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Drought Tolerant Maize for Africa (DTMA) Project

Characterization of Maize Producing Households in Masvingo and Bikita Districts in Zimbabwe

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CIMMYT
International Maize and Wheat Improvement Center

Department of Agriculture Technical and Extension Services (Agritex)

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DTMA

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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.

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Drought Tolerant Maize for Africa (DTMA) Project

Country Report – Household Survey

Characterization of Maize Producing Households in Masvingo and Bikita Districts in Zimbabwe

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Acknowledgements

The Drought Tolerant Maize for Africa (DTMA) initiative aims to address the challenge of combating the impacts of drought on people's livelihoods, food security and economic development. It links the efforts of several organizations and projects supporting the development and dissemination of drought tolerant maize in 13 countries in sub-Saharan Africa (SSA). The initiative is supported by the Bill & Melinda Gates Foundation, Howard G. Buffett Foundation, and the United States Agency for International Development (USAID). DTMA also benefits from the long-term, generous support of core donors to CIMMYT. 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 linked to food aid in SSA. However, for this to succeed, it needs to be embedded in local reality. For this purpose, each of the participating countries received support to conduct a community assessment and a household survey in target areas. This report presents the findings of the household survey, providing insight into the characteristics of maize producing households in the Masvingo and Bikita districts of Zimbabwe.

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 Girma Tesfahun Kassie and Olaf Erenstein, among others. We are grateful to Judie-Lynn Rabar, CIMMYT Science Writer/Editor, for editing this report. We also acknowledge the support of the Department of Agriculture Technical and Extension Services (Agritex).

The authors are responsible for any remaining errors and inferences.

Acronyms and abbreviations

AIDS	Acquired Immune Deficiency Syndrome
Agritex	Agricultural Technical and Extension Services
B&MGF	Bill & Melinda Gates Foundation
CIMMYT	International Maize and Wheat Improvement Center
DTMA	Drought Tolerant Maize for Africa project
GMB	Grain Marketing Board
ha	hectares
hh	household head
HIV	Human Immunodeficiency Virus
masl	meters above sea level
NGOs	Non-governmental organizations
NPK	Nitrogen, phosphorus, potassium (fertilizer)
PCA	Principal component analysis
SAS	Statistical Analysis Software
SSA	sub-Saharan Africa
STASTA	Statistical Package for Social Scientists
STERP	Short Term Economic Recovery Programme
t	Metric tons
USA	United States of America

1 Introduction

Maize is Zimbabwe's staple crop with approximately 2.1 million metric tons (t) required for the nation to be food secure. Unfavorable macroeconomic conditions and recurrent droughts have made it difficult for Zimbabwe to meet this target, compelling the government to import maize from neighboring countries. Maize production in Zimbabwe is predominantly in the high rainfall areas, although the crop is also grown in the dry areas prone to droughts. Farmers in such environments are often at the mercy of insufficient rainfall, resulting in poor harvest and consequential hunger in the aftermath of drought. These farmers subsequently liquidate their assets to meet household food requirements and as a result sometimes fail to fully utilize the land available for cultivation. There is thus an urgent need for the promotion of drought tolerant maize in Zimbabwe, which would be aided by a better understanding of the country's maize producing households in drought prone areas. This study aims to improve such understanding.

This study and the resulting report are part of the DTMA project; it was conducted in the Masvingo and Bikita districts in Masvingo Province located in Zimbabwe's medium drought risk zone. While complementing an earlier community assessment in the same area (Chikobvu et al. 2008), the study characterizes maize producing households and assesses the adoption of improved maize varieties among households. The data collected in the study also serve as a baseline on farm households for the construction of indicators that could subsequently be used to measure the impact of the adoption of improved maize varieties.

This report is organized into six main sections. After this introduction, the next section presents the sampling and data collection procedures, followed by a brief agro-ecological characterization of the survey locations. In section three, the characterization of households in the study districts is presented. Farm household livelihoods strategies are discussed in section four, including those related to crop and livestock production, off-farm/non-farm income generating activities,, income and expenditure profiles, and shock impacts on household livelihood outcomes. Section five covers farmer technology use in crop production, particularly maize varietal use, and discusses the econometric model that analyzed the factors influencing the proportion of land allocated to improved maize varieties. Finally, section six presents concluding remarks of the study.

2 Materials, methods, and background information

2.1 Sampling and data collection

From the 10 provinces in Zimbabwe, the south-eastern Masvingo Province was purposively selected because it is a predominantly dry arid region. The Province has seven districts, namely Bikita, Chivi, Zaka, Masvingo, Gutu, Mwenezi, and Chiredzi. The two districts of Bikita and Masvingo were purposively chosen because they fall into the medium drought risk zone and have substantial maize production (Figure 1). From each district, five wards (sub-districts) were randomly selected (Table 1) and a village was selected in each ward. In each of these villages, 10 households were randomly selected. The total sample size was 100 households. A structured questionnaire covering household demographic characteristics, assets, household livelihood strategies, production and risk analysis, and input allocation was used to collect the data. This was complemented with secondary data on agronomic characteristics of crop production, institutional factors, population, and economic activities in the two districts. The data were managed and analyzed using Excel, SPSS, and STATA.

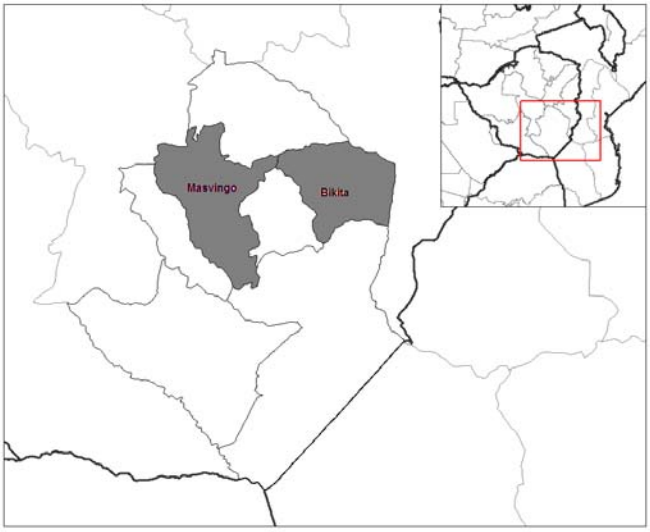

Figure 1. Map of Zimbabwe showing the survey districts.
Source: Wikipedia.

Table 1. Survey wards and selected characteristics.

District	Selected ward	Ward area (km^2)	Natural region
Masvingo	Mugabe	18	III & IV
	Mukosi	22	III & IV
	Shumba	13	IV
	Masvingo East	8	III
	Charumbira	11	III
Bikita	Duma	13	III
	Mupamaonde	22	IV
	Silveira	15	IV
	Chikuku	17	IV
	Bikita	9	III

2.2 Data analysis

The data generated were analyzed using descriptive statistics to characterize the sample households in terms of different socioeconomic and biophysical features. Building on Langyintuo (2008), principal component analysis (PCA) was used to generate the household level wealth indices based on 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 upon 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 to use. For example, income information does not capture the fact that people may have income in kind, such as crops that are traded (Cortinovis et al. 1993). Therefore, asset based indicators have become quite common in characterizing the welfare status of individuals and households (e.g., 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,

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

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 correlation matrix as we used in the original data. The covariance 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:

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

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, with indices ranging from the negative minimum to the mean of the negative indices. Wealth class three consisted of the rich wealth class with indices above the average of the positive wealth indices. Wealth class two included those households with indices between the mean values of the negative and positive wealth indices, and were classified as middle income.

Econometric modeling was also employed to explain the improved maize technology use pattern of sample households. This study revealed that virtually all of the sample households planted improved maize varieties—at least in the survey year. Therefore, adoption of improved maize is not an area of concern in this report, though the question of how the intensity of adoption varies among rural communities is an important issue. Accordingly, this study focused on analyzing the intensity of adoption, rather than adoption itself. In this particular case, our formulation of the model needs to consider that adopters will have greater than zero proportion of their land covered with improved maize.

Nonetheless, despite the fact that all but one sample household reported to have used improved maize varieties, there was an apparent difference in proportion of area allocated to maize. Some households allocated no land to maize in the year of the survey. This results in observations with fully observed explanatory variables (x) and unobserved dependent variables (y). The implication is that our latent dependent variable (y*)—which denotes interest in improved maize varieties—is not observed until the interest in the varieties exceeds some known constant threshold (L) is passed; i.e., we observe y* only when y* > L.

