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produced as part of the

Drought Tolerant Maize for Africa (DTMA) Project

Characterization of Maize Producing Households in Monze and Kalomo Districts in Zambia

Thomson Kalinda, Gelson Tembo, Elias Kuntashula, Augustine Langyintuo, Wilfred Mwangi, and Roberto La Rovere

CIMMYT MR
International Maize and Wheat Improvement Center

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DTMA
The Drought Tolerant Maize for Africa (DTMA) Project is jointly implemented by CIMMYT and the IITA, and is funded by the Bill & Melinda Gates Foundation and the Howard G. Buffett Foundation. The project is part of a broad partnership, 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 aims to reach 30–40 million people in sub-Saharan Africa with better technologies in 10 years.

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Country Report – Household Survey

Characterization of Maize Producing Households in Monze and Kalomo Districts in Zambia

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DTMA Country Report - Zambia

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Contents

Tables

Figures

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 accompanying food aid in SSA. However, for this initiative to succeed, it needs to be embedded in the local reality. Each of the participating countries was therefore supported to conduct a community assessment and a household survey in the target areas. This report presents the findings of the household survey which serve as a baseline and characterize the maize producing households in the Monze and Kalomo districts in southern Zambia.

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 of the study benefitted from constructive contributions from Girma Tesfahun Kassie and Olaf Erenstein, among others. We also acknowledge the logistical and technical support of the University of Zambia (UNZA). The authors are responsible for any remaining errors and inferences.

Acronyms and abbreviations

°C	degrees Celsius
AIDS	Acquired Immune Deficiency Syndrome
B&MGF	Bill & Melinda Gates Foundation
CIMMYT	International Maize and Wheat Improvement Center
DTMA	Drought Tolerant Maize for Africa project
FRA	Food Reserve Agency
FSP	Fertilizer Support Program
FSPP	Food Security Pack Programme (FSPP)
GDP	Gross domestic product
GRZ	Government of the Republic of Zambia
ha	hectares
HH	household
HIV	Human Immunodeficiency Virus
HYV	High yielding variety
IITA	International Institute of Tropical Agriculture
kg	kilograms
km	kilometers
MACO	Ministry of Agriculture and Cooperatives
masl	meters above sea level
MEU	Man equivalent unit
NGO	Non-governmental organization
OPV	Open-pollinated variety
PAM	Program Against Malnutrition
PCA	Principal components analysis
PFS	Probability of failed season
NGOs	Non-governmental organizations
SSA	sub-Saharan Africa
TLU	Tropical Livestock Units
ZMK	Zambian Kwacha (1US$ = ZMK4,100 during the survey)

1 Introduction

The Drought Tolerant Maize for Africa (DTMA) project is an initiative which is supported by the Bill & Melinda Gates Foundation (B&MGF) and Howard G. Buffett Foundation to accelerate drought tolerant maize development and deployment in 13 countries in sub-Saharan Africa (SSA). The DTMA Initiative joins the efforts of people, organizations and projects supporting the development and dissemination of drought tolerant maize in SSA. The work builds on the efforts of CIMMYT to develop and breed drought tolerant maize varieties. Maize sustains the life of more than 300 million of Africa's most vulnerable and it is Africa's most important cereal food crop. When recurrent droughts in SSA ruin harvests, lives and livelihoods are threatened or destroyed. Experts say that the situation may become even worse as climate change progresses. Developing, distributing and cultivating drought tolerant maize varieties are highly relevant interventions to reduce vulnerability and food insecurity in SSA. CIMMYT and the International Institute of Tropical Agriculture (IITA) have been working for over 10 years with national agricultural research institutes to adapt breeding techniques to SSA. As a result, over 50 new maize hybrids and open-pollinated maize varieties (OPVs) have been developed and provided to seed companies and non-governmental organizations (NGOs) for dissemination, and several of them have reached farmers' fields. These drought tolerant maize varieties produce about 20–30% higher yields than other maize varieties under drought conditions. DTMA will focus on improving, accelerating and enlarging the entire drought tolerant maize variety development and delivery pipeline targeted at SSA, including removing institutional bottlenecks for rapidly scaling up and out to reach 30–40 million people over a 10-year time frame (http://dtma.cimmyt.org).

This country study is part of the DTMA project. It presents the findings of the household survey which serves as a baseline and characterizes the maize producing households in the Monze and Kalomo districts of southern Zambia. These areas are part of the project's medium drought risk zone (20–40% PFS) target area. It complements an earlier community assessment in the same area (Kalinda et al. 2007).

The purpose of this study is to characterize the maize producing households and to assess the adoption of improved maize varieties. This study was also designed to collect baseline data on farm households to construct indicators that could be used to subsequently measure the impact of the adoption of improved maize varieties. Due to cost and time, the baseline study was conducted in only two selected districts in the country.

The report is organized in sections as follows. Section two presents the sampling and data collection procedure followed by a brief description of the agro-climatic characteristics of the survey districts. The households' access to agricultural production resources is presented in section three. Section four discusses farm households' livelihood strategies related to crop and livestock production as well as off-farm/non-farm activities that generate income. This section also presents the household income and expenditure profiles. Section five presents the use of agricultural technology and improved maize varieties. The report ends with a summary discussion on selected impact indicators.

2 Materials and methods

2.1 Sampling and data collection

Zambia is a landlocked country occupying an area of 752,614 km^2. The country shares borders with Zaire and Tanzania in the north, Malawi and Mozambique in the east, Zimbabwe and Botswana in the south, Namibia in the southwest, and Angola in the west. Zambia is divided into nine provinces:

Lusaka, Central, Copper Belt, Southern, North Western, Western, Luapula, Northern and Eastern Provinces. The Southern Province, which experiences 40–60% probability of drought occurrence, was selected to represent marginal maize growing conditions, with two districts selected, namely, Monze and Kalomo districts. In terms of agricultural classifications, Monze and most part of Kalomo fall in agro-climatic region II[1]. A small portion of Kalomo falls in region I[2]. Ten villages were selected in each district (Table 1), where farmers were proportionately selected randomly based on the distribution of maize production households to give a total of 350 households for the survey. Fifty-eight percent of the households were located in Monze District while the rest were located in Kalomo District.

Table 1. Selected survey villages.

District	Area (km^2)	Population	Selected villages	
Monze	6,687	165,741	Masenge	Hachaanga
			Kayumba	Moonga
			Halwindi	Mutwa
			Choonga	Moomba
			Kajomba	Hanamatinga
Kalomo	15,000	127,762	Simbale	Mafwafwa
			Sibalwa	Siamtendu
			Siantalusia	Simapangula
			Settlement A	Settlement B
			Siachuunga	Chikoli

Source: GRZ 2006a; GRZ 2006b.

2.2 Characterization of survey locations

Monze District is situated along the Great North Road/Railway route, approximately 200 km from Lusaka in the North and 300 km from Livingstone in the South. Its neighbouring districts are Mazabuka in the north; Gwembe in the east; Choma in the south; and Namwala in the west (see Figure 1 and Figure 2). With a population density of about 25 persons per km^2, the district could be divided into three physiographic regions as follows: the South-eastern part of the district with steep slopes borders Lake Kariba whose altitude is between 600 and 650 meters above sea level (masl); the Central High plateau area consisting of soft undulating old plains, which is ideal for maize growing; and the North West low flat plain where the Kafue Flats and Kafue National Park fall. The drainage pattern is from the south into the north where it drains into the Kafue River. The Kafue River is the largest river that crosses the district although it is at the borderline with Namwala District in the west and Mazabuka District in the north. The other notable river is the Magoye River (GRZ 2006a).

1 Agro-ecological region II is characterized by annual rainfall ranging between 800 and 1,000 mm and a growing season of 100 to 140 days (Ministry of Agriculture, Food & Fisheries 1995; Environmental Council of Zambia 2000).

2 Agro-ecological region I is predominantly fairly fertile ferro soils with high potential; some parts have Zambezi solonitzi soils, semi-arid plains, sandy soils with low potential.

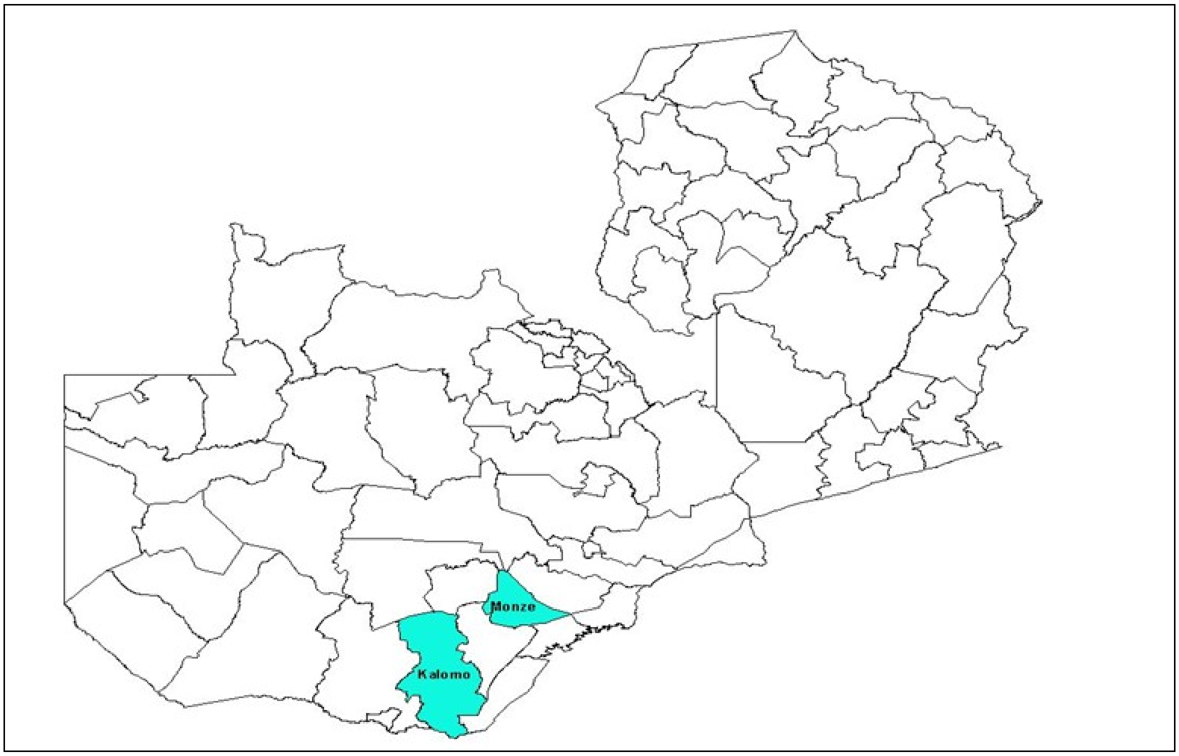

Figure 1. Map of Zambia showing selected survey districts.

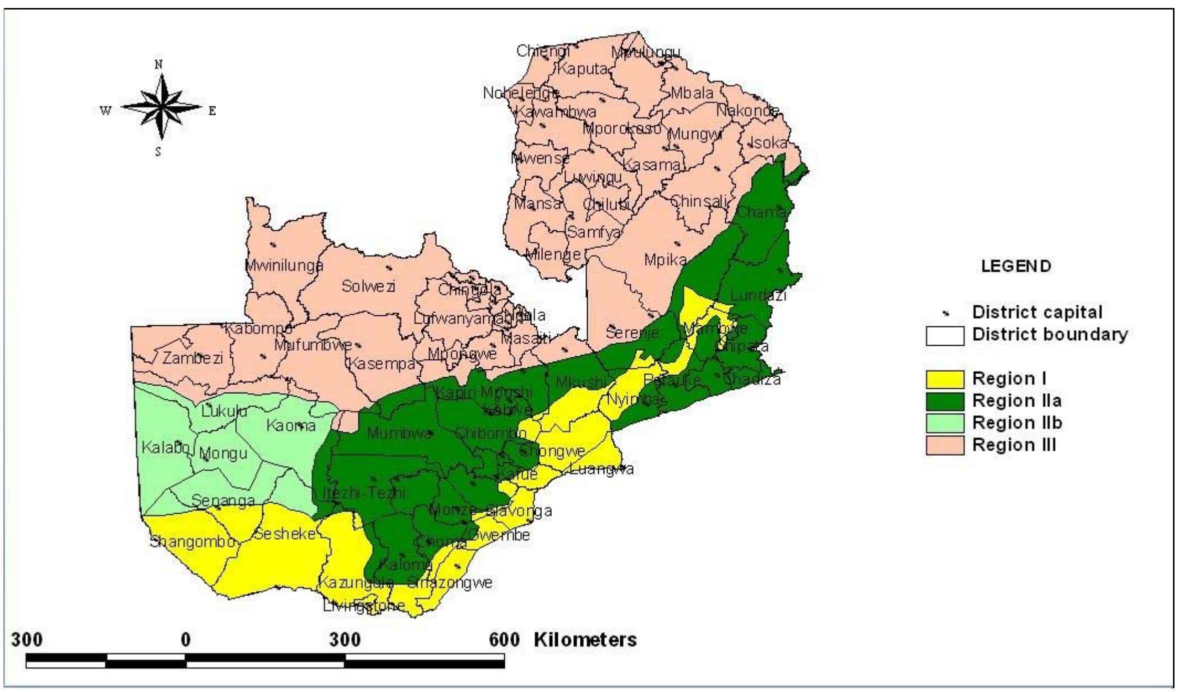

Figure 2. Agro-climatic distribution in Zambia.

Source: Compiled by A. Mambo, Soil Survey Unit, Mt Makulu, October 2001.

Similarly, Kalomo District is situated along the Great North Road about 120 km north of Livingstone town and 400 km south of Lusaka. The town is located some 1,300 m above sea level.

Kalomo District covers an area of approximately 15,000 km^2 with a total population of about 127,762. After the split with Kazungula, the district now only comprises the eastern part of its former area. To the north, it borders with Itezhi-tezhi and Namwala; it borders Chomain in the northeast; Kazungula and Livingstone are to the west, Sinazongwe in the east and also Zimbabwe in the east. The predominating topography of the district is a high plateau that is typical for most areas of Southern Province, consisting of a soft undulating plain. Its altitude is mostly around 1,300 m above sea level. The landscape toward the south is dominated by the steep slopes of the escarpment towards the Zambezi River. The general drainage pattern is toward the south, to the Zambezi River. There are only few perennial rivers in the district. The most noticeable of these is the Kalomo River (GRZ 2006b).

The agro-climatic and physical features for Monze and Kalomo districts are presented in Table 2 and Figure 2. Monze District is located in agro-ecological region II on the country's agro-ecological classification. The average altitude for Monze District is 1,120 masl. The minimum and maximum temperatures of the district are 4 and 42 degrees Celsius (ºC), respectively. The maximum rainfall registered in the district was 815 mm annually, while the average level of rainfall registered is 650 mm, which is normal rainfall expected for agro-ecological region II. Monze's minimum level of rainfall registered was 332 mm. In recent years, the average rainfall recorded in the whole district has been below the long term average in the region (GRZ 2006a).

Kalomo is also located in agro-ecological region II. However, a small portion of the southern part of the district is located in agro-ecological zone I. The average altitude of the district is 1,300 m above sea level. The minimum level of temperature is 2ºC while the maximum is 40ºC. The average rainfall registered is about 350 mm. This is also far below the long term average in region II (GRZ 2006b). The decreasing average amounts of rainfall received in the Monze and Kalomo districts reflect the trends of droughts and dry spells that have been experienced in the region in the past two decades. For instance, the country experienced four severe droughts in the past sixteen years. The droughts were experienced in the 1991–92, 1992–93, 2001–02, and 2004–05 seasons. These resulted in total crop failure and food shortages, affecting maize production, which is the major staple (Mungoma 2007).

Table 2. Agro-climatic characteristics of the survey districts.

Characteristic	**District**	
	Monze	**Kalomo**
Agro-ecological zone	Region II	Mainly in region II, some region I
Rainfall	800–1,000 mm	800–1,000mm, < 800 in some parts
Maximum level of rainfall registered	815 mm	1,200 mm
Minimum level of rainfall registered	332 mm	350 mm
Average level of rainfall	650 mm	800 mm
Average altitude of the district	1,120 m	1,300 m
Minimum level of temperature	4ºC	2ºC
Maximum level of temperature	42ºC	40ºC
Growing season	90–150 days	90–150 days. 80–120 days in region I
Soil conditions	Predominantly fairly fertile ferro soils with high potential	*Region II:* Predominantly fairly fertile ferro soils with high potential *Region I:* Predominantly fairly fertile ferro soils with high potential, some parts have Zambezi solonitzi soils, semi-arid plains, sandy soils with low potential
Vegetation	Dry miombo and acacia woodlands	Dry miombo and acacia woodlands. Some parts in region I have Kalahari, miombo and swamp vegetation

Source: GRZ 2006a; GRZ 2006b; GRZ 2005.

