maize with fertilizer. This again might lead to the rational decision of growing less maize with fertilizer than growing a lot of maize without any fertilizer. In fact, farmers could be tempted to grow maize without fertilizer on new lands that are being continuously available since the end of the civil war.

Table 27. Determinants of improved maize adoption in Mozambique

Results of Double hurdle model (model with selection and censoring)		
	Coefficients	Robust z
Intensity of adoption model		
District (1 = Sussundenga)	-0.1949**	2.69
Age of household head	-0.0018	-0.9800
Female headed household (1 =yes)	-0.0883	-1.4600
Received any credit (1 =yes)	0.0701	-0.6300
Member of farmers' association (1 =yes)	0.0613	-0.8900
Average education of household (years)	0.0190**	2.64
Access to extension services (1= yes)	0.0544	-1.2200
Proportion of land allocated to maize (%)	0.0023*	1.99
Livestock wealth (TLU)	0.0011	-0.2600
Proportion of household members in off-farm activities	0.0023+	-1.73
Uses fertilizer (1 = yes)	-0.2659**	2.94
Constant	0.2624*	2.11
Adoption Model		
District (1 = Sussundenga)	-0.8958**	5.01
Age of household head	-0.0118+	-1.92
Female headed household (1 =yes)	-0.1798	-0.8500
Household head has completed primary school	0.1194	-0.8400
Household head has completed secondary school	0.1435	-0.6500
Member of farmers' association (1 =yes)	0.2075	-0.8900
Any maize related extension service (1=yes)	0.3254+	-1.93
Proportion of land allocated to maize (%)	0.0273**	6.68
Proportion of household members in off-farm activities	0.0045	-1.0200
Received any credit (1 = yes)	-0.4997	-1.2300
Owns radio (1=yes)	-0.0117	-0.0900
Constant	-0.7394+	-1.90
/athrho	1.9507**	5.14
/lnsigma	-1.2280**	12.23
Rho	0.9604	
Sigma	0.2929	
Lambda	0.2813	
Number of observations	325	
Censored observations	186	
Uncensored observations	139	
Log likelihood = -136.4141		
Wald test of indep. eqns. (rho = 0): chi2(1) = 26.38, Prob> chi2 = 0.0000		

+,*, and ** denote significance at 10, 5 and 1% statistical error level.
Source: DTMA survey 2007.

6 Conclusions

Drought Tolerant Maize for Africa (DTMA) project of CIMMYT has conducted household level surveys with the purpose of establishing indicators for adoption and impact assessment studies of the project's technologies. This report presented the study in Mozambique based on a sample of 350 households in Mossourize and Sussungenga Districts.

The smallholder sector in Mozambique is characterized by holdings of multiple small plots, multiple crops, low input use, and low productivity. Smallholders have limited access to capital, little schooling, are at the mercy of highly variable rainfall, and suffer seasonal price risks. The overall agricultural sector is also characterized by the dominance of maize and maize based production systems.

The survey was conducted on respondents composed of 60% males and 40% females. Most (67.5%) of the respondents are household heads and 40% of the respondents are female. Nonetheless, 85.1% of the sample households are male headed. Average family size of the sample households was found to be slightly more than 7 persons with the average number of female family members a bit higher than that of males. Asset ownership based welfare analysis showed that 57% of the households do have negative welfare index and hence can be considered as poor households, whereas the remaining 43% can be considered as better off.

The sample households in this study had limited access to institutional services such as agricultural extension and other supports during trying times. For instance, in the 2006/7 season, only 12%, 10.9%, 8.9%, and 15.1% have attended field days, demonstration plot visits, maize related discussions, and made interactions with extension service providers, respectively. It was also found out that despite the presence of so many non-governmental organizations, few farmers have benefited from their interventions.

Maize production is the most dominant enterprise of the sample households. Different maize varieties are being produced by the sample households. One third of the maize planted in the two districts was an open pollinated variety, Matuba. The second most popular maize variety was SC513. Maize production is essentially a subsistence oriented economic activity in these communities. Hence, it is not the primary source of monetary income for the farming community. The sample households generate about 70% of their income from paid employment, crop sales, livestock and livestock product sales, and petty trading. On average, 60% of the members of the sample households are engaged in off-farm activities.

The most important challenge in the study communities is in general low productivity of the agricultural sector. The low productivity and production of agriculture has a direct bearing on the food economy of the households. The sample households have indicated different coping mechanisms to abate the food shortage they face now and then. The coping strategies include increased engagement in off-farm activities, selling small animals, reducing other expenditures, reduced frequency of food intake, selling other assets, selling cattle, withdrawing children from school, working for food, and receiving food aid.

Drought is an important agricultural risk in Sussundenga and Mossourize districts. About 60% of the respondents indicated drought as the number one serious shock in the past 10 years. The 2001/2

and 2005/6 cropping seasons were indicated to be the driest over the last 10 years. Maize was heavily affected by drought. More than 90% of respondents indicated that maize was negatively affected by drought.

Agricultural productivity can be enhanced through the use of improved technologies. Being a maize based farming system improved maize technologies play an important role in improving productivity. Nonetheless, the level of adoption of improved maize technologies was found to be quite low in the study communities. Location, age of household head, maize related extension services, and proportion of land allocated to maize were found to be important factors influencing adoption of improved maize varieties. The extent or intensity of adoption of improved maize varieties in these two rural districts of Mozambique was found to be influenced by location, average literacy level of the household, proportion of land allocated to maize, and fertilizer use. Accordingly, interventions that aim at increasing the role of the positive forces and mitigation of the negatives need to be identified, well designed and implemented.

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