Formulation of this data with ordinary least square will not generate any consistent dependable information, as the regression with zero values can hardly give results that can be inferred to the population. Therefore, Tobit model, censored only from the left side (L=0), is employed in this study.

Our model is specified as an unobserved latent variable, y*,

$$y_i^* = x_i^{'}\beta + \varepsilon_i, \; i = 1, ..., N. \qquad (3)$$

where $\varepsilon_i \sim N(0, \delta^2)$ y^* is a latent variable that is observed for values greater than L and censored otherwise, whereas x_i denotes $(K \times 1)$ vector of exogenous and fully observed regressors.

The observed y is defined by the following measurement equation

$$y = \begin{cases} y^* \text{ if } y^* > L \\ L \text{ if } y^* \leq L \end{cases} \qquad (4)$$

In our case, L=0 as the proportion of land allocated to improved maize is censored at 0. Thus, we have

$$y = \begin{cases} y^* \text{ if } y^* > 0 \\ 0 \text{ if } y^* \leq 0 \end{cases} \qquad (5)$$

With the assumption of homoskedastic and normally distributed error term and L=0, the likelihood function for the Tobit model can be given as

$$L = \prod_{i}^{N} \left[\frac{1}{\sigma} \phi \left(\frac{y_i - X_i\beta}{\sigma} \right) \right]^{d_i} \left[1 - \Phi \left(\frac{X_i\beta}{\sigma} \right) \right]^{1-d_i} \qquad (6)$$

Where $\phi(.)$ is the standard normal density, $\Phi(.)$ is the standard normal cumulative distribution function, $X_i\beta$ is the expected value of the observed dependent value for the non-censored observations, and d_i is a dummy (i = 0,1) indicator of censoring of an observation. .

2.3 Agro-climatic characterization of survey locations

Zimbabwe is a landlocked country, bordered by South Africa, Mozambique, Zambia, Namibia, and Botswana. The country is divided into five agro-ecological zones on the basis of annual rainfall variability (Vincent and Thomas 1960; Figure 2; Table 2). Natural regions I and II are the most productive. These regions are mid-altitude, 800–1,600 meters above sea level (masl) and receive substantial and well distributed rainfall. Regions III, IV, and V on the other hand are the semi-arid zones, characterized by low, unreliable rainfall.

Zimbabwe lies entirely within the tropics, but much of the Highveld and Eastern Highlands have a subtropical to temperate climate due to the modifying effect of altitude. Three seasons are recognized in Zimbabwe, notably; (1) a hot wet season from mid-November to March (summer); (2) a cold, dry season from April to July (winter); and (3) a hot, dry season from August to mid-November (spring). Air temperatures are closely related to altitude, with mean annual temperature ranging from about 25˚C in parts of the Zambezi Valley to less than 15˚C above 1,800 masl in the Eastern Highlands. Maximum temperatures are lowest in June or July and highest in October. During winter, mean daily temperature range between 11˚C and 20˚C. Mean maximum daily temperatures can exceed 32˚C during the spring.

Masvingo Province is located in the south-east region of the country, bordering Mozambique. More than 60% of the region is in natural region V and the remaining area is natural region IV, with spatial pockets of natural region III. A range of mountains pass through the province, giving some pockets diverging micro climates.

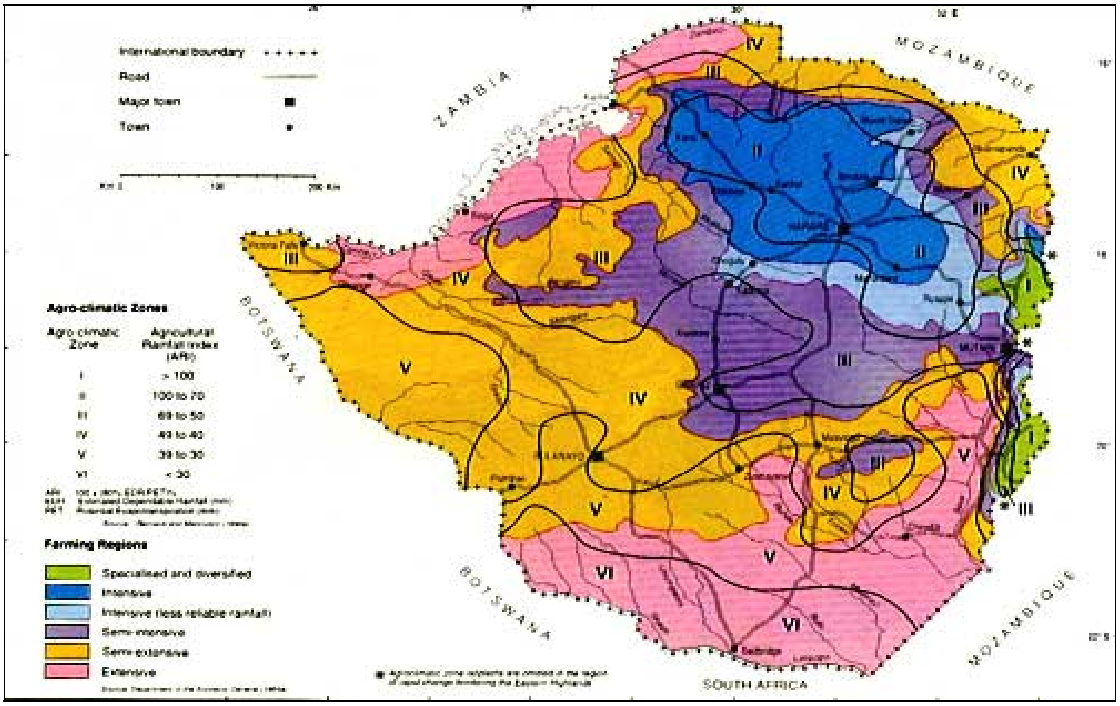

Figure 2. Map of Zimbabwe's natural regions.

Source: Vincent and Thomas 1960.

Table 2. Natural regions of Zimbabwe.

Natural Region	Area (km²)	Rainfall (mm yr⁻¹)	Farming system
I	7,000	>1 000	Specialized and diversified farming
II	58,600	750 – 1 000	Intensive farming
III	72,900	650 – 800	Semi-intensive farming
IV	147,800	450 - 650	Semi-extensive farming
V	104,400	<450	Extensive farming

Source: Vincent and Thomas 1960.

2.4 Drought and maize in Zimbabwe

Drought is a common occurrence in sub-Saharan Africa (SSA) in general, and in southern Africa in particular. It has been defined as the condition of abnormally low rainfall, outside the normal expected parameters that would support productive activities (World Bank 1998). The frequency of droughts and below-normal rains seem to be increasing in line with climate change. Droughts significantly reduce food availability at both national and household level, as well as limiting rural employment possibilities. Poor smallholder farmers in Africa have had to face the reality of crop failure and acute food shortages. The largest food crises in Africa that required large-scale external food aid have been attributed fully or partially to extreme weather events (Dilley et al. 2005). The impacts of droughts are contingent on the interaction of meteorological anomalies and these indirectly lead to increased environmental degradation, deforestation etc., which could be a factor in civil strife causations. In Zimbabwe, as in much of SSA, drought is frequent with devastating effects on household livelihoods. This is exacerbated by limited financial resources, inadequate understanding of drought impact, and poor coordination amongst agricultural agencies. Drought, therefore, is a form of supply-side shock outside a country's control and has consequences on domestic economic variables (World Bank 1998). In Zimbabwe, the famines of 1974, 1982, 1992, 2002, and 2004 affected the lives and livelihoods of millions of rural households, and were mainly caused by droughts (Rukuni et al. 2006).