3 Household characteristics

Household characteristics are discussed based on the livelihood approach, which is founded on the belief that people require a range of assets to achieve positive livelihood outcomes. The assets that people need are human, natural, physical, financial and social capital. Human capital represents the skills, knowledge, ability to labor and good health. These combined factors enable people to pursue different livelihood strategies and achieve their livelihood objectives. Therefore, the human capital discussed considers only households' access to potential labor resources required to carry out various farm operations, and thus achieve agricultural livelihood objectives. Natural capital refers to the natural resource stocks from which resource flows and services useful for livelihoods are derived. There is a wide variation in the resources that make up natural capital, from intangible public goods such as the atmosphere and biodiversity, to divisible assets used directly for production (trees, land, etc.). The natural capital assets discussion in the following sections will therefore consider total farm land available to households and the proportion put under cultivation annually. Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods. Farmers' acquisitions of various durable and liquid assets are discussed under physical assets. Financial capital denotes the financial resources that people use to achieve their livelihood objectives; hence the credit facilities available to farmers are discussed under financial assets. Social capital refers to the social resources upon which people draw in pursuit of their livelihood objectives. These are developed through networks and connectedness, to membership to formal groups, and relationships of trust, reciprocity and exchanges that facilitate co-operation and may provide the basis for informal safety nets amongst the poor. Farmers' access to social support networks is discussed under social capital.

3.1 Categorizing household access to capital assets

Drawing heavily on Langyintuo (2008) and Langyintuo and Mungoma (2008), this section discusses households' access to capital assets after normalizing their resource endowments and computing wealth indices using principal components analysis (PCA). Households' endowments by given assets vary tremendously making it difficult to compare them on a wealth ranking scale. To compare different forms of assets so that ranking households can be objective, the assets should be normalized. Normalizing households' assets involves constructing indices by rescaling the assets' values to between 0 to 1. The indices are then aggregated to obtain a composite index that is used for ranking the households. Following Filmer and Pritchett (2001), Langyintuo (2008) and Langyintuo and Mungoma (2008), the indices were rescaled from 0 to 1 as follows:

$$i = \frac{x_l - x_{\min}}{x_{\max} - x_{\min}}$$

where, i is the index, x_l is the level of the asset, while x_{min} and x_{max} are the minimum and maximum values of x, respectively taken from the actual data collected. Once scaled (or normalized), the indicators can be added together without the element of distortion, which would be introduced by widely differing value ranges.

Principal components analysis was used to calculate the wealth index of each household based on the normalized indices (Filmer and Pritchett 1998, 2001, and Zeller et al. 2005). The PCA extracts from a set of variables those few orthogonal linear combinations of the variables that capture the common information most successfully. Intuitively the first principal component of a set of variables is the linear index of all the variables that captures the largest amount of information is common to all of the variables. Suppose we have a set of K variables, a^*_{1j} to a^*_{Kj}, representing the ownership of K assets by household j. Principal components starts by specifying each variable normalized by its mean and standard deviation. For example, $a_{1j} = (a^*_{1j} - a^*_1)/s^*_1$, where a^*_1 is the mean of a^*_{1j} across all households and s^*_1 is its standard deviation. These selected variables are expressed as linear combinations of a set of the underlying components for each household j:

$$\begin{aligned} a_{1j} &= v_{11}A_{1j} + v_{12}A_{2j} + \ldots + v_{1K}A_{Kj} \\ &\ldots \qquad \forall j = 1,\ldots, j \\ a_{K1j} &= v_{K1}A_{1j} + v_{K2}A_{2j} + \ldots + v_{KK}A_{Kj} \end{aligned} \tag{1}$$

where A refers to the components and v the coefficients on each component for each variable (and do not vary across households). The solution for the problem is indeterminate because only the left-hand side of each line is observed. To overcome this indeterminacy, PCA finds the linear combination of the variables with maximum variance, usually the first principal component A_{1j}, and then a second linear combination of the variables, orthogonal to the first, with maximum remaining variance, and so on. Technically, the procedure solves the equations $(\mathbf{R} - \lambda\mathbf{I})\mathbf{v}_n = 0$ for λ_n and $\mathbf{v}_n$, where $\mathbf{R}$ is the matrix of correlations between the scaled variables (the as) and $\mathbf{v}_n$ is the vector of coefficients on the nth component for each variable. Solving the equation yields the eigenvalues (or characteristic roots) of $\mathbf{R}$, λn and their associated eigenvectors, $\mathbf{v}_n$. The final set of estimates is produced by scaling the $\mathbf{v}_n$s so their squares sum to the total variance.

The "scoring factors" from the model are recovered by inverting the system implied by Equation (1), and yield a set of estimates for each of the K principal components:

$$\begin{aligned} A_{1j} &= f_{11}a_{1j} + f_{12}a_{2j} + \ldots + f_{1K}a_{Kj} \\ &\ldots \qquad \forall j = 1,\ldots, j \\ A_{K1j} &= f_{K1}a_{1j} + f_{K2}a_{2j} + \ldots + f_{KK}a_{Kj} \end{aligned} \tag{2}$$

The first principal component, expressed in terms of the original (un-normalized) variables, is therefore an index for each household based on the expression:

$$A_{1j} = f_{11}(a^*_{1j} - a^*_1)/(s^*_1) + \ldots + f_{1K}(a^*_{Kj} - a^*_K)/(s^*_K) \tag{3}$$

The assigned weights are then used to construct an overall "wealth index", applying the following formula:

$$W_j = \sum_{i=1}^{k} [b_i(a_{ji} - x_i)]/s_i \tag{4}$$

where, $\boldsymbol{W_j}$ is a standardized wealth index for each household; $\mathbf{b}_i$ represents the weights (scores) assigned to the k variables on the first principal component; $\boldsymbol{a_{ji}}$ is the value of each household on each of the k variables; $\mathbf{x}_i$ is the mean of each of the k variables; and $\mathbf{s}_i$ the standard deviations.

A negative index ($-W_j$) means that, relative to the communities' measure of wealth, the household is poorly endowed and hence worse-off while a positive figure (W_j) signifies that the household is well-off. A zero value, which is also the sample mean index, implies the household is neither well-off nor worse-off.

In this analysis, PCA was run on 22 indicators using SPSS. Eight components were extracted. The first component was chosen for use in constructing the index because it explained about 20% of the total variance in the 22 indicators (Table 3).

Table 3. Total variance explained using principal components extraction method using standardized values of variables.

Component	Extraction sums of squared loadings		
	Total	% of variance	Cumulative %
1	4.302	19.557	19.557
2	1.738	7.902	27.459
3	1.275	5.795	33.254
4	1.241	5.642	38.896
5	1.172	5.329	44.225
6	1.119	5.089	49.314
7	1.078	4.899	54.213
8	1.052	4.783	58.996

Source: Survey data, 2007.

The scores assigned to the indicators on component 1 are shown in Table 4. The impact of each variable on the overall index was calculated as the score divided by the standard deviation. When a household moves from 0 to 1 on a particular indicator, its score on the overall index is increased by the amount of the "impact" ratio for that indicator (Langyintuo et al. 2005).

It was observed that 63% of the whole sample was poorly endowed, relative to the communities' measure of wealth (Figure 3). The well-off households had a mean wealth index of 1.00 while the poorly endowed ones had a mean wealth index of -0.58. More than half (51%) of the households in Monze District were well endowed, compared to Kalomo District (27%). More than 86% of the female-headed households were poorly endowed, compared to 58% for male-headed households.

Table 4. Scoring factors and summary statistics for variables entering the computation of the first principal component.

Variable	Mean	Std. Deviation	Score	Impact
Bicycles	0.268	0.227	0.110	0.486
Draft animals	0.123	0.184	0.160	0.870
Ox-drawn ploughs	0.081	0.116	0.190	1.631
Ox-drawn harrows	0.066	0.153	0.174	1.134
Wheelbarrows	0.050	0.160	0.082	0.516
Radios	0.198	0.177	0.107	0.603
Private well	0.023	0.095	0.050	0.527
Cultivator	0.052	0.119	0.179	1.505
Mobile phone	0.062	0.169	0.079	0.466
Farm size	0.020	0.056	0.072	1.284
Cropped land	0.121	0.109	0.121	1.111
Household size	0.339	0.162	0.131	0.807
Value of livestock	0.038	0.084	0.089	1.059
Motor vehicle	0.010	0.080	0.060	0.755
Motorcycle	0.020	0.118	0.033	0.280
Tractor harrow	0.004	0.060	0.001	0.024
Private borehole	0.006	0.076	0.016	0.211
Water pump	0.023	0.150	0.035	0.232
Scotch carts	0.037	0.190	0.071	0.374
Television sets	0.103	0.305	0.094	0.307
Membership to farmer groups	0.504	0.501	0.068	0.135
Access to credit 2005–06	0.109	0.312	0.017	0.055

Source: Survey data, 2007.

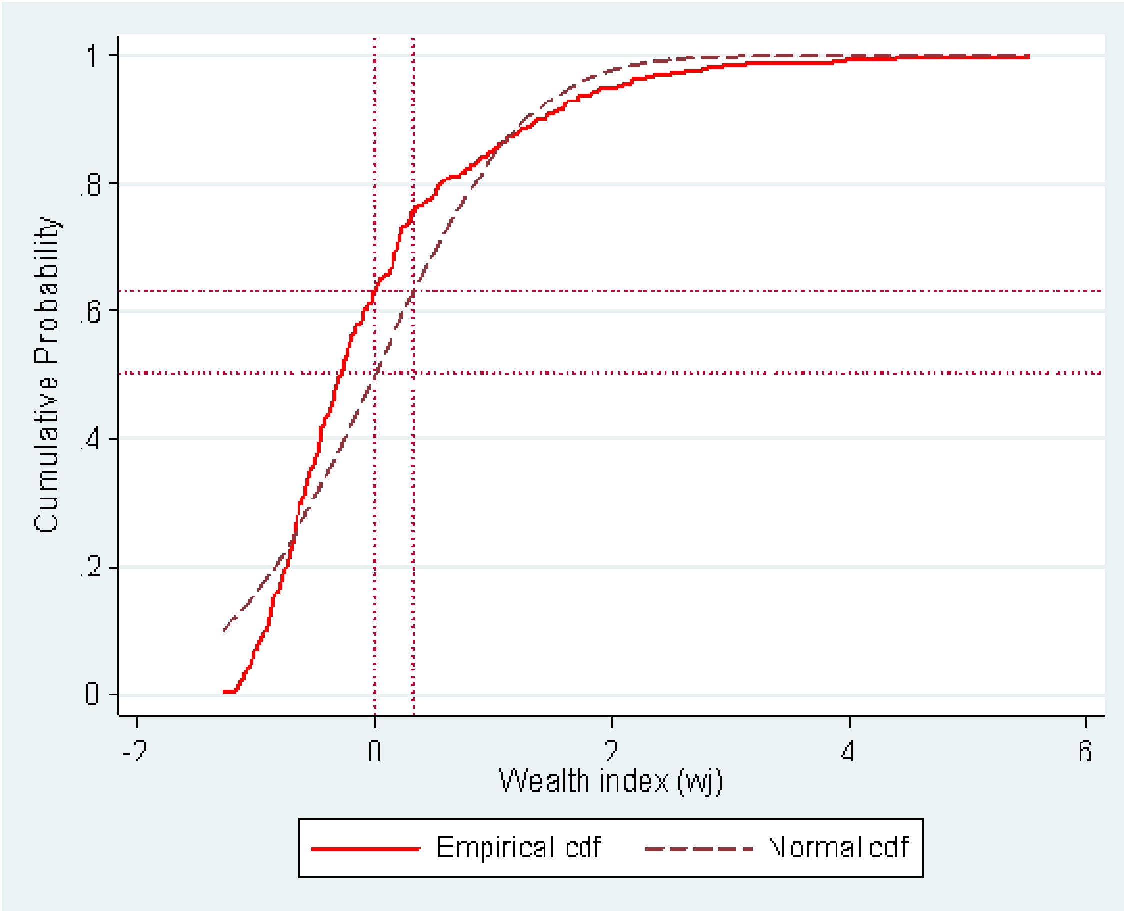

Figure 3. Distribution of wealth index ranking of households.

3.2 Human capital

The demographic characteristics of the sample households as presented in Table 5 suggest that the overall sample comprised 18% female-headed and 82% male-headed households. Seventy-nine percent of the household heads were married, 11% widowed and about 4% either divorced or separated while 6% single. Age has an impact on the productive capacity of smallholder farmers. The estimated mean age of the household heads in the sample was about 46 years. The mean age for household heads in Monze District was 48 years while for those in Kalomo District, it was 43 years. This age profile means that the majority of the household heads could be regarded as potentially productive farmers with the capacity to adopt new farming practices. About 89% of those interviewed had some formal education. Of these, 55% had primary school education and 30% secondary school education. About 2% reported that they had post-secondary school education and another 2% had some training in adult education. Some 11% reported having no formal education.

At the household level human capital is a factor of the amount and quality of labour available; this varies according to household size, skill levels, health status, etc. The focus here is on households' access to farm labor. Most rural households depend on family labour for various farm activities: therefore, the size of the household has an impact on labour supply. The size of the household for the sample household ranges from 1 to 20, with a mean size of 8 people (Table 5).

Table 5. Demographic characteristics of sampled households.

	District		
	Monze	**Kalomo**	**Whole sample**
Household size (members)	5.98 (1–15)	7.10 (1–20)	6.44 (1-20)
Man equivalent units (MEU)	4.04	4.38	4.18
Age of household head	47.8 (21-91)	42.6 (22-78)	45.6 (21-91)
Distribution of household heads in age groups (proportion)			
≥ 60 years	0.42 (0-3)	0.24 (0-2)	0.34 (0-3)
16–59 years	2.83 (0-8)	3.23 (0-8)	3.00 (0-8)
≤ 15 years	3.47 (1-10)	3.77 (1-10)	3.60 (1-10)
Female-headed HH (%)	22.1	12.3	18
Education level of HH head (%)			
Illiterate	15.2	5.5	11.4
Primary education	57.8	50.0	54.6
Secondary	23.0	40.4	30.3
Post-secondary	2.5	2.1	2.3
Adult education	1.5	2.1	1.7
Marital Status of HH head (%)			
Single	6.4	4.8	5.7
Married	76.0	83.5	79.1
Divorced	2.9	3.5	3.2
Separated	2.0	0	1.2
Widowed	12.7	8.3	10.9

Note: Figures in parenthesis are the ranges.
Source: Survey data, 2007.

Following Runge-Metzger (1988) and Langyintuo et al (2005), each household member was converted to a man equivalent unit (MEU) with the assumption that individuals in different age groups cannot perform normal farm operations at similar rates of efficiency. For instance, under normal circumstances, a 5-year old cannot weed a farm with the same efficiency as a 30-year old, but there would hardly be any difference between 20- and 40-year olds. Therefore, the development of MEU[3] takes into consideration the differences in labour use efficiencies among different age categories. The estimated MEUs ranged from 1 to 14 with a mean of 4.18, being somewhat lower in Monze District (Table 5). In Kalomo District about 39% of the female-headed households have less than the sample mean of MEU compared with 7% for the male-headed households (Table 6). In Monze District, the differences were not significant.

Table 6. Household labour force availability by gender of household head (%).

	District					
	Monze		**Kalomo**		**Whole sample**	
Labor force	Female (n =45)	Male (n = 159)	Female (n = 18)	Male (n = 128)	Female (n = 63)	Male (n =287)
0–2	2	3	6	2	3	2
2.1–4	16	9	33	5	21	7
4.1–6	44	32	22	25	38	29
6.1–8	13	29	11	24	13	27
8.1–10	16	15	22	20	17	17
> 10	9	13	6	23	8	17
Mean MEU	4.50	3.91	3.25	4.54	4.14	4.18

Source: Survey data, 2007.

[3] Man equivalent units (MEU) were defined as follows: household members less than 9 years = 0; 9–15 or above 49 = 0.7; 16–49 = 1 (compiled after Runge-Metzger 1988).

3.3 Natural capital

The land tenure system in the study area and the rest of Zambia is predominantly traditional or customary. Customary land is usually vested in traditional leaders (local chiefs and headmen) who are its custodians. Individuals or households have a right to land. However, access to land is granted by the community's chief or headman who allocates pieces of land on which the households can establish their homesteads, cultivate crops and raise their livestock. The individuals or households do not own the land but have usufructuary rights over it for their production and sustenance. Within the households, the heads (usually men) apportion the land to family members for farming and building purposes. The usufruct rights are usually lifelong, and transfer of these rights upon the death of the holder is common. The inheritance of land use rights ensures that future generations of the family are guaranteed land use rights. The majority of the households (82%) have customary ownership of the land they cultivate which they inherited from their parents or relatives. The other 18% have access to communal land obtained from local chiefs and headmen. Very few households (0.1%) are using rented land or have formal title deeds for their land.

The distribution of total farm land among the sample households is disproportionate. While some households have up to 74 ha, others have less than a hectare (Table 7). The average cropped area is about 3 ha with farmers in Kalomo District cultivating slightly larger areas than those in Monze District. In general, an average of two individuals is supported on one hectare of land in Monze and Kalomo districts (Table 7). Table 8 suggests that female-headed households have smaller farm sizes. In Kalomo District, the difference between the two genders in terms of the size of land owned is that none of the sampled female-headed households owned land of 3 to 5 ha in size.

Table 7. Land use by district.

	District		
	Monze	Kalomo	Whole sample
Total farm land (ha)	4.01 (0.25–22)	10.43 (0.4–74)	6.68 (0.25–74)
Total cropped land (ha)	2.57 (0.1–13)	3.65 (0.25–26)	3.02 (0.1–26)
Mean years of fallow	2.04 (0–12)	2.91 (0–8)	2.53 (0–12)
Man-land ratio	1.87 (0.04–49.8)	2.43 (0.04–19)	2.10 (0.04–49.8)
Land use intensity (R-value)	0.57 (0.05–1)	0.52 (0.06–1)	0.54 (0.05–1)

Note: Figures in parenthesis are the ranges.
Source: Survey data, 2007.

Table 8. Access to farm land by gender and district (%).

	District					
Farm size	Monze		Kalomo		Whole sample	
Range (ha)	Female	Male	Female	Male	Female	Male
0–1	22.2	10.1	11.1	3.9	19.1	7.3
1.1–2	24.4	20.1	38.9	2.3	28.6	12.2
2.1–3	20	16.4	22.2	8.6	20.6	12.9
3.1–4	13.3	17.6	0	9.4	9.5	13.9
4.1–5	11.1	11.9	0	9.4	7.9	10.8
> 5	8.9	23.9	27.7	66.4	14.3	42.9

Source: Survey data, 2007.

In terms of land distribution among different wealth categories, the well endowed households own about 70% of total or cultivated land (Figure 4). Households in the well endowed wealth category own farm sizes in excess of 60% over the sample average (10.9 ha compared with 6.7 ha, Figure 5) while those in the poorly endowed category own farm sizes about 30% less than the sample average (4.2 ha). Similarly, corresponding figures for the cultivated land areas show that the well endowed households own cultivated areas in excess of 45% over the sample average (4.4 ha compared with 3.0 ha) while the poorly endowed households have cultivated areas about 27% less than the sample average (2.2 ha).

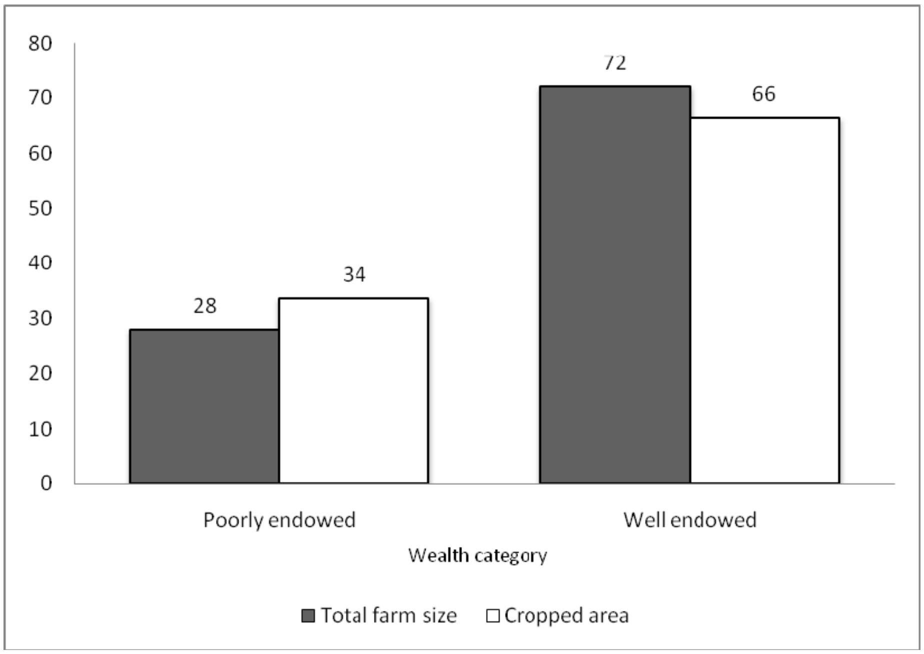

Figure 4. Proportional distribution of land types by wealth group.
Source: Survey data, 2007.

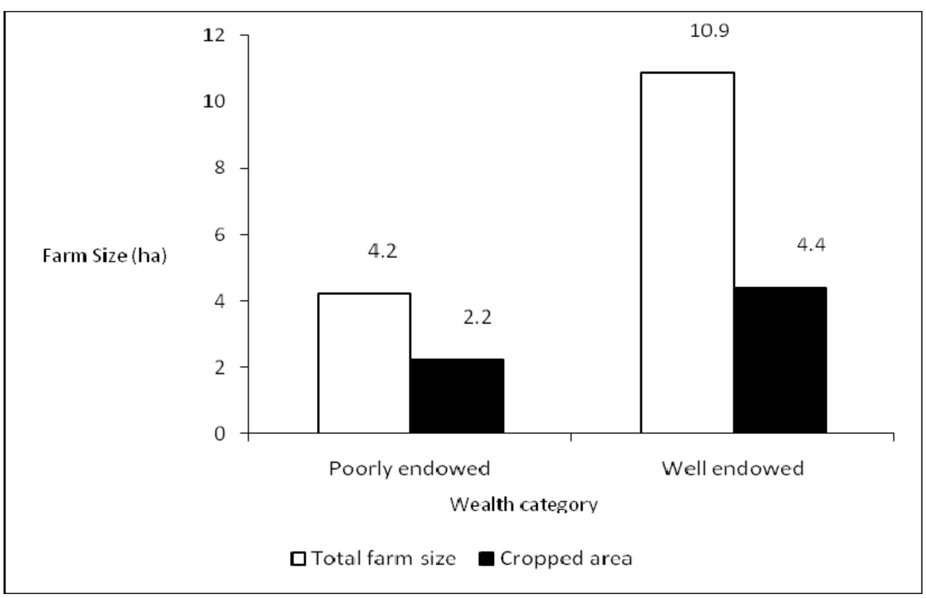

Figure 5. Ownership of land by wealth group.
Source: Survey data, 2007.

Determinants of cultivated farm size

Information on the dynamics of whether farm sizes have been increasing or decreasing over time is important for the design of land development interventions. For instance, if cultivated land areas have been decreasing, crop intensification or the use of improved technologies (including seed) could be proposed. When respondents were asked to indicate how their current land size compares with what they cultivated in the past, more than half of them (51%) indicated that it had decreased. Twenty-five percent recorded an increase, and 24% indicated that their cultivated farm sizes remained the same (Figure 6).

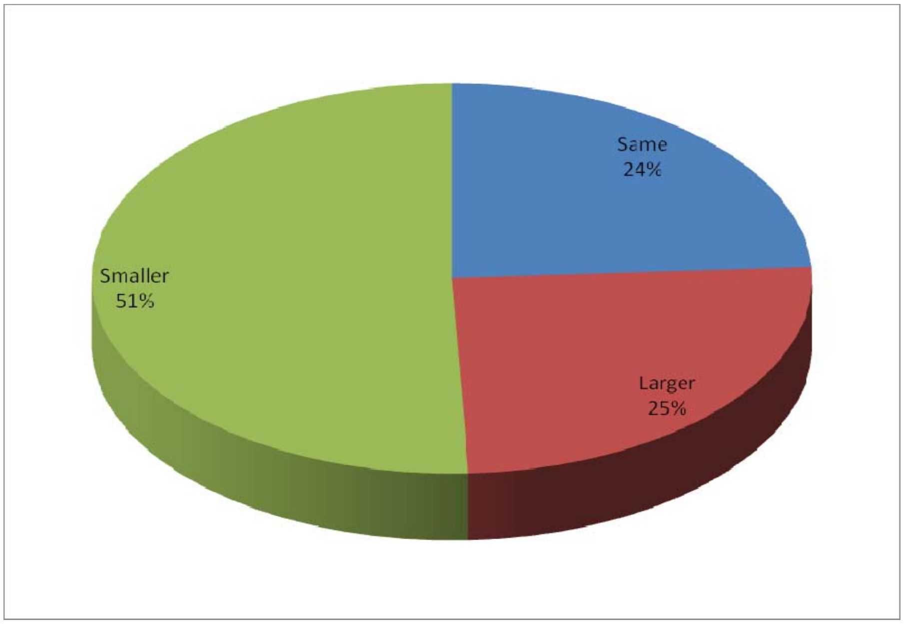

Figure 6. Dynamics of farm size over time.

Source: Survey data, 2007.

Table 9 shows that the three most important reasons for any change in cultivated farm size have generally been the availability of cash to purchase various inputs, household food needs, availability of cash to purchase seed, and expected family labor availability. The major factors that determine the cultivated land size do not differ significantly between the two survey districts, but in Monze District, factors such as current grain prices, expected grain price after harvest, expected family labor availability, cash availability to hire labor, and draft power were relatively more important.

Table 9. Determinants of cultivated farm size by district.

	Monze	Kalomo	Whole sample
Expected family labor availability	50	31.5	42.2
Cash availability to hire labour	26.8	17.8	23
Cash availability to purchase other inputs	85.4	89.7	87.2
Current grain prices	6.1	0.7	3.8
Expected grain price after harvest	9.6	2.7	6.7
Food needs	61.1	92.5	74.4
Availability of seed	58.6	61	59.6
Draft power	0.5	4.1	2

Source: Survey data, 2007

3.4 Physical capital

Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods. Infrastructure consists of changes to the physical environment that help people to meet their basic needs and to be more productive while producer goods are the tools and equipment that people use to function more productively. The following components of infrastructure are usually essential for sustainable livelihoods: affordable transport; secure shelter and buildings; adequate water supply and sanitation; clean, affordable energy; and access to information (communications). The most common and important physical assets include bicycles, radios, draft animals (cattle) and farming tools (Table 10 and Table 11). Animal ploughs are relatively more common in Kalomo as compared to Monze.

Table 10. Proportion of households that own assets (%).

	District		
Asset	**Monze**	**Kalomo**	**Whole sample**
Motor vehicle	0.5	3.4	1.7
Motorcycle	2.9	3.4	3.1
Bicycle	62.3	73.3	66.9
Tractor	0	0.7	0.3
Tractor plough	0.5	0.7	0.6
Tractor harrow	0	2.1	0.9
Draft animals	30	63	43.7
Animal plough	30	69.2	46.3
Animal harrow	10.8	27.4	17.7
Animal scotch cart	5.4	1.4	3.7
Wheelbarrow	10.8	7.5	9.4
Television set	12.8	6.9	10.3
Radio	65.2	67.1	66
Private well	8.8	2.7	6.3
Private borehole	0.5	0.7	0.6
Water pump	0.5	4.8	2.3
Cultivator	14.2	28.1	20
Diesel pump	0	0.7	0.3
Water tank	0	2.1	0.9
Mobile phone	12.3	11.6	12
Land phone	0.5	0	0.3

Source: Survey data, 2007.

Table 11 summarizes the mean number of each asset owned by the households, disaggregated by wealth status. As expected, well endowed households have consistently more of each asset than their poorly endowed counterparts.

Table 11. Distribution of mean number of assets by wealth group.

	Wealth group		
Asset	**Poorly endowed**	**Well endowed**	**Total**
Motor vehicle	0.009	0.038	0.020
Motorcycle	0.032	0.054	0.040
Bicycle	0.564	1.215	0.806
Tractor	0.000	0.008	0.003
Tractor plough	0.005	0.008	0.006
Tractor harrow	0.009	0.015	0.011
Draft animals	0.409	3.608	1.597
Animal plough	0.245	1.554	0.731
Animal harrow	0.014	0.515	0.200
Animal scotch cart	0.000	0.100	0.037
Wheelbarrow	0.041	0.200	0.100
Television	0.027	0.231	0.103
Radio	0.586	1.131	0.789
Private well	0.032	0.131	0.069
Private borehole	0.005	0.008	0.006
Water pump	0.009	0.046	0.023
Cultivator	0.018	0.677	0.263
Diesel pumps	0.000	0.008	0.003
Water tanks	0.000	0.023	0.009
Mobile phones	0.050	0.246	0.123
Fixed phone	0.005	0.000	0.003

Source: Survey data, 2007.

Good quality housing is a status symbol, which may have implications for the household's access to social services. As shown in Table 12, different types of houses or dwellings exist, but the predominant type is the brick house with grass thatch. This is more common in Kalomo District (73%), compared to Monze District (50%).

Table 12. Types of dwelling used by households (%).

	District		
Dwelling type	**Monze**	**Kalomo**	**Whole sample**
Mud hut with grass thatch roof	14.8	4.8	10.6
Mud hut with grass asbestos/iron roof	3.5	0.7	2.3
Brick house with grass thatch roof	49.7	72.6	59.3
Brick house with asbestos/iron roof	30.5	19.9	26.1
Block house with asbestos/iron roof	1.5	0	0.9
Pole and adobe with grass thatch roof	0	2.1	0.9

Source: Survey data, 2007.

3.5 Financial capital

Most farmers in developing countries like Zambia generally have limited access to credit from financial institutions. They therefore lack financial resources to meet immediate cash needs and other important requirements such as farm inputs like fertilizer and seed. Since credit is usually in short supply, it is often very costly when available. Table 13 shows that there appears to be a limited number of credit sources for farmers in both Monze and Kalomo districts. None of the farmers in Kalomo District said they had received cash credit while those in Monze District reported to have gotten some cash credit from various sources.

Table 13. Access to credit by households (%).

Access to	District Monze	Kalomo	Whole sample
Input credit	15.8	4.8	11.2
Cash credit	7.8	0	4.6
Source of cash credit			
Financial institution	2.0	0	1.1
Money lender	.5	0	.3
NGO	2.0	0	1.1
Other	3.4	0	2.0

Source: Survey data, 2007.

Some NGOs attempt to fill the credit vacuum by providing either cash or input credits to farmers (Table 13). Some farmers sometimes receive input credit from private companies operating out-grower schemes for the cultivation of cash crops, such as cotton, and tobacco. The government also helps by providing subsidized input credit to selected farmers under the Fertilizer Support Programme (FSP) and the Food Security Pack Programme (FSPP). This intervention is not without its critics. There has been considerable debate about the sustainability of input subsidies and its impact on the private sector. The challenge thus remains to find solutions to the problem of increasing access to credit by poor small-scale farmers who lack collateral assets. These results show that there has been a gap in the provision of credit services in rural areas. This limited and often complete lack of access to rural financial services hampers smallholders' efforts to improve or expand their farm activities, so as to earn income.

3.6 Institutional and social capital

Rural and farm households sometimes need social support to effectively achieve a better quality of life. Social support networks or social capital examined here is concerned with household participation in governmental and NGO support programmes. Farmers in rural areas in Zambia, including those in Monze and Kalomo districts, face difficulties in accessing various forms of institutional support mainly because they live in remote and distant places with limited or poor infrastructure such as roads and telecommunications. Table 14 shows the levels of access to institutional support to the survey households.