Maize is an important crop for African households and plays a major role in household food self sufficiency, especially since it is adaptable to diverse agro-ecological areas. More than a quarter of a billion Africans depend on maize as a staple food and thus any disruption in the supply of maize has dire consequences (Science Daily 2007). Farmers in Zimbabwe and Africa as a whole are planting more maize for home consumption to guard against possible drought and the resulting food shortages. This accounts for the large proportion of land allocated to maize, as compared to other crops. However, given that more than 80% of the farmers grow maize almost exclusively on a rainfed basis and have limited capacity to irrigate, maize production among smallholder farmers is often left to the vagaries of nature. Maize is highly susceptible to drought, making it a high-risk crop in semi-arid areas. In Zimbabwe, about 90% of the communal lands[1] in natural regions III, IV, and V are categorized as extremely marginal for maize production (Whitlow 1979). Hence, the development and dissemination of drought tolerant maize varieties among resource-poor smallholder farmers is urgently needed. These varieties enhance the prospects of increasing yields and mitigating hunger in the wake of recurrent droughts. With drought tolerant maize varieties, farmers are likely to be more food secure and can allocate less land to maize and invest in other crops for a more balanced diet and improved soil fertility.

The reliance on rainfed agriculture makes farmers susceptible to droughts. This is, however, only one of a number of factors that contribute to the persistent food insecurity for Zimbabwe's small-scale farmers. Other factors include unavailability of inputs on the open market and the changing incentive structure in relation to the political economy of agriculture in Zimbabwe. Hybrid maize varieties were introduced in Zimbabwe in 1949, making Zimbabwe the second country after the USA to produce and commercially grow hybrid maize. Zimbabwean agricultural growth has slowed over the past decade, aggravated by poor rainfall and unfavorable macroeconomic conditions. The recent regional drought caused a 70% shortfall in annual maize production. Besides drought and lack of improved agricultural inputs, declining soil fertility from continuous maize cultivation also contributes to poor crop performance in Zimbabwe.

The national average yield of maize in the period from 1989–91 was 1.6 t/ha, dropping the following year to 1.2 t/ha with an average of 750 kg/ha in the semi-arid cropping systems (CIMMYT World Facts and Trends, 1991–92 and 1993–94). Production was highest in the 1980–81 cropping season with an average above 2,833,400 t. This subsequently declined to as low as 624,000 t in the 2006–07 cropping season.

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[1] Communal lands in Zimbabwe refer to mostly rain-fed, marginalized farming areas in the agro-ecological region IV and V, characterized by customary land tenure, high population densities, small farm sizes, low use of agricultural inputs, and low productivity (Mutisi 2009). Communal lands are thus areas where agriculture production is done at substance level. Land is communally owned and everyone has the right to use it.

3 Household characteristics

3.1 Categorizing household access to capital assets

Farm households rely on human, natural, physical, financial, and social capital for their livelihood ventures. Human capital considers households' access to potential labor resources that are needed in various agricultural activities. Natural capital assets involve facilities such as the amount of land available to households for farming activities. Physical assets incorporate the various durable assets owned by the households; while credit facilities are classified under financial assets. Social capital refers to the households' access to support from the social system and social networks.

The capital endowments vary considerably between households, making them difficult to compare or to characterize household wealth status. It is therefore necessary to find a common denominator that can be used to classify households by their assets. That is why the asset based wealth index calculation was employed.

Estimating the household wealth index

The PCA was run on the selected rural wealth status indicators using the Statistical Package for Social Scientists (SPSS). Eleven components were extracted in the first stage of PCA, but only the first five were significant (based on the criterion of an Eigen value greater than 1 (Table 3). The first component was chosen for use in constructing the index because it explained 18% of the total variance in the 11 indicators.

Table 3. Total variance explained using PCA.

Component	Initial Eigen values		
	Total	% of Variance	Cumulative %
1	3.354	25.797	25.797
2	1.967	15.128	40.924
3	1.258	9.676	50.600
4	1.039	7.994	58.594
5	0.989	7.610	66.204
6	0.938	7.218	73.422
7	0.758	5.832	79.254
8	0.739	5.685	84.939
9	0.643	4.946	89.884
10	0.520	4.001	93.886
11	0.437	3.364	97.249
12	0.192	1.473	98.723
13	0.166	1.277	100

Source: Survey data.

The weights (or scores) assigned to the indicators contributing to component 1 are shown in Table 4. The impact of each variable on the overall index is calculated as the score divided by the standard deviation. Following Filmer and Pritchett (2001), the assigned weights were then used to construct an overall 'wealth index', applying the formula in equation 2.

Table 4: Characteristics of the first principal component.

	Mean	Std. Deviation	Score
Number of bicycle(s) owned	0.2959	0.54127	0.064
Number of draft animals owned	1.1429	1.64348	0.237
Number of radio(s) owned	0.2857	0.47624	0.063
Number of private well(s) owned	0.2857	0.47624	0.056
Number of mobile phones owned	0.0408	0.24530	0.047
Any received cash and/input credit in 2005–06 season	1.4388	0.49879	-0.090
Number of cow(s) owned	0.8980	1.54979	0.264
Number of bull(s) owned	0.0816	0.37094	0.143
Number of improved cow(s) owned	0.0816	0.46912	0.217
Number of improved bull(s) owned	0.0204	0.14212	0.002
Number of improved heifer(s) owned	0.0306	0.22494	0.219
Number of local goat(s) owned	2.1327	2.65795	0.188
Number of pig(s) owned	0.1224	0.78995	0.003

Source: Survey data.

The wealth index of the interviewed households ranged from -0.783 to 7.627 (Figure 3). About 65% of the households are poorly endowed—i.e. a wealth index of <0. At the district level, Masvingo households (average wealth index of 0.125) are somewhat better endowed than those in Bikita (average wealth index of -0.136). Based on the categorization indicated in section 2.2, about 11% of the sampled households are well off, 54% average, and 35% poor. The mean wealth index of the poor class is -0.634, the average is -0.021, and the well off is 1.878. However, for the well-off group, the wealth indices are positively skewed.

3.2 Human capital

Human capital is the presence of skills, knowledge, and available labor within a household, depending on household size, education, and age. Table 5 presents some demographic characteristics of the households, of which 81% are male headed. The average age of household heads (hh) in both Masvingo and Bikita is about 50 years, with a range of 22 to 87 years old. About half of the household heads attained primary level education, while about 44% attained secondary education. Only about 2% of household heads were illiterate and only 1% attended adult education. The majority of the household heads were married (82%) and about half of them make crop production decisions jointly with their spouse. The time spent at the homestead also influences key production practices and the management of the production process. The majority of the household heads (79%) are temporarily absent from their homesteads, while 9% are absent for at least 6 months of the year.

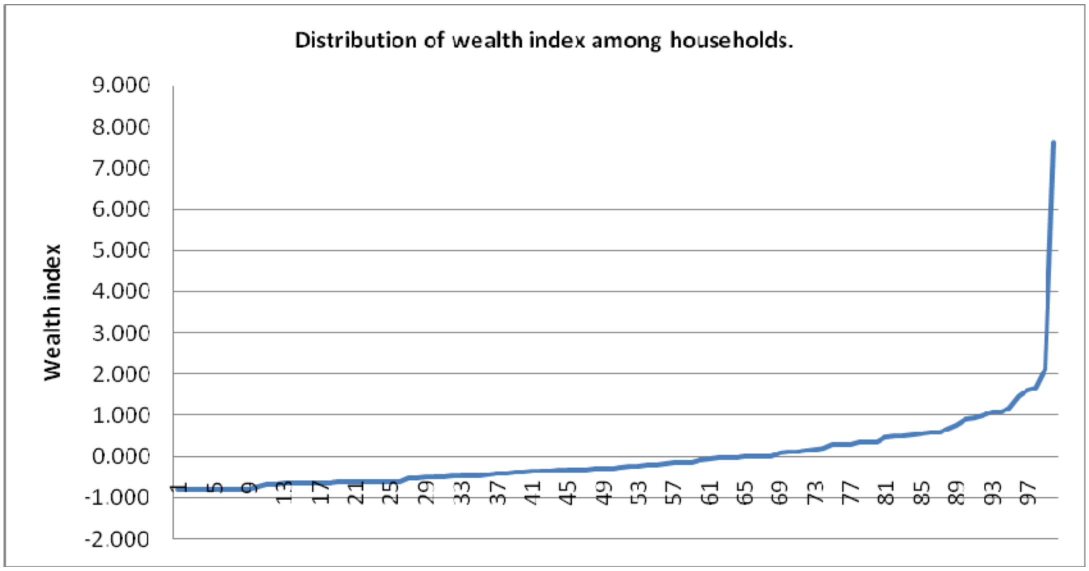

Figure 3. Distribution of households' wealth in the study area.

Source: Survey data.

Table 5. Descriptive statistics by survey district.