The results indicate that support in terms of food relief or aid was accessed by a majority of the sample households. This mainly came from NGOs like World Vision International, Care International and Catholic Relief Services. The predominance of food aid support reflects the problem of poor food crop production among smallholder farmers in Southern Province and elsewhere, which has been caused by droughts or floods. Some of the NGOs have been providing direct food relief to poor and vulnerable households while others have been involved in food-for-work programmes. Apart from food aid support, other forms of institutional support to farmers involve provision of inputs like seed and fertilizers. Since credit is acknowledged to be in short supply, and it is often very costly when available. The government has attempted to cater for the lack of access by providing input credit to farmers. Under the Fertilizer Support Programme and the Food Security Pack Programme, the government has been providing fertilizer and improved seeds to many vulnerable but viable smallholders. The government provides a small loan, repayable in kind, consisting of seed for a cereal (i.e. maize, millet, rice), plantings for tuber (sweet potato, cassava), and seed for a legume (groundnuts, beans) to farmers identified as vulnerable. In the past few years, millions of farmers have received input packages on credit, and this has had a positive effect on the availability of and access to food for needy households.

Table 14. Sources of institutional support to households in Zambia (%).

Source	Type of support			Months of support
	Food	Seed	Fertilizer	
World Vision International	31.1	0.6	0	3.6 (1-12)
Action Aid	0.3	0	0	4 (4)
Catholic Relief Services	3.7	0	0.3	1.6 (1-4)
Care International	11.7	1.1	0.3	5.4 (1-6)
Government Starter Pack	0.3	0.9	0.3	1.5 (1-6)
Programme Against Malnutrition	0.3	0	0	2.5 (2-3)
World Food Programme	0.3	0.6	0	2 (2-2)

Note: Figures in parenthesis are the ranges.

Source: Survey data, 2007.

Access to information about new technologies such as seed or fertilizer is important in determining the level of utilization of improved maize varieties and fertilizers among the small-scale farmers. The provision of research and extension information is an important responsibility of the government to the farming population. In Zambia, public agricultural extension services are provided through extension workers of the Ministry of Agriculture and Cooperatives (MACO). These activities are complemented by NGOs and private seed companies as well as tobacco and cotton out-grower scheme operators. Table 15 shows the level of access to field demonstrations by the sample households. The results show that there is very limited coverage of extension services in the country in general and access to field days, and demonstrations in particular.

Table 15. Access to field demonstrations (%).

Hosting organization	No. of field days attended	No. of field demonstrations attended	No. of times discussing maize production
Agricultural extension	1.22 (0-5)	0.6 (0-5)	1.4 (0-6)
Agricultural research	1 (1-1)	0.3 (0-1)	0.4 (0-2)
NGO	1.0 (0-3)	0.3 (0-2)	0.6 (0-4)
Seed company	0.8 (0-4)	0.4 (0-4)	1 (0-8)
Cotton company	1.2 (0-4)	0.7 (0-4)	0.5(0-8)
Tobacco company	0.1 (0-1)	0	0.2 (0-2)
Agric. development agency	0.5 (0-2)	0.1 (0-1)	0.5 (0-2)

Note: Figures in parenthesis are the ranges.

Source: Survey data, 2007.

The limited access to public extension in most rural provinces is mainly due to inadequate resource allocation to the agricultural sector. The cuts in government expenditure have had a direct consequence on the quality and coverage of government agricultural services, such as extension. Public expenditure cutbacks have meant that there are fewer extension activities like demonstrations as well as fewer extension workers recruited to serve the rural communities. Fewer farmers in Monze District than those in Kalomo District belong to any farmer associations or cooperatives.

3.7 Summary

A number of livelihood indicators for maize producing households according to the different wealth categories, and the gender of the household head are summarized in Table 16 and Table 17. For most of the physical assets and livestock, the well endowed households in the sample own more than the poorly endowed households (Table 16). The well endowed households also generally have higher access to social capital. A comparison of some of the indicators by gender category shows that the female headed households are less endowed as compared to their male-headed counterparts (Table 17).

Table 16. Selected household characteristics by wealth group.

Variable	Full sample	Sub-samples[a] Poorly endowed	Well endowed	
	(1)	(2)	(3)	
Number of households	349	220	129	
	---------- Mean ----------			
Household size	6.44	5.49	8.06	***
Age of the HH (years)	45.6	46.3	44.5	
Number of males aged 15–60 years	1.46	1.23	1.84	***
Number of females aged 15–60 years	0.78	0.64	1.02	***
Farm size in hectares	6.68	4.22	10.88	**
Cultivated land area (ha)	3.02	2.22	4.38	***
Area under maize (ha)	2.36	1.69	3.50	
Number of draft animals	1.60	0.41	3.63	***
Tropical livestock units (TLU)	4.96	2.77	8.69	***
Value of livestock owned (ZMK)[b]	4,001,312	2,189,139	7,091,840	***
	---------- Percent (%) ----------			
Male-headed HH	82	75	93	***
Households with married heads	79	70	93	***
Head reached secondary school	33	26	44	***
Most educated	47	41	57	***
Modern roof on main house	29	22	41	***
Households receiving credit 2005–06	11	10	13	
HHs in farmer groups	50	39	70	***
HHs access to extension officers	62	58	71	**
HHs receiving agric. input aid in 2005–06	5	5	5	
HHs attending field days in 2005–06	25	24	27	
HHs attending demonstrations in 2005–06	11	11	11	

[a] Mean differences between sub-samples tested by unequal-variance *t* tests. [b] Exchange rate: 1 US$ = ZMK4,100. Significance level: **=5%, ***=15%.
Source: Survey data, 2007.

Table 17. Selected household characteristics by gender of household head.

Variable description	Total sample	Gender [a] Female-headed	Male-headed	
Number of households	350	63	287	
Age of the HH head (years)	46	52	44	
Households with married heads (%)	79	14	93	
Head reached secondary school (%)	30	19	33	
Farm size (ha)	6.7	2.8	7.6	**
Cultivated land area (ha)	3.02	2.01	3.25	***
Households receiving credit 2005–06 (%)	12	12	11	
Households in farmer groups (%)	51	48	52	
Access to extension officers (Mean no. of contacts/year)	8.7	8.5	8.8	

[a]Group-mean difference tests by unequal-variance t tests. Significance: ** = 5%; *** = 1%.
Source: Survey data, 2007.

4 Household livelihood strategies

Rural and urban households engage in various livelihood strategies to earn a living. This section examines some of these livelihood activities in which the surveyed rural households are involved. The respondents were asked to indicate what they considered to be major activities that are sources of income for their households. The results as shown in Figure 7 show that the households depend mostly on agriculture for their livelihoods. On-farm income comes from the sale of both food and cash crops (grains, fruits and vegetables), as well as livestock and fisheries products. Off-farm income includes cash income from both agricultural work and non-agricultural activities like self-employment, formal employment, petty trading, remittances, and others.

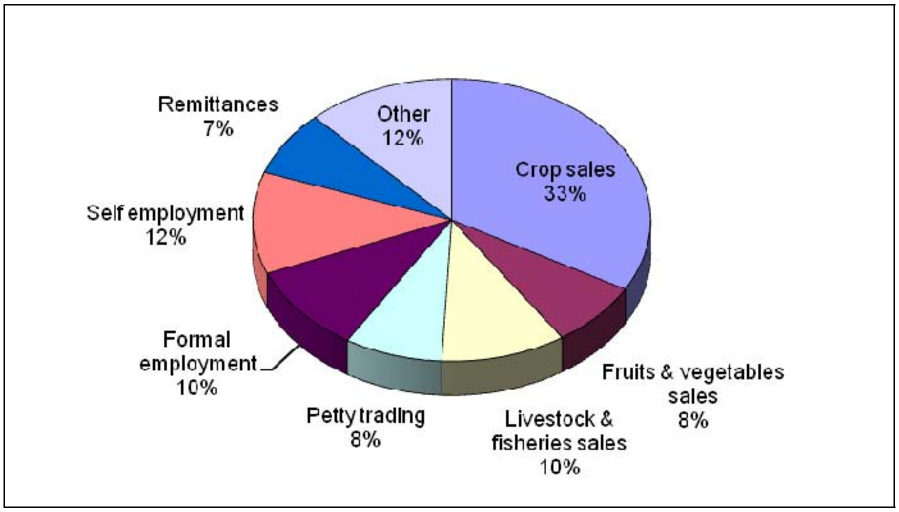

Figure 7. Sources of household income.

Source: Survey data, 2007

4.1 Crop production and marketing

In Monze and Kalomo districts, crop production is generally done at subsistence level, complemented by limited semi-commercial and commercial farming. The major crops grown are maize, sorghum, groundnuts, millet, tobacco and cotton while minor ones include cowpeas and vegetables (such as tomatoes, onion, cabbages, and other leafy vegetables). Production of some crops has increased in the area since the mid-1990s. These are cotton, sorghum and cassava. Increase in cassava has been due to the promotional activities of NGOs such as Programme Against Malnutrition (PAM) and World Vision International in drought-prone areas of the country. In the case of cotton, multinational companies such as Dunavant are responsible for the increase by providing input credit to farmers. Tobacco production has also increased, particularly in Kalomo District, mainly due to the white commercial farmers from Zimbabwe who have settled in the area.

Maize is the major staple crop in most parts of Zambia. Results of this survey show that in total, maize constitutes the single largest cultivated crop, occupying 60% and 61% of the cultivated area in Monze and Kalomo districts, respectively (Figure 8 and Figure 9). Both local and hybrid maize varieties are cultivated by the surveyed households. Other important crops in the area are groundnuts, cassava, beans, sweet potatoes and others. The planting of different varieties of crops, particularly maize, is a risk management strategy adopted by farmers in addition to spreading crops over different plots.

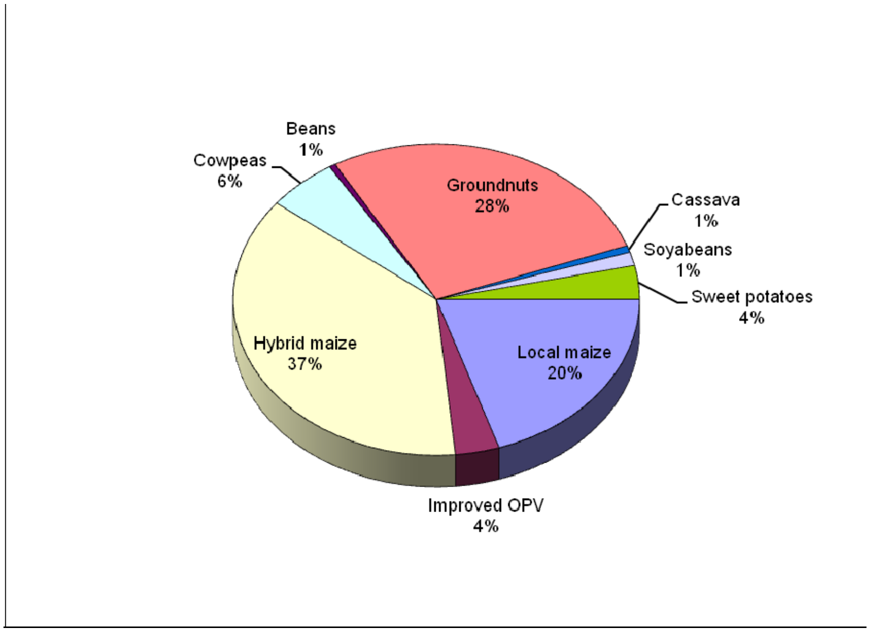

Figure 8. Distribution of land area among crops in Monze District.
Source: Survey data, 2007.

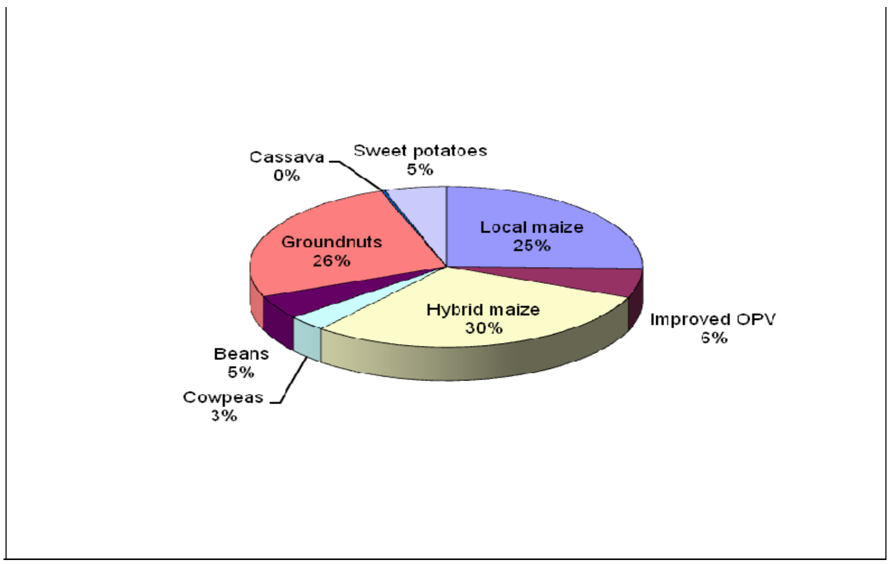

Figure 9. Distribution of land area among crops in Kalomo District.
Source: Survey data, 2007.

Farming households sell a proportion of their crops for cash. Table 18 shows how the sample households utilized their maize crop in the 2005–06 season. The farmers in Monze and Kalomo districts mostly sell their maize grain to the government operated Food Reserve Agency (FRA) and a few of them sell their maize in the city market in the districts. As shown in Table 18, households mainly consume the maize they produce. The households also use their maize for meeting social obligations such as giving out the grain as gifts to relatives and reserving some grain as seed for the next season. In addition to maize grain, households grow other food grains which supplement their maize grain stock. Considering the three types of maize grains produced, the households had a deficit with the local varieties but surpluses with the OPVs and the hybrids, probably reflecting the higher productivity of the improved varieties as compared to the local maize.

Table 18. Disposal of maize harvest among the households.

Amount	Local land race Maize	Improved OPV Maize	Hybrid maize
Harvested (kg)	897 (0–4,000)	1,858 (0–32,000)	2,574 (0–11,4000)
Consumed (kg)	829 (0–8,300)	696 (0–3,000)	1,119 (0–56,000)
Sold (kg)	145 (0–12,000)	747 (0–14,000)	789 (0–20,000)
Given out as gifts (kg)	21 (0–650)	68 (0–1,390)	31 (0–3000)
Reserved (kg)	8 (0–100)	26 (0–1,020)	1 (0–50)
Lost during harvest (kg)	8 (0–400)	15 (0–370)	9 (0–250)
Surplus/deficit (% of total maize grain production)	-12.7	16.5	24.3

Note: Figures in parenthesis are the ranges.
Source: Survey data, 2007.

4.2 Livestock production and marketing

Households keep livestock, especially small ruminants and poultry in addition to their crop production activities as a livelihood and risk management strategy. Livestock provide meat for direct household consumption and manure for crop production. Additionally, they play various roles in accomplishing social obligations such as in marriages, where they are used as dowry payments. Sample household livestock ownership in the two districts from the survey is reported in Table 19. The farm households in the sample own cattle and most keep some combination of small livestock like goats, pigs, chickens, ducks, and other livestock. As can be seen in Table 19, cattle are the most important livestock species owned by the households and are used for various purposes. For most categories of livestock, the well endowed households own more livestock than those that are poorly endowed (Table 19 and Figure 10). The estimated Tropical Livestock Units (TLU) per household averaged about 2.8 for the poorly endowed households and 8.7 for the well endowed households. More male- than female-headed households keep larger numbers of cattle (Figure 11).

Most farmers sell their livestock to local people and itinerant urban traders. However, the marketing of livestock has been negatively affected by outbreaks of livestock diseases in recent years. These are mainly attributed to the low and limited farmer access to veterinary services in most rural provinces, due to privatization policies and public sector expenditure cutbacks. Livestock diseases like foot and mouth disease in places like Southern and Western provinces that lead to heavy losses of oxen have had a major impact on both cash and food crop production and thus negatively affect the livelihoods of farmers. In order to mitigate this problem, farmers have been advised to vaccinate their animals (especially cattle) and to frequently dip them to avoid outbreaks of certain livestock diseases.

Table 19. Mean number of livestock owned by wealth group.

Livestock	Wealth group: Poorly endowed	Well endowed	Total
Cows – local	4.07	4.66	4.48
Bulls – local	1.22	1.59	1.46
Young bulls – local	2.44	1.86	2.03
Heifer – local	0.00	0.00	0.00
Calves – local	2.71	2.53	2.59
Cows – improved	2.94	2.68	2.75
Bulls – improved	1.80	3.60	3.00
Young bulls – improved	0.00	1.00	1.00
Heifer – improved	0.00	1.33	1.33
Calves – improved	1.60	2.50	2.15
Goat – local	3.00	1.33	2.00
Pigs	6.84	8.01	7.32
Sheep	0.00	7.25	7.25
Transport animals	5.15	8.38	6.38
Chicken – local	10.37	15.47	12.31
Chicken – improved	13.43	30.80	20.67
Other	8.86	22.90	17.12
Tropical Livestock Units	2.77	8.69	4.96

Source: Survey data, 2007.