Attribute of household		Masvingo	Bikita	Whole sample
Gender of hh head (%)	Male	82	80	81
	Female	18	20	19
Marital status (%)	Married	82	82	82
	Widowed	16	16	16
	Divorced	2	2	2
	Single	0	0	0
Education level (%)	Illiterate	2	2	2
	Primary	50	48	49
	Secondary	48	40	44
	Post secondary	0	8	4
	Adult education	0	2	1
Main decision maker (%)	Household head	48.9	36.7	42.7
	Spouse	8.5	2.0	5.2
	Both	42.6	61.2	52.1
Residence type (%)	Temporarily absent	80	78.3	78.8
	Absent for at least 6 months	10	8.7	9.1
	Always present	10	13	12
Household head age	Average (range)	49.7 (25-82)	48.5 (22-87)	49

Source: Survey data.

The main source of labor in the two districts is family labor, complemented by limited hired labor. In some cases during peak periods of labor demand, farmers resort to communal labor (i.e. farmers come together and take turns working in each other's fields). Following Runge-

Metzger (1988), each household member was converted to a man equivalent unit (MEU)[2] with the assumption that individuals in different age groups do not have the same efficiency. Of the sampled group, only 20.5% households were female-headed. The female-headed households had a higher proportion of the worse-off group (Table 6). The household age distribution and implications for dependency ratio[3] are explored in Table 7. The dependency ratio in Table 8 measures the proportion of the population that is dependent on the labor force available in the survey districts. The dependency ratio is approximately 1.2 for both districts, implying that for every 10 working-age people, there are 12 dependents. This ratio is generally high, as is the case in most of countries in southern Africa, and has been mainly driven by the high prevalence of HIV-AIDS. Harwood et al.(2004) proclaim that the HIV-AIDS scourge increase the dependency ratio as it reduces the denominator population. Male headed households have higher dependency ratios within the two districts compared to female headed households, possibly due to higher capacity of males to generate income through cash crop production and other non-farm sources and hence the higher capability to take care of extended family members.

Table 6. Age and sex distribution by wealth group.

Gender of respondent		Age class of respondents			Total
		<39 years	**39 to 61 years**	**>61 years**	
Male (n)	Rich	1	4	4	**9**
	Middle farming class	13	11	6	**30**
	Poor	4	1	4	**9**
	Total	**18**	**16**	**14**	**48**
	Rich	1	1	0	**2**
Female (n)	Middle farming class	6	16	1	**23**
	Poor	12	12	1	**25**
	Total	**19**	**29**	**2**	**50**

Source: Survey data.

Table 7. Household age distribution and dependency ratio by district and gender.

Age group	Masvingo			Bikita		
	Male	Female	Total	Male	Female	Total
>60 years (%)	10.2	1.4	11.6	7.4	4.2	11.6
16-60 years (%)	36.7	8.9	45.6	22.8	22.8	45.6
<16 years (%)	34.9	7.9	42.8	22.3	20.5	42.8
Total (%)	81.8	18.2	100	52.5	47.5	100
Dependency ratio	1.23	1.05	1.19	1.31	1.08	1.19

Source: Survey data.

[2] MEU was calculated after Runge- Metzer (1988) as follows: Households members less than 9 years = 0; 9 years to 15 years and/or above 49 years= 0.7; and 16 years to 49 years =1.

[3] Dependency ratio= (household member below 16 years + household members above 60 years)/ household members between 16 and 60 years.

3.3 Natural capital

In Zimbabwe, the traditional land tenure system prevails for smallholders. In general, the land is often held by a group, community lineage or clan, family, or individuals and an individual in the community may give out a piece of land to another person for use, with the local leader's knowledge. Once acquired, land may be passed on from generation to generation. Household farm size ranged from 1 to 13 hectares, with the majority of households having 2 to 5 hectares (ha). The average farm size was 3.9 ha in Bikita, apparently lower than Masvingo District. Female-headed households had somewhat larger farm sizes (3.91 ha versus 3.83 for male-headed), and these were often widows who inherited from late husbands, or divorcees who returned to their home villages. The annually cropped area averaged 1.4 ha per household, with the remaining land either abandoned, fallowed, or under tree crops (Table 8). The majority of crops are rainfed except for the vegetables and fruit trees, especially in the early days of establishment. The man-land ratio averaged 1.1 person per hectare, but were significantly lower in Bikita (Table 8). In line with expectations, farm size is positively associated with the wealth ranking of the households (Table 4).

Table 8. Land use by households.

	Bikita	Masvingo	Whole sample
Farm size, ha(range)	3.5 (1-13)	4.2 (1-12)	3.85 (1-13)
Abandoned, ha(range)	2.5 (0.1-3)	2.75 (0.1-3)	2.63 (0.1-3)
Fallow, ha(range)	1.2 (1-2)	1.6 (1-2.25)	1.37 (1-2.25)
Tree crop, ha(range)	1.6 (0.04-2)	1.8 (0.1-2)	1.7 (0.04-2)
Cropped, ha(range)	1.23 (0.5-3)	1.64 (0.5-5)	1.44 (0.5-5)
Man-land ratio [std dev.]	1.05 [0.92]	1.16 [0.93]	1.11[0.92]

Source: Survey data.

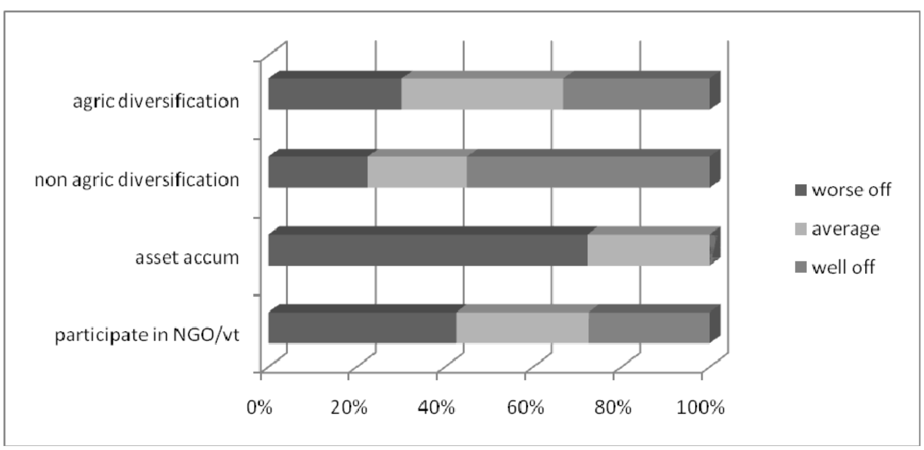

Figure 4. Proportional distribution of land by wealth groups.

Source: Survey data.

Farmers consider an array of factors before committing land resources to a cropping enterprise, with cash availability to purchase inputs and seed availability being particularly important in the study area (Table 9). Expected family labor availability and food needs also played an important role.

Table 9. Factors determining cultivated farm size (% of households reporting).

Factors	Most important	Important	Less important	N
Cash availability to purchase other inputs	21	34	17	72
Seed availability	20	22	23	65
Expected family labor availability	16	8	16	40
Cash availability to hire labor	11	11	10	32
Draft power	6	6	3	15
Expected grain prices after harvest	2	8	3	13
Food needs	17	7	14	38
Current grain prices	0	1	6	7
Any of the above	93	97	92	

Source: Survey data.

At least half the households reported no change in farm size over time (Figure 5). Farm sizes were increasing for 32% in Masvingo and 20% in Bikita; whereas they were decreasing by 12% and 9%, respectively. For the households that increased their land sizes, seed availability was the main reason (50%), followed by an array of other reasons (enough labor 8.3%, better rainfall 8.3%, enough draft power 8.3%, enough land to expand 4.2%, food needs 4.2%, commercial agriculture 1%). Those who reduced their land sizes attributed this primarily to poor rainfall (50%), followed by an array of other reasons (no cash to hire draft labor 20%, inadequate seeds 10%, diversifying into other activities 10%, and lacking implements 10%).