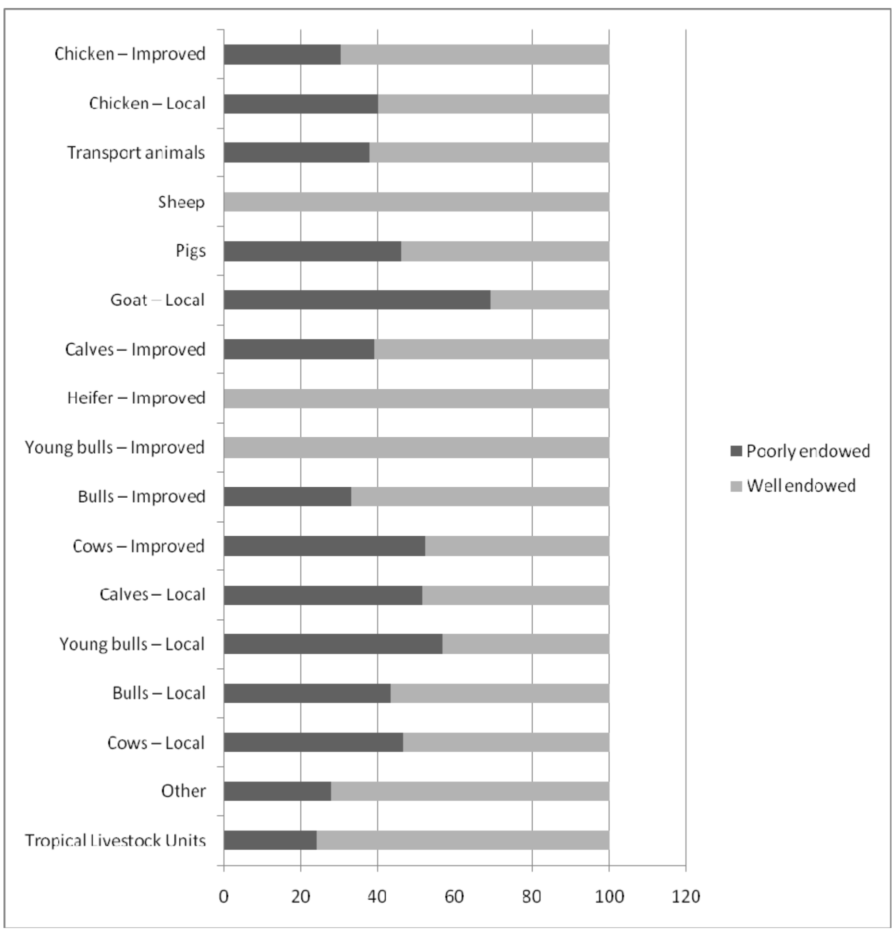

Figure 10. Proportion of livestock owned by wealth group.

Source: Survey data, 2007.

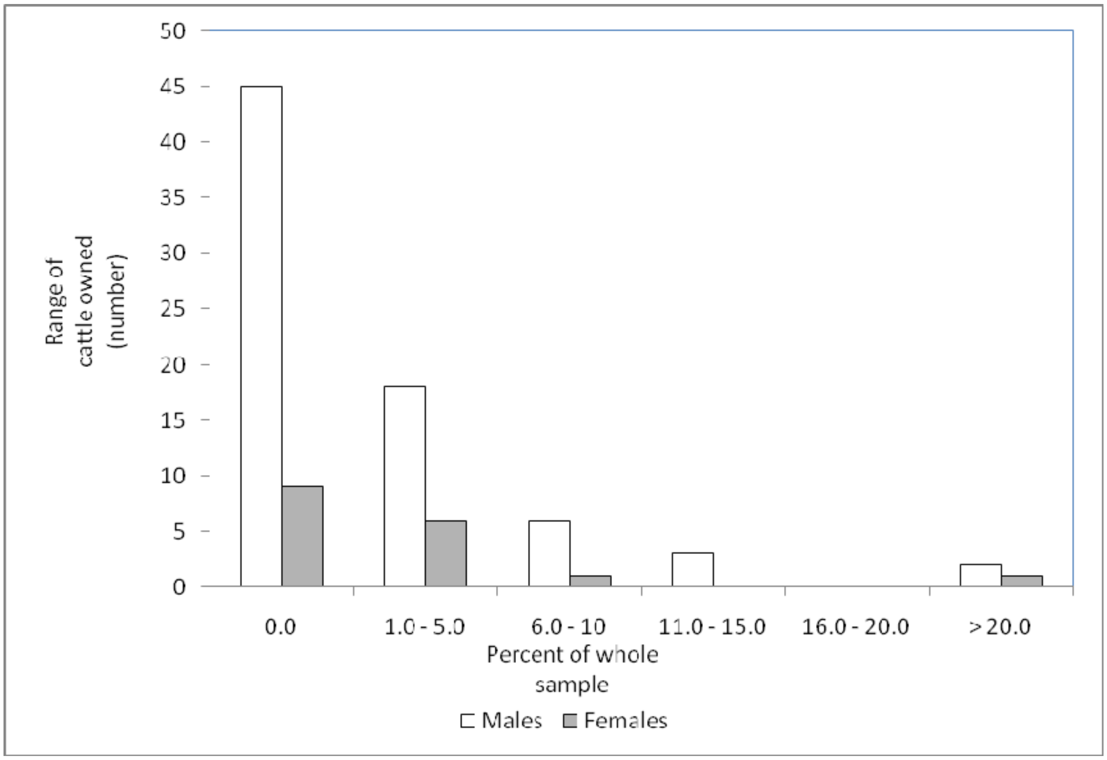

Figure 11. Distribution of cattle ownership by gender of household head.

Source: Survey data, 2007.

4.3 Income and expenditure profiles of households

Apart from agriculture, the sample households engage in both the formal and informal sectors to generate income for their livelihoods. The respondents were asked to estimate the total annual income earned by their household. As shown in Table 20, the combined incomes from these activities reported for the 2005–06 season by households in Monze and Kalomo districts were Zambia Kwacha (ZMK) 0.8 million and ZMK 1.6 million, respectively.

Agriculture is the major economic activity for rural families in Zambia. Farming generates food as well as cash for the farmers. Agriculture alone contributed 20% of Gross Domestic Product (GDP) in 2005, of which about 80% was from the smallholder sub-sector. Agriculture also contributes about 60% of employment in the country (GRZ 2006). Sales of crops, livestock and fisheries, as well as fruits and vegetables contribute about 50% of income in the two districts, reflecting the important role of agriculture in the livelihood strategies of the households (Table 20). Figure 12 shows the proportions of households engaged in other off-farm activities, such as petty trading, self-employment and formal employment to earn incomes. Some households also receive remittances. The estimated income from remittances in Monze and Kalomo districts were 8% and 7% of total household income, respectively. In addition to above-mentioned activities, people are also involved in a diversity of other livelihood activities, including collection of natural products (mushrooms and honey); selling of firewood; handicrafts; and transportation among others.

Table 20. Sources of household income by district.

	Monze	Kalomo	Whole sample
Total income (ZMK million)	0.83	1.63	1.15
Sources of income (%)			
– Crop sales	34.3	30.4	33.2
– Fruits and vegetables	7.1	7.8	7.5
– Livestock and fisheries	10.7	9.0	10.2
– Petty trading	7.5	8.7	8.0
– Formal employment	13.3	8.0	10.0
– Self-employment	10.5	13.1	11.6
– Remittances	8.1	6.5	7.4
– Other	8.4	16.5	12.1

Source: Survey data, 2007.

Farming households are thus engaged in various off-farm activities in order to supplement their incomes (Table 20). An estimated 22% of households are employed in both the formal (such as civil service work as teachers) and informal sectors (such as bicycle repair work, artisanal work, local beer brewing, etc). Among the different wealth categories, a larger proportion of well endowed households are in self and formal employment as compared to the poorly endowed households (Figure 12).

The poorly endowed households acquire a larger proportion of their income from sales of agricultural commodities as compared to the well endowed households whilst the well endowed families obtain a larger proportion of their income from non-agricultural activities such as petty trading and self-employment as compared to the poorly endowed families.

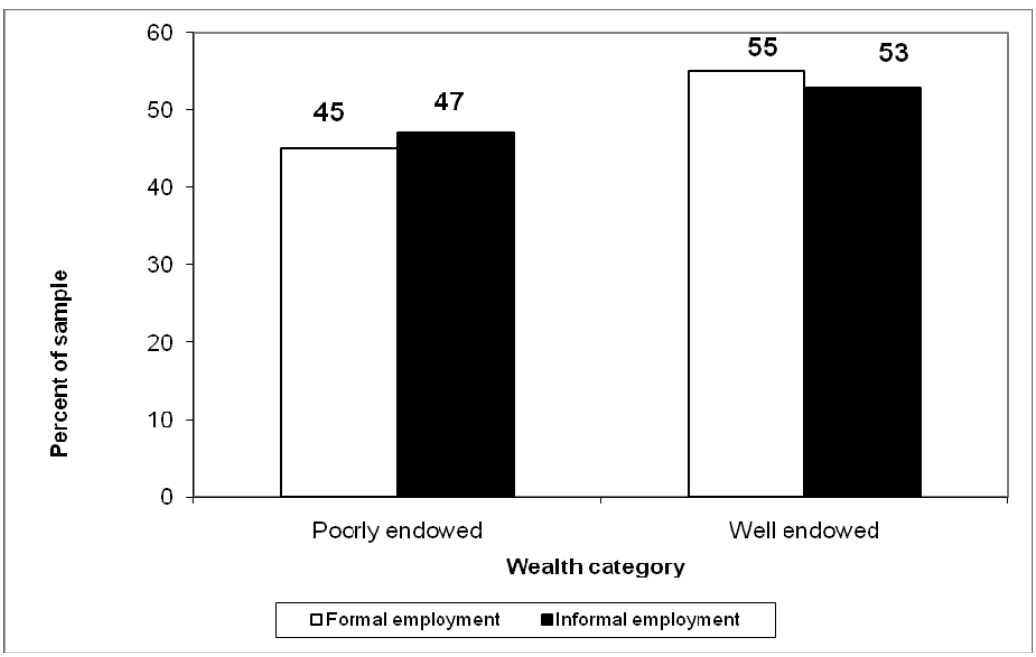

Figure 12. Proportion of households involved in off-farm activities in different wealth groups.

Source: Survey data, 2007.

Other than giving an indication of the incomes earned in 2005–06, the households were also asked to give estimates of their expenditure. As shown in Table 21, total expenditure reported for the 2005–06 season by households in Monze and Kalomo districts were ZMK 1.3 million and ZMK 1.1 million, respectively. About 20%, 17%, and 14% of the estimated total household expenditure in Monze and Kalomo districts were spent on education, staple foods and clothing, respectively. Other important expenditure items were bicycle repairs and gifts (18%), and medical bills (11%). The high proportion of expenditure spent on food, education and medical bills is not surprising. In the case of medical bills, even though access to health facilities is free, households are expected to meet costs such as purchase of drugs and other specialized treatment. This is the same with education. Households have to meet some expenses such as nominal school fees and purchase of books. Some households also purchase staple foods like maize in seasons when they have poor harvests due to droughts or floods.

Table 21. Expenditure patterns of households by district.

	Monze	Kalomo	Whole sample
Total expenditure (ZMK million)	1.29	1.08	1.20
Expenditure (% of total)			
– Staple food	16.8	22.5	16.8
– Tobacco/alcohol	6.4	9.2	6.6
– Educational	24.7	16.7	19.9
– Medical	16.5	3.4	10.6
– Clothing	19.8	8.3	14.1
– Fuelwood, paraffin	2.8	2.5	2.4
– Bicycle repairs, gifts	0.0	24.5	18.0
– Remittances	5.4	5.2	4.8
– Social contribution	3.2	3.7	3.0
– Miscellaneous	4.5	4.1	3.9

Source: Survey data, 2007.

Regarding expenditure, the well endowed households bought or spent more on farm inputs, food, tobacco and alcohol, education, clothing, social contributions, and remittances as compared to the poorly endowed households (Table 22).

4.4 Outcome of livelihoods

Livelihood outcomes are what people seek to achieve through their livelihood strategies, which are diverse at every level. Therefore, livelihood outcomes are the achievements—the results—of livelihood strategies. Outcome categories can be examined in relation to categories such as: more income; increased well-being, reduced vulnerability; improved food security; more sustainable use of the natural resource base; social relations and status; dignity and (self) respect; and so on.

Table 22. Income and expenditure profiles by wealth group

	Whole sample	Wealth group	
		Poorly endowed	Well endowed
Income profile			
Total income (ZMK Million)	1.15	0.69	1.93
Income by category (% of total)			
– Crop sales	33.2	38.1	23.6
– Fruits and vegetables sales	7.5	7.9	7.2
– Livestock sales	10.2	10.9	9.1
– Petty trading	8.0	5.9	13.6
– Formal employment	10.0	9.4	11.5
– Informal employment	11.6	11.2	12.6
– Remittances received	7.4	6.7	10.2
– Other	12.1	9.8	12.2
Expenditure profile			
Total expenditure (ZMK million)	1.20	1.13	1.33
Expenditure category (% of total)			
– Staple food	16.8	16.0	27.8
– Tobacco/alcohol	6.6	5.4	13.4
– Educational	19.9	20.8	21.3
– Medical	10.6	12.4	4.7
– Clothing	14.1	15.9	11.8
– Fuelwood, paraffin	2.4	2.4	3.5
– Bicycle repairs, gifts	18.0	16.0	0.0
– Remittances	4.8	4.7	6.3
– Social contribution	3.0	3.0	3.9
– Miscellaneous	3.9	3.5	7.3

Source: Survey data, 2007.

Among the sample households in Monze and Kalomo districts, the major envisaged outcomes include increased agricultural production, increased food security, increased access to markets, education, health, land ownership, social status and job opportunities. Households were asked to rank these envisaged outcomes with '1' representing the outcome being 'most important'. Availability of agricultural production and food security were rated highly by the households. In addition to being ranked by a large number of the households, these outcomes—directly related to the availability of food— were ranked highly on the scale (Table 23). At the other extreme, a few households gave a very low ranking to increased social status and getting out of agriculture. Only 19 and 6 households ranked these two livelihood outcomes respectively, perhaps indicating that the majority of households pay little attention to these. The other outcomes fell in between the scale spectrum.

Table 23. Ranking of envisaged livelihood outcomes by district.

Livelihood outcome	Monze		Kalomo		Whole sample	
	N	Rank	N	Rank	N	Rank
Increase agricultural production	182	1.24 (0.61)	139	1.50 (1.02)	321	1.35 (0.82)
Reduce agricultural production risk	72	3.38 (1.49)	46	3.54 (1.43)	118	3.44 (1.46)
Reduce marketing risk	41	2.98 (1.19)	33	3.36 (1.63)	74	3.15 (1.41)
Increase food security	190	1.99 (0.84)	138	1.99 (0.95)	328	1.99 (0.89)
Improve health status of members	107	3.72 (1.22)	76	3.58 (1.39)	183	3.66 (1.29)
Increase volume of household assets	65	4.42 (1.25)	49	4.16 (1.32)	114	4.31 (1.52)
Increase education level of HH members	123	3.68 (1.04)	95	3.6 (1.32)	218	3.65 (1.17)
Increase land ownership	19	4.42 (1.86)	30	4.37 (1.30)	49	4.39 (1.53)
Improve social status	8	4.87 (2.03)	11	5.64 (1.68)	19	5.32 (1.83)
Increase income / reduce income risk	100	3.64 (1.57)	70	3.61 (1.69)	170	3.63 (1.62)
Increase job opportunities / earn wages	14	3.42 (1.95)	14	4.78 (3.02)	28	4.11 (2.59)
Get out of agriculture	3	2.67 (1.53)	3	5.00 (6.08)	6	3.83 (4.17)

Source: Survey data, 2007.

Increased access to food or food security is by far the most important livelihood outcome and the availability of food, especially in a direct manner, cannot be overemphasised. About 47% of households indicated that they fell short of food for some members of the households at some time in the last year. Around 80% of households have at least experienced shortages of food from September to January. To cope with food shortages, most households sell small animals (23%), work for food (17%), reduce other expenditures (14%), reduce frequency of food intake (14%) or engage in more off-farm activities (12%). A few other households sell cattle or other assets, or farm equipment, receive food aid, or withdraw children from school (Figure 13).

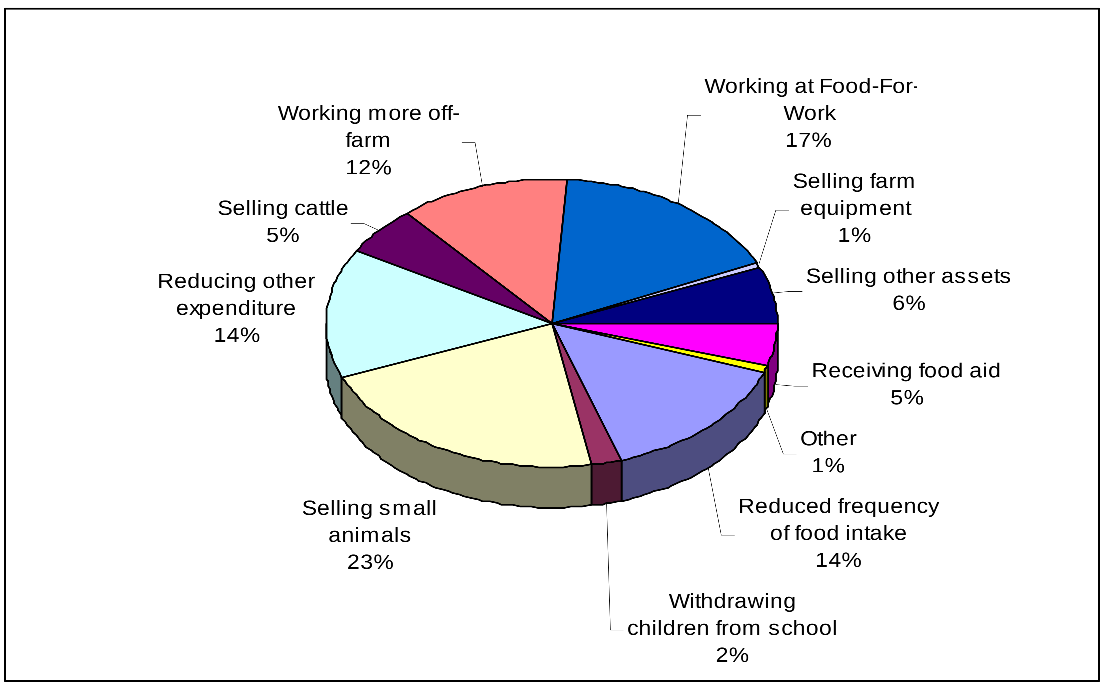

Figure 13. Most important food shortage coping mechanisms.

Source: Survey data, 2007.

Shocks are a key element in the environment in which households seek to achieve their livelihood strategies. Shocks usually refer to sudden events that have a significant impact—usually negative—on livelihoods. They are irregular and vary in intensity and include events such as natural disasters, civil conflict, losing one's job, a collapse in crop prices for farmers, etc. These can be classified into categories such as: human shock (e.g. illness, accidents); natural shock (e.g. floods, earthquakes); economic shock (e.g. job losses, sudden price changes); conflict (e.g. war, violent disputes); and crop/livestock health shocks. Shocks and trends may be linked. For example, some changes that appear as trends at a national or even regional level (such as increased infection rate for diseases such as AIDS and malaria) can impact upon a household or individual as severe shocks (i.e. death in the family).

Several shocks affected the production activities of the sample households. Common shocks among the households (in order of being cited by more households) included drought, loss of livestock, livestock diseases, plant pests and diseases, erratic rainfall, increases in input prices and floods (Table 24 and Table 25). The rankings of the shocks in terms of severity show that drought is the single most important shock experienced by households.

Drought and food insecurity were cited frequently as the most serious threats to household livelihood. Other serious threats were disease, HIV and AIDS, lack of cash, hunger, lack of resources, poverty, theft or crime, and lack of agricultural inputs (Figure 14).

Table 24. Mean rankings on perceived shocks/risks to households.

Shocks / Risks	N	Mean (Std. Dev.)
Drought	326	1.29 (0.71)
Floods	100	2.4 (1.36)
Landslide	8	4 (1.51)
Frost	14	2.93(1.21)
Plant pests and diseases	157	3.18(1.35)
Livestock diseases	232	2.46(1.13)
Destruction of crops	58	3.21(1.17)
Dangerous weeds	52	3.69(0 .98)
Increases in input prices	101	3.06(1.11)
Large drop in maize prices	90	3.72(1.17)
Large drop in wheat prices	5	3 (1.22)
Large drop in other prices	3	4(1)
Large drop in cassava prices	12	3.33(1.56)
Loss of farm land	13	3.31(1.44)
Loss of livestock	242	2.81(1.25)
Death of breadwinner	54	2.52(1.54)
Illness of breadwinner / wife	42	3.74(1.31)
Theft of property	33	3.21(1.62)
Burning of property	21	3.43(1.63)
Household's breakdown	11	3.36(1.80)
Erratic rainfall	117	3.43(1.52)
Conflict	5	3(1.41)
Other	8	3.75(0.89)
Risk on livestock	4	4.5(1)

Source: Survey data, 2007.

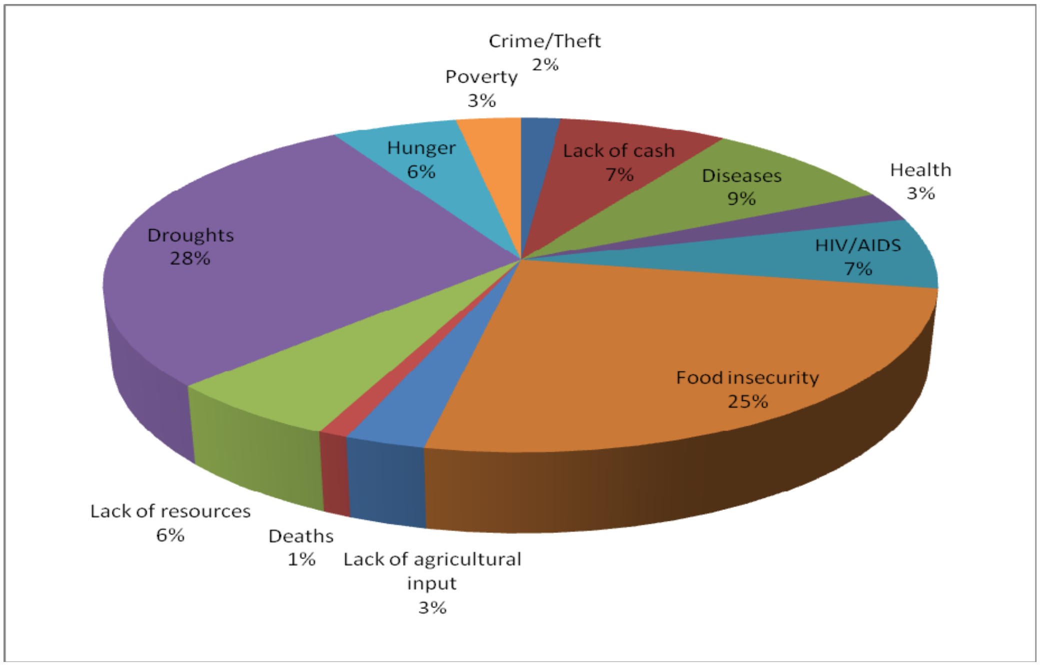

Figure 14. Most serious threats to livelihoods.

Source: Survey data, 2007.

Table 25. Major crop and livestock production risks farmers face (%).

Production risk	Yes	No	Not applicable
Drought	98 (319)		2(6)
Floods	94 (94)	3(3)	3(3)
Landslide	100(8)		
Frost	93(13)	7(1)	
Plant pests and diseases	80 (126)	17(27)	3(4)
Livestock diseases	78(180)	20(46)	3(6)
Destruction of crops	88(51)	5(3)	7(4)
Dangerous weeds	90(47)	4(2)	6(3)
Large increases in input prices	96(97)	2(2)	2(2)
Large drop in maize prices	96(86)	2(2)	2(2)
Large drop in wheat prices	100 (5)		
Large drop in other prices	100(3)		
Large drop in cassava prices	83(10)	8(1)	8(1)
Loss of farm land	100(13)		
Loss of livestock	85(204)	12(30)	3(7)
Death of breadwinner	87(47)	7(4)	6(3)
Illness of breadwinner / wife	81(34)	5(2)	14(6)
Theft of property	52(17)	39(13)	9(3)
Burning of property	62(13)	33(7)	5(1)
Household's breakdown	73 (8)	18(11)	9(10
Erratic rainfall	97(114)	2(2)	1(1)
Conflict	100(5)		
Other shock	50(4)	50(4)	
Risk on livestock	100(4)		
Risk on off-farm income	100(1)		

Note: In parenthesis are the numbers of households reporting.

Source: Survey data, 2007.

Production and price risk analysis

Rural Zambians are highly aware of the production and price risks they face, and have therefore developed an array of risk management strategies and coping mechanisms. Conventional analyses of coping mechanisms have focused upon measures that are taken to compensate for a shock that has already occurred. There is, however, a growing awareness that the poor can take action to prepare themselves for unexpected set-backs, or, in some cases, prevent them from occurring. The sample households in Monze and Kalomo districts were asked to rank how risky the main crops they produced are in terms of yield fluctuations on a scale of 1 (most affected) to 6 (least affected). Table 26 shows the results which indicate that the households perceived the crops as being affected by yield fluctuations in the following order: hybrid maize, OPV maize, local maize, cowpeas, groundnut, and cassava.

The coping strategies of households against production risks include four major interventions. They diversify within the agriculture sector or to other sectors, accumulate assets, or simply participate in NGO or government programmes. Agriculture diversification was observed by far to be the most important strategy across the major crops and wealth groups. Following agriculture diversification, the order of importance of the other strategies was NGO or government participation, followed by non-agriculture participation and finally asset accumulation (Figure 15).

Table 26. Ranking of how risky various crops are in terms of yield fluctuations.

Crop	N	Mean rank (Std. dev)
Local maize	336	2.8 (1.63)
OPV maize	312	2.1 (1.34)
Hybrid maize	333	1.5 (1.11)
Groundnuts	128	4.6 (1.19)
Cowpeas	328	3.3 (1.42)
Cassava	10	4.7 (1.64)

Source: Survey data, 2007.

The sample households were asked about their perceptions on output prices (or marketing risk). Selling price was found to be a determinant of how much crop households would sell, by more than 50% of households growing local, OPV and hybrid maize. Most households, about 90%, indicated that the amount of OPV and hybrid maize to sell depended on the selling price. In comparison, only 53% of households indicated that the amount of local maize to sell was determined by the selling price (Table 27). This implies that most households view OPVs and hybrids more as commercial enterprises. However, it was observed that when the selling price increases, fertilizer usage by most households (more than 90%) in all the three enterprises also increases. When selling price increases, slightly more hybrids than OPV or local maize producing households would demand more credit (Table 27). If the selling prices of the crop enterprises decreases slightly, more than 50% of the households would sell their assets in the case of OPV and hybrid enterprises while only 1% of households would sell assets in the case of local maize. More households would buy more assets if the selling prices of the various crop enterprises were to increase (Table 27).

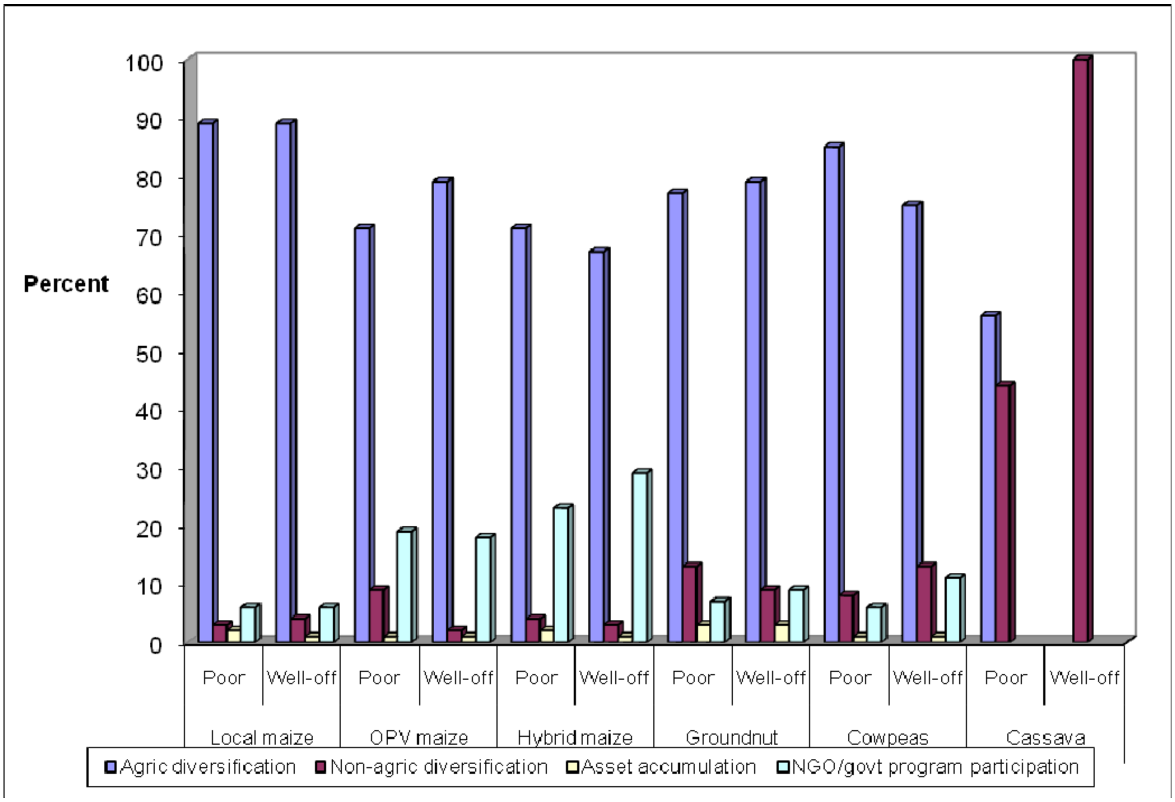

Figure 15. Production risk coping strategies by wealth groups (% households).
Source: Survey data, 2007.

Table 27. Major coping mechanisms for crop price risks (% households).

		Local maize	OPV maize	Hybrid maize
Selling price determining how much to sell	Yes	53	91	90
	No	47	9	10
Fertiliser usage when selling price increases	Increases	94	97	97
	Same	6	3	3
Acquisition of credit if selling price is attractive	Yes	58	66	70
	No	42	34	30
Assets if selling price decreases	Sell some	1	54	54
	Unaffected	39	46	46
	Keep more	60	-	-
Assets if selling price increases	Sell some	1	1	1
	Unaffected	39	15	12
	Keep more	60	84	87

Source: Survey data, 2007.

The sample households were also asked about their perceptions of crop profitability and riskiness. The most profitable crop enterprise among the three major ones was perceived to be hybrid maize production, followed by OPV maize, and finally, local maize. In terms of drought tolerance, the households gave almost the same rank to the three crop enterprises (Table 28).

Table 28. Mean ranking on profitability and drought tolerance of maize enterprises.

Crop	N	Profitability	Drought tolerance
Local maize	330	3.4 (1.39)	1.9 (0.92)
OPV maize	312	2.3 (1.06)	1.8 (0.85)
Hybrid maize	333	1.6 (1.06)	1.8 (1.07)

Source: Survey data, 2007.

When asked about their perceptions of the trends in profitability, most households perceive profitability in local maize as being constant over time. However with regards to OPV and hybrid maize, slightly less than 50% and more than 70% of the households perceive an increase in the profitability of the two enterprises, respectively (Figure 16).