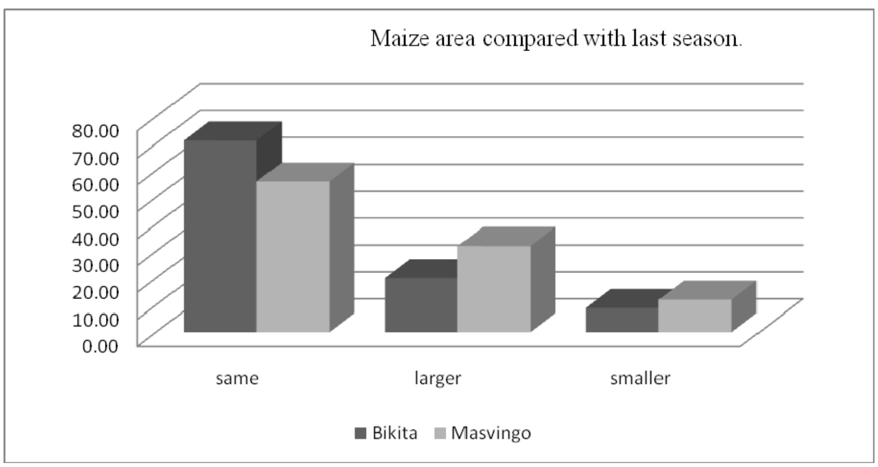

Figure 5. Dynamics of maize area.

Source: Survey data.

3.4 Physical capital

The farm households had brick dwellings with a roofing of either thatch or asbestos/iron sheets. In Bikita, 56% of the respondents indicated that they reside in houses made of bricks under thatch roof whereas 58% of respondents in Masvingo reported the same. Similarly, 44% of the respondents in Bikita live in brick houses roofed with asbestos/iron sheets and about 42% of the respondents in Masvingo reported to have lived in similar residences. The most common assets include wheelbarrows, draft animals, draft ploughs, radios, television sets, bicycles, and private wells (Table 10). Only one household owned a tractor, but without tractor drawn tillage implements such as plough or harrow. Tractors are apparently used for carting farm produce to the market. Normally, tractors are used for tilling, dicing, and harrowing agricultural fields as well as transporting farm inputs and produce.

Table 10. Asset ownership by district.

	Bikita (N=50)	Masvingo (N=50)	Whole sample (N=100)
Animal plough	58(1-2)	48(1-2)	53
Wheelbarrow	54(1-2)	58(1-2)	56
Draft animals	46(1-6)	38(1-8)	42
Mobile phones	4(1-2)	2	3
Private well	32(1-2)	22	27
Bicycle	28(1-3)	24(1-3)	26
Radio	26(1-2)	30	28
Television	12(1-2)	16(1-2)	14
Scotch cart	16	20	18
Animal harrow	8	10(1-2)	9
Water pump	8	2	5
Motor vehicle	2	0	1
Tractor	2	0	1
Private borehole	2	0	1
Generator	2	0	1
Cultivator	0	8	4
Water tanks	0	2	1

Source: Survey data.

3.5 Financial capital

Agricultural credit can be an important factor for agricultural production, particularly as impoverished rural households have difficulty saving (Chimedza 1994). Households in the surveyed communities generally lacked sufficient cash resources to meet their needs and access to credit was very difficult. NGOs have been playing an important role in trying to address this challenge by providing the communities with seed and fertilizer relief. The majority (97%) of the respondents noted that there are times when cash is badly needed but in short supply; 79% said this period was between October and December. Only about half the households received cash and/or input credit in the previous year (Table 11). Those that had not received credit typically cited lack of a credit source within the vicinity as in the main season (Table 11).

Table 11. Access to credit by district.

	Bikita	Masvingo	Whole sample
Non-access to credit (%)	54	34.7	44.4
Reasons for non-access to credit (%)			
– No credit source	59	35	50
– Did not look for credit	11	24	16
– No collateral	22	12	18
– Inadequate inputs from government program	7	29	16

Source: Survey data.

3.6 Institutional and social capital

The survey results suggest that both government and non-government institutions provide support to households in the survey districts. Among the NGOs, Christian Care was the dominant service provider in the districts (30% in Bikita and 36% in Masvingo), providing food, seed, and fertilizer relief. For the adoption of new technologies, field demonstrations and field days are important with farmer participation widespread in the study area (Table 12). The government, through the Department of Agricultural Technical and Extension Services (Agritex), was also the main provider of technical support for farmers in the districts (18% in Bikita and 36% in Masvingo). Afri-care was also mentioned by 6% of farmers in Balaka and by 8% in Masvingo as source of agricultural technologies and support services.

Table 12. Access to field demonstrations.

Organizer	Field day (% attending)			Field demonstrations (% attending)		
	Bikita	Masvingo	Whole sample	Bikita	Masvingo	Whole sample
Agritex	64	62	63	30	59	45
Research organization	1	0	1	1	1	1
NGO	8	20	14	0	16	8
Seed company	0	4	2	0	4	2
Cotton company	0	4	2	0	4	2

Source: Survey data.

3.7 Summary indicators by household wealth category

Table 13 presents selected livelihood indicators for different wealth classes. For most of the physical assets, as expected, the relatively rich class owned more than others. Similarly, farm size and livestock numbers tended to be more favorable for the well off. Access to credit reveals that the worse off group access credit more often than the other two groups, which may be linked to the fact that credit institutions target the most vulnerable groups. Similarly, association membership appears positively associated with poverty. This is driven mainly by development partners encouraging farmers to form associations for support.

Table 13. Selected indicator variables.

	Whole sample	Worse off	Average	Well off
Farm size (ha)	3.83	3.32	3.86	5.33
Access to credit (%)	55	21.8	61.8	16.4
Membership to an association (%)	67.3	31.8	57.6	10.6
Physical assets (number)				
Bicycles	0.30	0.06	0.37	0.73
Television sets	0.15	0.09	0.11	0.55
Radio sets	0.29	0.17	0.26	0.82
Livestock (number)				
Local cows	0.88	0.03	0.93	3.36
Goats	2.15	0.60	2.30	6.36
Local chickens	6.59	5.06	6.52	11.83

Source: Survey data.

4 Household livelihoods strategies

In the rural areas people engage in a diverse number of livelihood strategies such as crop production, livestock production, and petty trading to support themselves. This chapter examines some of these livelihood activities, corresponding household income and expenditure and the outlook in the two districts of Zimbabwe.

4.1 Crop production and marketing

Crop production in the study districts is mainly done for subsistence. Maize, groundnuts, sorghum, and millets are the major crops grown. Maize is an important staple food crop and, as such, every household grows it. Groundnuts are also popular because of their substitution as cooking oil, and they have become more popular with an increase in the scarcity of conventional cooking oil. The minor crops grown include cowpea, cassava, rice, and tea. As a strategy to minimize crop failure or spread production risks, crops are usually grown on different plots.

Maize occupies the largest share of the land cropped, with hybrid maize accounting for at least 30–40%, with an additional 3–4% under maize OPVs and 1% under landraces (Figure 6 and Figure 7). It is followed by groundnuts (24–26%). The two districts are semi-arid, so small grains such as sorghum and millet would have been favorable, but account for only 9–14%.

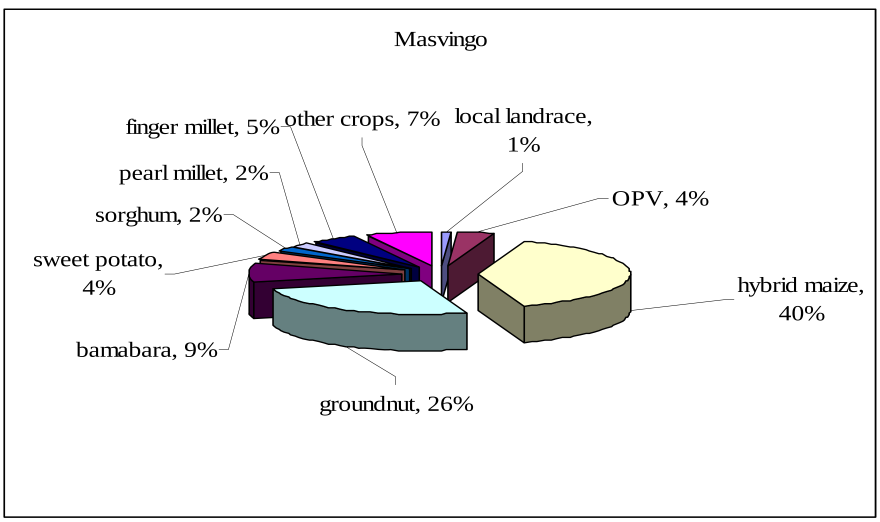

Figure 6. Distribution of land area among crops in Masvingo District.