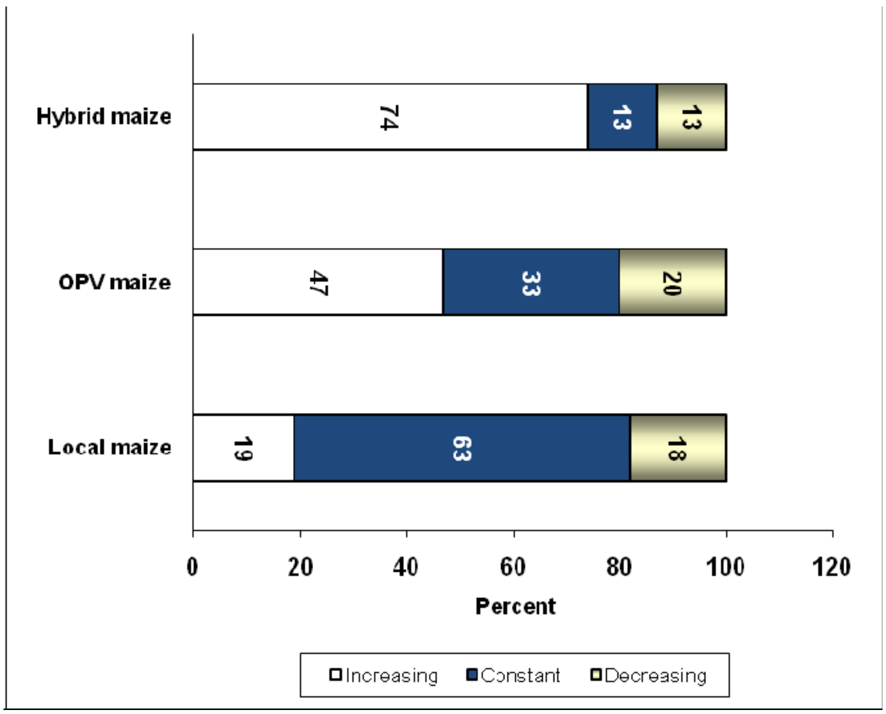

Figure 16. Perceptions of households about the trend in profitability of crop enterprises (%).
Source: Survey data, 2007.

Most households would opt to increase production when it comes to local maize production as a way of improving profits. However, for OPVs and hybrid maize, most households would opt to reduce production costs (Figure 17). This could be attributed to the fact that local maize is not as much a commercial crop as compared to OPVs and hybrid maize.

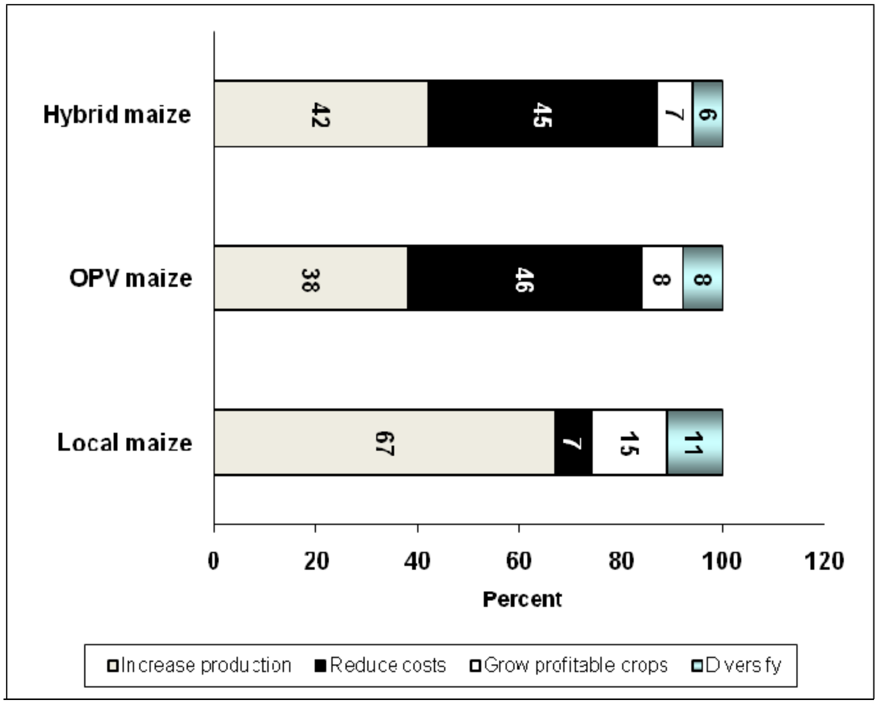

Figure 17. Plans to improve profitability by households (%).

Source: Survey data, 2007.

The sample households were asked to indicate what action they would take in case of crop failure. In case of failure of the local maize crop, more households (87%) would sell their assets. In case of failure of the OPV and hybrid maize crop, between 50% and 60% of the households would sell their assets (Figure 18). This reveals that households are more willing to compromise on their assets to ensure that they have their local maize crop for home consumption.

Households were asked to indicate what happens to assets such as livestock if their crop yield increases. The results show that with crop yield increases, most households would buy assets. However, yield increases in hybrid maize would lead to more households buying assets followed by yield increases in OPV maize. Local maize yield increases would lead just slightly half of the households to accumulate more assets (Figure 19). A sizeable number of households would maintain their asset levels. This is because most of the local maize is not earmarked for sale.

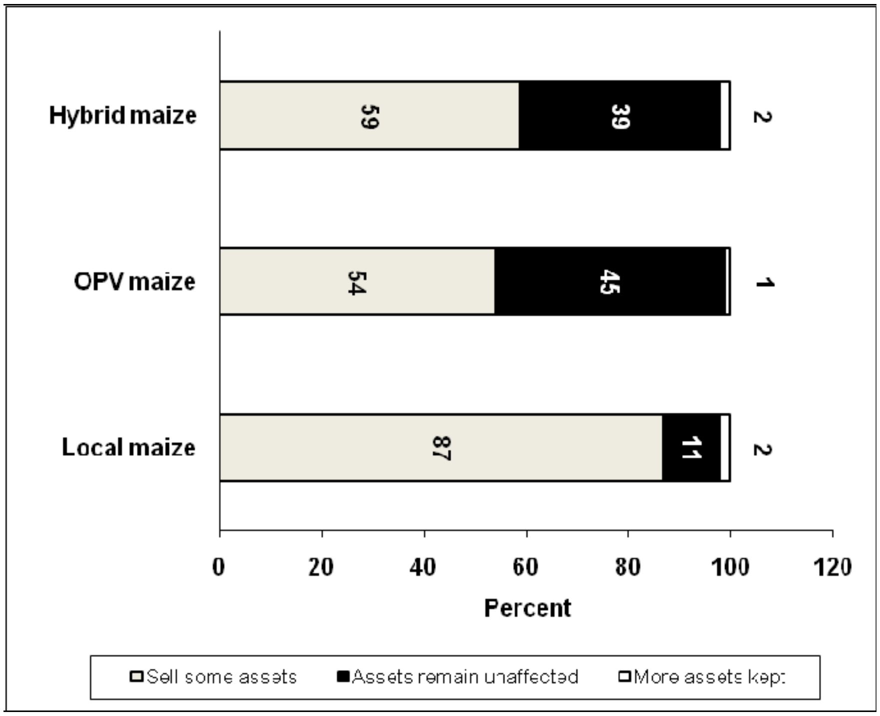

Figure 18. Status of assets in case of crop failure (% households).
Source: Survey data, 2007.

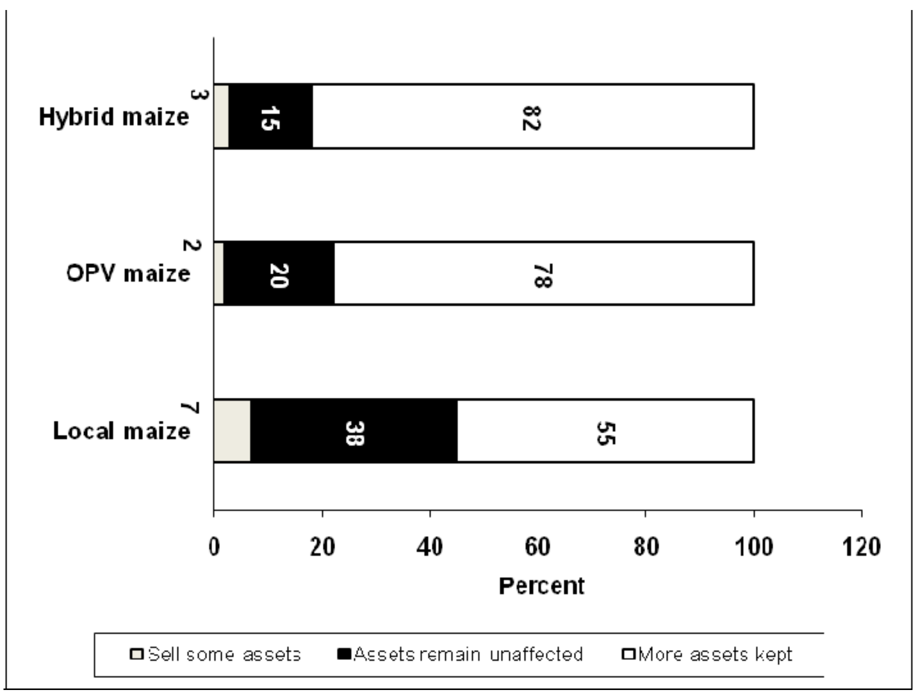

Figure 19. Status of assets in case of crop yield increases (% households).
Source: Survey data, 2007.

5 Technology use in crop production

5.1 Input use by farm households

Availability of inputs such as seed, fertilizer, pesticides and herbicides is essential to increase the utilization and productivity of improved maize seed. As shown in Table 29 in the 2005–06 season about 52% of the sampled small holders in Monze and Kalomo districts applied basal dressing fertilizer to their crops while 54% of them applied urea. Pesticides and herbicides are also important farm inputs for crop production. However, at least 98% of the sampled households did not use pesticides and herbicides. It is surprising to note such a low use of the pesticides and herbicides compared to other inputs even when the country has various crop diseases and pests. Pesticides are relatively expensive and are not part of the subsidized input packages given to farmers, although they are quite critical for the production of various crops.

Table 29. Non-seed input use by district.

Input	Monze			Kalomo			Whole sample		
	Mean	Std	N	Mean	Std	N	Mean	Std	N
Basal fert.(kg)	134.9	88.4	84	256.7	276.9	99	200.8	220.3	183
Urea (kg)	129.2	91.3	86	301.9	529.2	103	223.4	403.9	189
Herbicides (l)	5	-	1	-	-	-	5	-	1
Insecticides (l)	251	386.5	6	-		-	251	386.5	6
Manure (kg)	11.5	12.0	2	-	-	-	11.5	12.0	2

Source: Survey data, 2007.

Some communities in both Monze and Kalomo districts have benefited from input subsidy programs. One such program is the Fertilizer Support Program which was started in the 2002–03 farming season. The program aims at improving access of smallholder farmers to agricultural inputs by rebuilding the asset base of farmers through direct income transfers of input subsidies. The government makes a 50% downpayment to supplies on the inputs supplied, and the remaining is paid by farmers. Private traders and projects/NGOs are also important sources but only a few smallholders obtained fertilizer from private traders and NGOs in the 2005–06 season. Most farmers are knowledgeable about the use and benefits of fertilizer application to their crops. However, the high cost of the fertilizer rather than availability prevents the farmers from purchasing and applying fertilizer on their crops. As noted earlier, the availability of cash to purchase various inputs including fertilizer is a major factor or constraint that determines the size of land that is cultivated.

Analysis of smallholder farmers' sources of maize seed in Figure 20 shows that the major source of seed are purchases from seed agro-dealers or seed retail outlets (74%). Other sources were NGOs, MACO, seed companies and cooperatives. Others got free seed from sources including government and NGO programs. Some households used recycled seed. Reasons why some farmers did not use improved maize seed included high management costs, including fertilizers. The only sure way of increasing the purchase and utilization of improved maize seed amongst smallholder farmers is by making credit available for both fertilizer and improved maize seed.

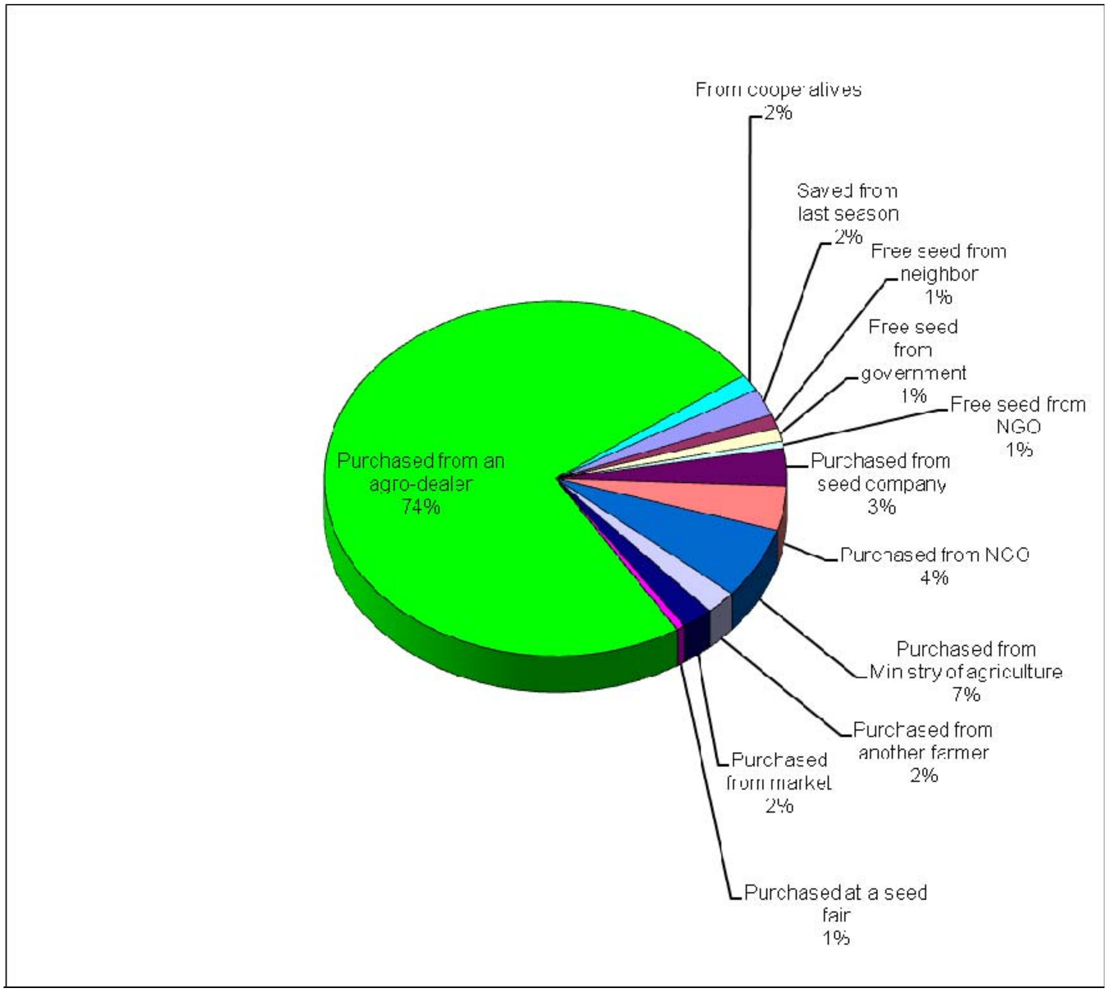

Figure 20. Sources of maize seed among the households.

Source: Survey data, 2007.

Up to three different maize varieties are planted each season. The choice is often influenced by extension staff of the MACO, marketing agents from private seed companies, local agro-dealers or NGOs such as World Vision International and Care International through field days and demonstrations. The most popular hybrid maize varieties planted during the 2005–06 season were SC 513 (48.4%), MRI 534 (9.7%) and MRI 634 (8.4%). Pool 16 is the most popular OPV and was grown by about 5% of the households while Gankata is the most popular local variety and was grown by about 15% of the households (Table 30). In terms of maize varieties planted, a larger proportion of well endowed households plant improved varieties as compared with those in the poorly endowed households (Table 30). Some of the households' perceptions about improved maize seed are listed in Table 31 by wealth group.

In the 2005–06 cropping season, some farmers stopped using some of the maize varieties and this was due to lack of cash to purchase improved varieties, unsatisfactory performance of improved varieties and the non-availability of the preferred improved seed (Figure 21).