Source: Survey data.

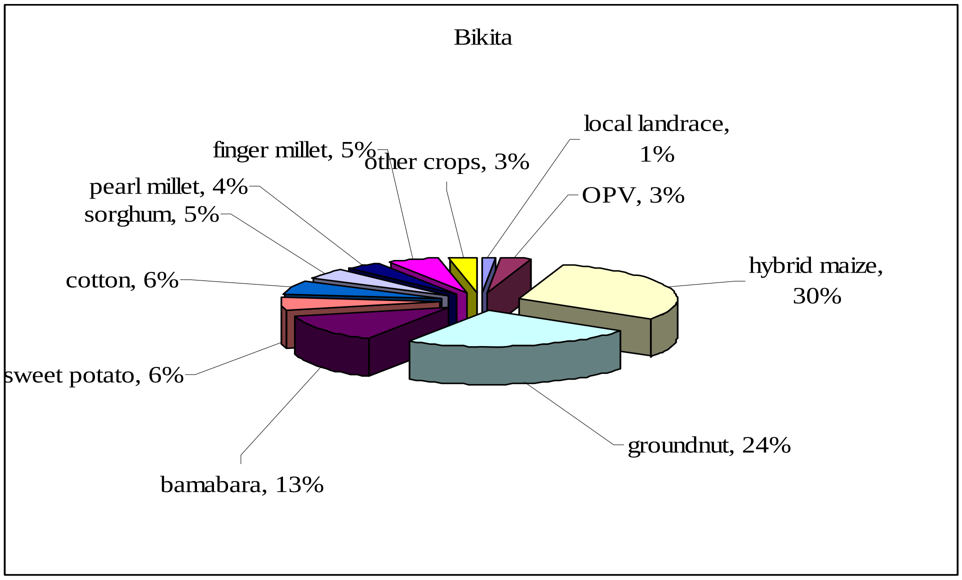

Figure 7. Distribution of land area among crops in Bikita District.

Source: Survey data.

Most of the maize produced is for household consumption, which is particularly high in Bikita, reflecting the subsistence nature of the farmers (Table 14). Maize is only sold after households have harvested more than they need for themselves and their immediate families. Only 19 respondents reported selling maize, with quantities ranging from 100–1,000 kg, while 10 respondents sold 30–120 kg of other cereals. Among those that sold maize, 79% sold it at local markets, while 10.5% sold to the GMB and at their homesteads. The other cereals were also primarily sold at the market place (60%), while the remainder was sold from the homestead (40%). Those who sold at the market place were apparently searching for better returns; those who sold the cereal at their homestead sought to reduce the cost of marketing.

Grain buyers included middlemen, established agents, marketing cooperatives, other farmers, and the GMB. The average sales price of grain maize ranged from ZM$ 3,000 to 6[4] million, and of other cereals from ZM$ 6,000 to 2 million.

Table 14. Disposal of crops harvested by district.

Disposal (%)	Bikita		Masvingo	
	Maize hybrid	Improved OPVs	Maize hybrid	Improved OPVs
Consumption	93	94	60	67
Sold	1	1	40	33
Reserving for next season	4	1		
Giving out as gifts	2	4		

Source: Survey data.

4.2 Livestock production

Households keep livestock to diversify their livelihoods and manage risks. Livestock provides for income when sold, meat for household consumption, manure for crop production, and are used

[4] The official exchange rate was 1USD =ZM $30,000 while parallel market one was 1USD = ZM $3,000,000.

for various social functions such as rituals and marriage ceremonies. Overall, the herd averages 0.88 cattle, 2.15 goats, and 6.59 chickens. The livestock ownership is closely associated with the wealth groups (Table 15).

Table 15. Average livestock holding by wealth group.

Livestock type (#)	Worse off	Average	Well off
Cattle	0.03	0.93	3.66
Chicken	5.06	6.52	11.82
Goats	0.6	2.3	6.36
Pigs	0	0.22	0

Source: Survey data.

4.3 Income and expenditure profiles of households

Households engage in agriculture and informal activities to generate income for their livelihoods. Fruit and vegetable sales were the most widely reported sources of income (85%), but with a wide range in monetary contributions (Table 16). About half the households also obtained income from petty trade, remittances, self-employment and livestock sales. Only 38% of the interviewed households were getting (cash) income from crop sales.

Table 16. Sources of household income.

	Sources of income (% hh reporting, n=100)	Income range (ZM$ million)	
		Bikita	Masvingo
Fruit and vegetable sales	85	0.05-168	0.05-100
Petty trading	48	2-2400	2-1200
Remittances	48	0.1-960	0.1-120
Self employment	46	0.3-150	0.3-360
Livestock/fish sales	44	1-120	1-50
Crop Sales	38	0.03-59	0.03-59
Paid job	33	10-240	10-240
Other sources	34	0.1-18	0.1-80

Source: Survey data.

4.4 Outlook of livelihoods

Nearly all farm households sought to increase agricultural production as their strategy to enhance livelihoods (Table 18). They particularly envisaged diversification, but were often held back due to lack of access to inputs and land. Households subsequently mentioned increasing food security (primarily through increasing production) and a range of other strategies (Table 18). A little over a third specifically mentioned reducing agricultural production risk, primarily through diversification.

Household expenditures averaged ZM $125 million, including ZM$ 32 million for staple foods. Expenditures in Bikita were more than double those reported in Masvingo, albeit that expenditures on staple foods were largely similar (Table 17). The relative contribution of the diverse expenditure classes that include food stuffs, education, medicine, clothing, tobacco, and alcohol are presented in Table 17. Those on education and staple foods accounted for more than two-thirds in both districts, education being particularly high in Bikita.

Table 17. Expenditure patterns of households by district.

	Bikita	Masvingo
Expenditure (%)		
– Educational expenses	71.1	28.4
– Staple food	17.6	39.2
– Tobacco and alcohol	2.0	5.9
– Social contributions	0.6	1.3
– Fuel	0.5	1.8
– Medical	4.4	12.2
– Clothing	3.0	9.4
– Miscellaneous	0.5	1.3
– Remittances	0.2	0.5
Expenditure on staple foods (ZM$ million)	33	32
Total expenditure (ZM$ million)	173	78**

Note: **statistically significant difference at 5%.

Source: Survey data.

Table 18. Strategies to improve livelihood outcomes.

Livelihood outcome	% of households
Increase agricultural production	96
Increase food security	61
Increase volume of household assets	40
Reduce agriculture production risk	37
Improved health status of members	35
Increase land ownership	26
Improve its social status	24
Increase job opportunities/earn wages	14
Increase income/reduce income risk	13
Get out of agriculture	10
Reduce marketing risk	7

Source: Survey data.

Household perception about production risk

Drought was the most common shock reported by half of the households in the area and was thought to contribute to food insecurity. Large increases in input prices were reported as the second most common shock, followed by a range of biotic and abiotic factors (Table 19). Nearly all households affected by the shock pointed out that it affected maize production, reiterating the importance of maize (Table 19).

Table 19. Shocks to household livelihoods.

Shock	Households affected (%)	Maize production affected (%)
Drought	49	46
Large increases in input prices	35	34
Floods	17	16
Destruction of crops by animals	12	10
Plant pests and diseases	11	10
Erratic rainfall	11	10

Source: Survey data.

Recurrent droughts were widely perceived as the main production risk. Crops were variously ranked in terms of their yield risk—with the various types of maize typically being ranked amongst the more risky crops (Table 20). The main strategy to reduce/eliminate production risks of these selected crops was typically agricultural diversification, and to a lesser extent, non-agricultural diversification and participation in support programs (Table 21). Limited access to credit and inputs were perceived as important production risks and households had resorted to participation in NGOs and government programs to source inputs for crop production, since these could not be found on the open market. However, these seed and fertilizer relief packages were typically not sufficient to meet farmer needs. Figure 8 provides a breakdown of the coping strategies for hybrid maize production risk for the different wealth groups. Agricultural diversification remains the prevailing strategy for each wealth group. However, the lower 35% wealth category more commonly supplement their wealth with participation in support programs and asset accumulation; whereas the wealthiest 11% supplement theirs with non-agricultural diversification.

Table 20. Risk ranking of crops in terms of yield fluctuations.

Crop (n)	***Risk ranking (% households, 1-most risky; 6-least risky)***					
	1	**2**	**3**	**4**	**5**	**6**
Landrace maize (n=9)	66.7	22.2	11.1			
OPV (11)	36.4	18.2	27.3	18.2		
Hybrid maize (81)	19.8	8.6	40.7	21.0	2.5	7.4
Millet (29)	27.6	6.9	6.9	37.9	13.8	6.9
Sorghum (23)	17.4	8.7	17.4	17.4	21.7	17.4
Beans (14)	14.1	28.6	42.9		14.4	
Groundnuts (66)	9.1	22.7	24.2	28.8	12.1	3.0
Sweet potato (5)			20.0	80.0		
Cotton (4)	50.0				50.0	
Cowpea (9)		11.1	11.1	55.6		22.2

Source: Survey data.

Table 21. Main strategy to reduce/eliminate production risks of selected crops (% households).

Crop (n)	**Agric diversification**	**Non-agric diversification**	**Participation NGO/Gvt programs**
Local maize (n=9)	66.7	22.2	11.1
OPV (13)	84.6	15.4	
Hybrid maize (83)	68.7	12.0	14.5
Millet (28)	85.7	14.3	
Sorghum (19)	78.9	10.5	10.5
Beans (14)	71.4	28.6	
Groundnuts (58)	70.7	10.3	13.8
Cow peas (4)	25.0	50.0	25.0
Sweet potato (5)	60.0		40.0
Cotton (4)	100.0		

Source: Survey data.

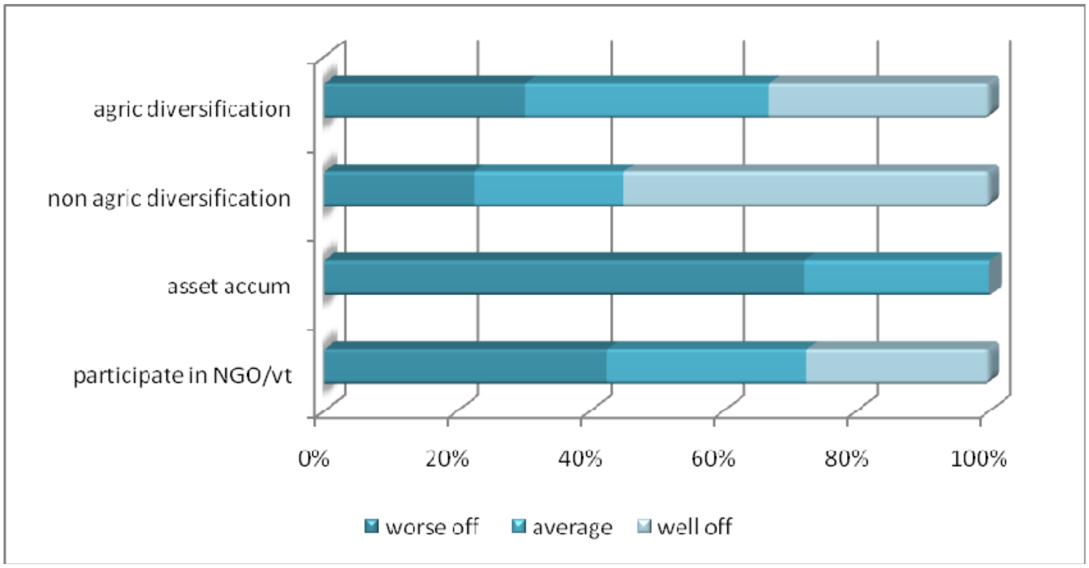

Figure 8. Maize production risk coping strategies by wealth groups.

Source: Survey data.

Household perception about price risk

The main price risks reported by farmers include both output and input prices. Unattractive maize prices contributed to farmers opting to grow maize primarily for home consumption. Expensive and difficult to access inputs implied that many households relied on government subsidized input credit schemes as well as NGO seed relief packs. All wealth groups relied on support program participation as their price risk coping strategy, supplemented by diverging contributions in terms of asset accumulation and diversification (Figure 9).

All farm households agreed that output price was crucial in determining how much to sell. If the (hybrid) maize price was more attractive, 78% would increase their fertilizer usage, 84% would acquire more credit, while 83% would accumulate assets. However, unattractive maize prices were not expected to have too much effect on assets.

Table 22 presents farmers' perceptions on the allocation of land to hybrid maize in response to selected crop production and price scenarios in the study area. Most farmers indicated that they would not change their production of OPV and hybrid maize if the output price were less than normal, while 33% would decrease production of landrace maize. However, in the case of an increase in the price, all farmers suggested they would increase production of landrace maize and 27.3% and 51.8% would increase production of OPV and hybrid respectively.

About 70% of the farmers reported they would increase production of OPV and hybrids if access to fertilizer is improved. Similarly, with improved access to credit, more than 70% of the farmers would increase production of both local and hybrid maize.

In terms of other crops, almost all farmers agreed they would increase production of cotton and sweet potatoes if the output price was higher, yield was higher, and access to fertilizer and credit was better.

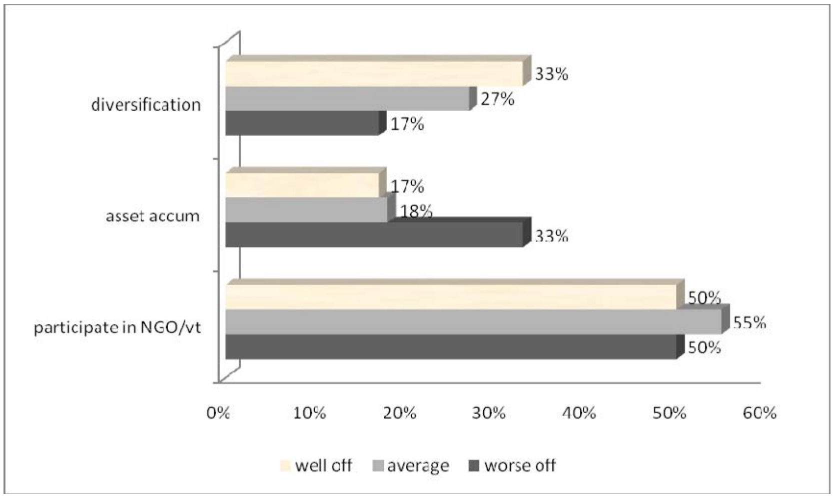

Figure 9. Price risk coping strategy adopted by wealth groups.

Source: Survey data.

Table 22. Response of farmers in allocation of land to hybrid maize under different scenarios.

Strategy	Price less than normal (%) n= 33	Price higher than normal (%) n= 33	Yield less than normal (%) n= 52	Yield higher than normal (%) n=53	Fertilizer available and affordable (%) n=53	Fertilizer less available and unaffordable (%) n=53	Credit is available and affordable (%) n=52
Decrease	1.8		1.1	1.1		19.8	
Same	98.2	48.2	35.2	35.2	30.8	78	23.5
Increase		51.8	63.7	63.7	69.2	2.2	76.5

Source: Survey data.

5 Technology use in crop production

5.1 Input use by farm households

Although hybrid maize prevails in the study area, the use of complementary external inputs and mechanization is relatively limited. Non-seed input use primarily revolves around soil fertility management with about half the households reporting the use of basal NPK fertilizer, top dressing fertilizer, and animal manure (Table 23). The low fertilizer usage can be attributed to physical shortages on the market and their high prices. With the liberalization of the economy, the market situation in the country has changed of late. Many agricultural inputs were controlled commodities and supposedly channeled through government programs and agencies like GMB and "Operation Maguta/Inala,"[5] although substantial amounts found their way to the parallel market.

[5] Operation Maguta/Inala is a government initiated program run by the national army to assist farmers with inputs for mass production.

Table 23. Non-seed input use by households by district.

	NPK		*SA/Urea*		*Animal manure*	
District	**Bikita**	**Masvingo**	**Bikita**	**Masvingo**	**Bikita**	**Masvingo**
N use (%)	17(34%)	28(56%)	27(54%)	26(52%)	27(54%)	25 (50%)
Quantity (kg)	1150	738	1765	1370	388.5	758

Source: Survey data.

Figure 10 summarizes the sources of chemical fertilizer and legume seed at the time of the survey. The local market was then a particularly important source for basal fertilizer and legume seed. The GMB and town markets played an important role in supplying top dressing fertilizer.

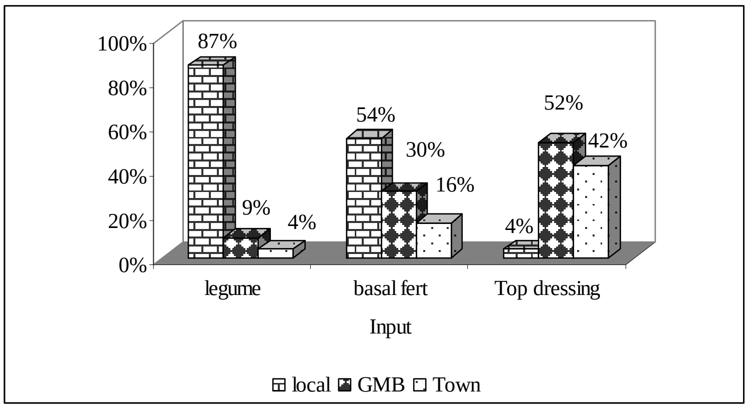

Figure 10. Sources of crop inputs.

Source: Survey data.

Half of the surveyed farmers planted the hybrid SC 513, making it by far the most common maize variety in the two districts. Other popular varieties included the PANNAR varieties and the ZM series, like ZM 521, ZM 421, and Matuba (which are OPVs) (Table 24). SC 513's popularity stems from its suitability to the study area and good performance even in areas with short growing season and with poor rainfall distribution. However, farmers pointed out that it was not readily available on the open market. Maize varietal choice was thus largely determined by which varieties were available on the market or distributed to farmers. Indeed, about half of the maize seed used by the farmers originated from NGOs (Figure 11). Farmers also mentioned high management requirements of some of the other varieties, whereas others were new and unknown. Improved OPVs mainly came through NGOs in the form of seed packs. In cases where households failed to receive adequate seed, they relied on retained seed.

The maize varietal use is associated with farmer dependence on the assistance from NGOs like Christian Care and CARE International, as well as from government sponsored programs like "Operation Maguta/Inala," which was aimed at boosting agricultural production. Seed is rarely available in local shops mainly due to the impasse between government and major seed suppliers on pricing policies. The Ministry of Agriculture controls the seed market in Zimbabwe, which is responsible for gazetting seed prices. However, from the seed suppliers' point of view, these prices are not realistically viable for their operations; hence most of them have significantly downsized operations, which have caused an endemic shortage of seed in the country in the past five or so years.

Table 24. Maize varieties planted by households (%) by district.

	District		Whole sample
	Bikita	Masvingo	
SC 513	52.1	48	50
PANNAR	8.3	8	8.2
PANNAR 413	4.2	8	6.1
ZM 421 (OPV)	4.2	2	3.1
SC 403	6.3	2	4.1
SC 401	2.1	8	5.1
ZM 521 (OPV)	2.1	16	9.2
Pioneer	6.3	-	3.1
Pioneer 3253	4.2	-	2.0
Matuba (OPV)	2.1	-	1.0
Pioneer 6423	2.1	-	1.0
Pioneer 535	2.1	-	1.0
SC 917	-	2	1.0
Pannar 473	-	4	2.0
SC 413	2.1	-	1.0

Source: Survey data.

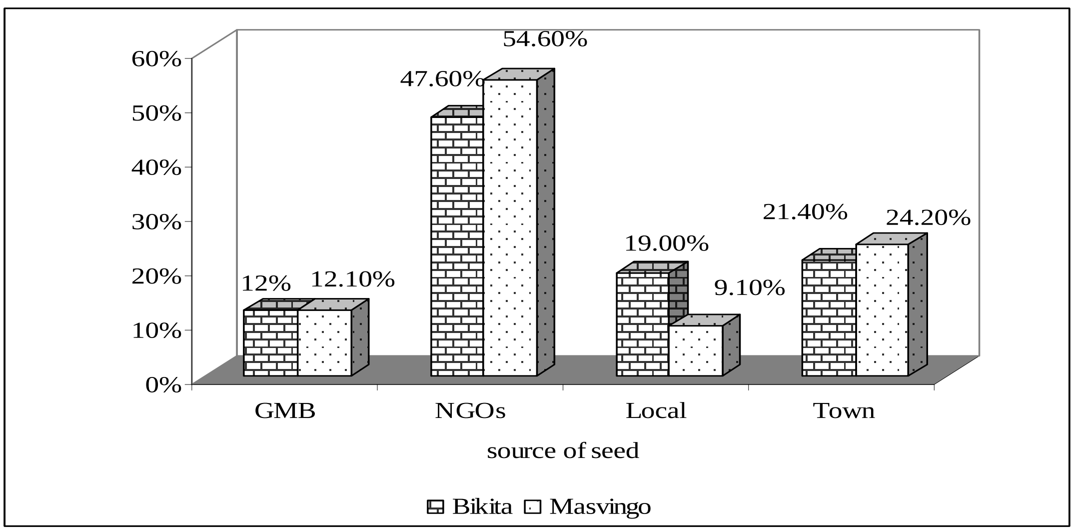

Figure 11. Sources of maize seed by district.

Source: Survey data.

5.2 Intensity of adoption of improved maize varieties

Adoption of improved maize varieties is no longer a matter of concern in Zimbabwe, as virtually all households use them, be it OPV or hybrid. More interesting is the intensity of adoption which we tried to analyze using standard Tobit model. The chi-square test at seven degrees of freedom shows that the Tobit model we estimated was found to be highly significant, implying the rejection of the null hypothesis that all explanatory variables do not have any effect on intensity of adoption (Table 25).

Table 25. Results of Tobit regression for intensity of adoption.

Proportion of land to improved maize |	Coefficient	Std. Err.	P>|t|
Farmer association	0.227†	0.051	0.000
Credit access	0.011	0.050	0.824
Primary education	0.058†	0.021	0.007
Secondary education	0.019	0.028	0.500
Poor group	0.028	0.054	0.604
Well off group	0.097	0.078	0.218
Plot size	-0.023†	0.008	0.009
Constant	0.141	0.101	0.165
Sigma	0.225	0.018	
Num. of observations =	97		
LR $chi^2(7)$ =	35.40		
Pseudo R^2 =	0.7146		

Three variables included were found to have significant influence in the proportion of land allocated to improved maize varieties at the household level. Being a member of a social group or an institution was found to positively and significantly influence land allocated to improved maize. This can be explained through the benefits of information and experience sharing among peers and fellow farmers. More involvement and thus more interaction with fellow farmers increases the land allocated to improved maize varieties.

Similarly, attending primary education—as compared to being illiterate—was found to have a very strong and positive influence on land allocated to improved maize varieties. The estimated coefficient shows that if a farmer moves from illiteracy to primary education the proportion of land he/she allocates to improved maize increases by 0.058%. This is an important finding, as land is very limited and education has always been reported to have a complex relationship with the level and intensity of adoption.

Another important finding in this estimation is that as plot size owned by a household increases, the proportion of land allocated to improved maize decreases. This simply means farmers who own smaller plots tend to allocate more of their land to improved maize varieties. There are two potential explanations for this, although not necessarily complementary. First, it can be argued that maize is the crop of the poor who are forced to allocate all resources to the staple food crop. Second, farmers with bigger plots have the luxury to diversity their production, rather than allocating more land to a crop will little market incentive.

6 Conclusions and recommendations

This study reiterates the importance of maize and drought in the study area. Farmers are addressing the drought and market risks by diversifying their livelihoods and relying on various coping strategies, including a subsistence orientation of maize production and limited external input use. Much of the cropped land was dedicated to maize cultivation, yet staple grains accounted for a high proportion of household expenditure. The limited availability of suitably improved maize seed on the market was also flagged as a concern. Despite this, the use of improved maize varieties and particularly hybrids like SC 513 is reportedly still widespread.

New drought tolerant maize varieties have the potential to positively contribute to the livelihoods in the areas surveyed as well as similar smallholder maize growing areas. For this reason, farmers need access to new high quality seed and complementary inputs like fertilizers to enhance and stabilize yield levels. This means farmers should have access to these inputs at the right time, at the right place, and in the right quantities.

The study thus recommends:

- To widely demonstrate the available and suitability of drought tolerant maize varieties and help facilitate farmers' access to quality seed.
- To complement the varietal focus with complementary research to address some of the maize production constraints, such as soil fertility, to help increase production and hence food security.

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