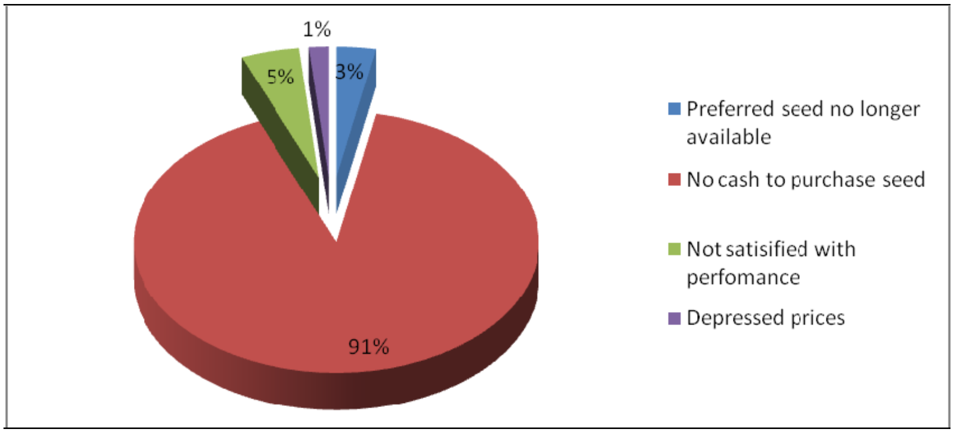

Figure 21. Reasons for the stoppage of improved maize varieties in Zambia.
Source: Survey data, 2007.

A number of maize production indicators for maize producing households according to the different wealth categories and the gender of the household head are summarized in Table 32 and Table 33. In terms of various indicators such as maize cultivated area, maize productivity and input use, the households in the well endowed category have significantly larger values than those in the poor category (Table 32). This also applies to the male-headed households compared to the female-headed households (Table 33).

Table 30.Maize varieties grown by district and wealth group (%).

		District		Wealth group	
Variety	**Whole sample**	**Monze**	**Kalomo**	**Poorly endowed**	**Well endowed**
SC513	48.4	36.4	66.1	42.3	44.4
Gankata	14.6	12.4	18.5	14.7	15.4
MRI 534	9.7	10.9	6.5	1.4	7.2
MRI 634	8.4	7.6	9.7	5.7	14.4
MRI 594	7.1	9.8	3.2	6.6	8.2
MRI 514	6.8	9.2	3.2	7.1	6.2
MRI 614	6.8	8.7	4	7.1	6.2
MRI 513	5.5	8.7	0.8	4.7	7.2
Pool 16	4.5	3.3	6.5	6.2	1.0
MRI 734	4.2	3.8	5.8	3.3	6.2
MM 604	3.9	5.4	1.6	2.8	6.2
Obatampa	3.2	1.6	5.6	2.8	4.1
DK 8051	1.9	1.1	3.2	2.4	1.0
MRI 624	1.9	0.5	4	1.9	2.1
MMV 400	1.6	2.2	0.8	1.4	1.0
SC627	1.6	4	-	1.4	2.1
SC621	1.3	2.2	-	-	4.1
MM 603	1	1.6	-	1.4	-
Pan 6243	1	0.5	1.6	0.9	1.0
Pan 599	1	1.6	-	0.5	2.1
SC514	0.9	1.6	-	0.5	1.0
MRI 744	0.6	0.5	0.8	0.5	1.0
Pan 67	0.6	1.1	-	0.5	1.0
Pan 513	0.6	0.5	-	0.5	-
SC403	0.6	-	1.6	0.9	-
MRI 621	0.6	-	1.6	-	2.1
SC709	0.6	-	1.6	0.5	1.0
MRI 694	0.3	0.5	-	0.5	-
MM 601	0.3	0.5	-	0.5	-
Pannar 6363	0.3	0.5	-	-	1.0
SC407	0.3	0.5	-	0.5	-
MMV 600	0.3	0.5	-	0.5	-
Pan 506	0.3	0.5	-	0.5	-
DK8013	0.3	0.5	-	0.5	-
MRI 604	0.3	-	0.8	-	1.0
DK 8010	0.3	-	0.8	0.5	-
MRI 627	0.3	-	0.8	-	1.0
SC613	0.3	-	0.8	0.5	-
Total	143	135.3	153.2	138	153

Source: Survey data, 2007.

Table 31. Selected household perceptions about improved maize seed by wealth group.

HHs perceiving high yielding varieties	Full sample	Sub-samples Poorly endowed	 Well endowed
		Percent (%)	
- seed as cheaper	16	15	18
- as readily available	34	31	37
- with higher grain price	26	25	26
- as more tolerant to field pests	56	54	58
- as more tolerant to storage pests	48	47	50
- as earlier maturing	85	86	83
- as having higher yield potential	79	79	80
- as having more stable yields	7	8	5
- as more tolerant to water/soil stress	83	81	86
- as having larger cobs/grains	50	48	54
- as more palatability	23	25	22
- as having better processing quality	56	57	53

Source: Survey data, 2007.

Table 32. Selected maize production indicators by wealth group.

Variable	Full sample	Sub-samples[a] Poorly endowed	 Well endowed	
	(1)	(2)	(3)	
Number of households	349	220	129	
	---------------------------- Mean	----------------------------		
Cultivated land area (ha)	3.02	2.22	4.38	***
Area under maize (ha)	2.36	1.69	3.50	
Maize area under improved seed (ha)	1.60	1.14	2.38	***
Improved maize seed purchased (kg)	22.7	12.3	40.5	*
Basal dressing fertilizer purchased (kg)	109	47	216	***
Top dressing fertilizer applied (kg)	108	46	215	***
Maize yield (kg/ha)	1,660	1,522	1,894	

Note: [a] Mean differences between sub-samples tested by unequal-variance *t* tests. Significance level: *=10%, ***=1%.
Source: Survey data, 2007.

Table 33. Selected maize production indicators by gender of household head.

Variable description	Total sample	Gender [a] Female-headed	 Male-headed	
Cultivated land area (ha)	3.02	2.01	3.25	***
Area under maize (ha)	2.37	1.59	2.54	***
Area under improved maize seed (ha)	1.61	1.11	1.72	***
Improved maize adoption rate (% of farmers)	83%	75%	85%	*
Improved maize adoption rate (% of cropped area)	71%	63%	73%	*
Improved maize seed purchased (kg)	22.7	10.8	25.3	**
Quantity of inorganic fertilizer used [NPK] (kg)	109	61	120	***
Quantity of inorganic fertilizer used [urea] (kg)	108	60	119	***
Maize yield (kg/ha)	1,694	1,412	1,756	

Note: [a]Group-mean difference tests by unequal-variance t tests. Significance: * = 10%, ** = 5%, *** = 1%.
Source: Survey data, 2007.

5.2 Determinants of adoption of improved maize seed

Farmers make choices on what to grow and which technologies to adopt, aiming at maximizing their expected utility. In agriculture, they will look for production alternatives that will help them reduce costs while taking full advantage of the benefits that can be generated from that alternative. We can define the farmer's optimization problem as

$$\text{Max } E(U) = E\{[\alpha\pi_1 + (1-\alpha)\pi_2]A - C(\alpha, A); \rho, g\}, \tag{1}$$

where, $E(.)$ is the expectations operator, $E(U)$ is the expected utility, *a* is the proportion of cultivated land area devoted to improved technologies; $\pi_1 = f_1(r_1, p_1, y_1)$ is net revenue per hectare from fields on which the improved technologies are used; and $\pi_2 = f_2(r_2, p_2, y_2)$ is net revenue per hectare allocated to traditional technologies; *A* is the fixed quantity of land available to the household; $C(\alpha, A)$ is the cost function, *ρ* is a measure of risk preferences; and *g* is a vector of farm and household characteristics. Notice that both π_1 and π_2 are functions of input prices (*r*), output prices (*p*), and yield (*y*).

Thus, the optimal adoption rate, α^*, can be obtained by taking the first-order conditions of (1) with respect to and solving for *a* (Shapiro, Brosen and Doster 1992):

$$\alpha^* = f(\bar{\pi}_1, \bar{\pi}_2, \Sigma, A, \rho, g), \tag{2}$$

where, Σ is a matrix of second and possibly higher-order moments of the joint probability distribution function. In general, and in line with equation (2), the adoption theory attempts to explain adoption using a set of variables drawn from five broad categories: prices of inputs and outputs, risk factors, quasi-fixed capital, and shift factors (such as location). However, prices are rarely included in adoption models as they are regarded as implicit in the choice being modelled and are often further determined by farm size and location variables (Neven et al. 2006). Equation (2) and these considerations form the basis of our empirical model.

The empirical model

Typically, because of the discrete or partly-discrete nature of adoption decisions, they tend to be modelled in the limited dependent variable framework. Logit and probit models are used in the adoption literature to model the probability of adoption. However, while explaining the probability of adoption, logit and probit models are incapable of shedding light on the extent or degree of adoption. This information can be obtained if the dependent variable, y_i, is partly binary and partly continuous. Such a variable represents both the decision to adopt at censoring point, and, once the technology has been adopted, the degree of adoption. Since not all maize producers use improved varieties and because even those who have adopted may not allocate all of their maize area to these varieties, the proportion of the maize area under improved varieties is likely to be censored at zero and fits the definition of y_i referred to above.

Tobin (1958) developed a framework for estimating models of censored dependent variables. The Tobit model is defined as

$$y_i = \begin{cases} y_i^* & \text{if } y_i^* > 0 \\ 0 & \text{otherwise,} \end{cases} \tag{3}$$

where $y_i^* = \boldsymbol{\beta}'\mathbf{x} + \mu_i$ is a latent variable, μ_i is an independently and identically distributed normal random error term with mean zero and constant variance σ^2, and **x** and **β** are vectors of covariates and parameters to be estimated, respectively. In effect, the Tobit model is a combination of a probit (at the censoring point) and a linear regression model (when above the censoring point). The estimates of a Tobit model approach those of ordinary least squares (OLS) as the degree of censoring (number of censored observations) tends to zero, and are inconsistent if the error term is heteroskedastic.

In general, three paradigms have guided the choice of covariates used in empirical adoption studies (Langyintuo et al. 2005): i) the innovation-diffusion, ii) the adopters' perception, and iii) the economic constraints models. However, evidence has shown that none of these is by itself adequate in representing the adoption problem (Langyintuo et al. 2003; Ajayi et al. 2003). We select our covariates, **x**, with emphasis on all three paradigms (Table 34).

A number of risk factors and quasi-fixed capital were included to help capture risk-sensitivity (size of the farm operation; and alternative, off-farm income), access to financial capital (size of operation; access to credit; education of the household head; education of most educated member), human capital (age of the household head; the two education variables described above; sex of the household; number of active male and female members supplying farm labor; and marital status of the household head), social capital (participation in farmer organizations, access to remittances, etc), and physical capital (asset endowment; degree of modernity of the main house). For most explanatory variables, *ceteris paribus*, a higher value is expected to increase the probability of adoption and, for adopters, the extent to which such practices have been adopted. A number of variables representing the decision maker's perception with respect to the technology were also included in the model.

Equation (3) was estimated using the maximum likelihood methods, taking the two regimes jointly (Wooldridge 2002; Greene 2000). Heteroskedasticity was, however, significant in our cross-sectional data as indicated by a Breusch-Pagan / Cook-Weisberg test (χ_1^2 = 17, p-value<0.0001). To correct this problem and, thus, improve the efficiency of our estimates, we used robust standard errors.

Because the Tobit model is inherently nonlinear in the coefficients, its estimated parameters do not by themselves represent the marginal effects of the explanatory variables on the dependent variable. Instead, the marginal effects are functions of both the parameters and the data. Skipping the algebraic details, it has been shown that the marginal effect of a variable x_j on the dependent variable *y* can be computed as (Wooldridge, 2002; Greene, 2000):

$$\frac{\partial E(y)}{\partial x_j} = F(z)\frac{\partial E(y \mid y > 0)}{\partial x_j} + E(y \mid y > 0)\frac{\partial F(z)}{\partial x_j}, \qquad (4)$$

where, $F(z)$ is the standard normal cumulative distribution function evaluated at $z = \frac{\mathbf{x\beta}}{\sigma}$, $E(y)$ is the unconditional expected value of *y*, and $E(y \mid y > 0)$ is the expected value of *y* given that *y* is above zero. Equation (4) implies that the overall effect of a small change in an explanatory variable can be decomposed into: i) the change in the number of hectares allocated to improved practices by those farmers that use these practices, weighted by the probability of adopting improved practices; and ii) the change in the probability of using improved practices, weighted by the number of hectares expected to be allocated to improved practices. This ability to unpack the overall effect, also referred to as the McDonald and Moffit (1980) decomposition, makes it a lot easier to interpret the marginal effects and has an inherent intuitive appeal.

Results

Table 34 presents and describes the farm and household characteristics, and the households' perceptions regarding improved maize varieties. The table also compares these across the two strata of farmers—adopters and non-adopters of improved varieties. The results show that the majority of the households were male-headed (82%) and married (79%). They own 6.7 hectares of land and cultivate just under half of it. About 33% and 47% of household heads and the most educated household members, respectively, had reached secondary school or higher. Furthermore, while over half (51%) of the households participated in local farmer organizations during the 2005–06 agricultural season, only a few accessed credit (11%), attended field days (25%), and/or attended field demonstrations (11%). More than three-quarters of households felt that improved maize varieties matured earlier, and had higher yield potential, and tolerated water and moisture stress more than landrace varieties.

When compared to non-adopters, adopters were more likely to be male-headed, to have educated heads and members, and to be members of farmer groups, with differences being statistically significant. They also had significantly larger farm sizes, more male members in the active age group, and were more likely to have houses with modern roofs (iron or asbestos sheets). Adopters also were more likely (than non-adopters) to perceive improved varieties as having higher yield potential and larger cobs and grains than landraces.

Factors affecting adoption of improved varieties

While the results discussed above indicate significant differences between adopters and non-adopters of improved varieties, they are unconditional and, thus, do not explain adoption. Table 35 presents the results of the Tobit model of adoption (Equation 3). Columns (1) and (2) present parameter estimates and their standard errors, respectively. The marginal effects are split into their two components, as in Equation (4), and are presented in Column 3 (effect on use intensity, given that the household has adopted the improved varieties) and Column 4 (effect on the probability of adoption).

Table 34. Household and farm characteristics and perceptions about improved maize seed by adoption category

Variable	Variable description	Full sample	Sub-samples		
			Non-adopters	Adopters	
		-------------------	Mean	--------------------	
hsex	Male-headed households (%)	82%	73%	84%	*
hage	Age of the hh head (years)	45.7	48.7	45.0	
dmar	Households with married heads (%)	79%	73%	80%	
hedus	Head reached secondary school (%)	33%	24%	34%	*
maxed2	Most educated: secondary school (%)	47%	39%	49%	
dhse	Modern roof on main house (%)	29%	19%	31%	**
m16to59	Number of males aged 15-60 yrs	1.46	1.45	1.46	
f16to59	Number of females aged 15-60 yrs	0.78	0.61	0.81	*
farms	Farm size (ha)	6.70	4.34	7.18	**
crpar	Cropped land area (ha)	3.03	2.98	3.04	
dcred	Households receiving credit 2005–06 (%)	11%	8%	12%	
dforg	Households in farmer groups (%)	51%	37%	53%	**
dceo	HHs accessing to extension officers (%)	63%	63%	63%	
dsprice	HHs perceiving HYV seed as cheaper (%)	16%	10%	17%	
davail	HHs perceiving HYV as readily available (%)	34%	37%	33%	
dgprice	HHs perceiving HYV with higher grain price (%)	26%	20%	27%	
dfpest	HHs perceving HYV as more tolerant to field pests (%)	55%	61%	54%	
dspest	HHs perceving HYV as more tolerant to storage pests (%)	49%	53%	48%	
dearly	HHs perceiving HYV as earlier maturing (%)	85%	78%	86%	
dyldpot	HHs perceiving HYV as having higher yield potential (%)	79%	69%	81%	*
dylds	HHs perceiving HYV as having more stable yields (%)	7%	7%	7%	
dstress	HHs perceiving HYV as more tolerant to water/soil stress (%)	83%	81%	83%	
dsize	HHs perceiving HYV as having larger cobs/grains (%)	50%	36%	53%	**
dpalat	HHs perceiving HYV as more palatability (%)	23%	22%	24%	
dproces	HHs perceiving HYV as having better processing quality (%)	56%	49%	57%	
dagaid	HHs receiving agric input aid in 2005–06 (%)	5%	7%	5%	
dfdays	HHs attending field days in 2005–06 (%)	25%	24%	25%	
dfdem	HHs attending demonstrations in 2005–06 (%)	11%	14%	11%	
Number of households interviewed)		350	59	291	

Note: Unequal-variance t tests: *=Sig at 10%; **=Sig at 5%; *=Sig at 1%. [a]HYV = High-yielding or improved varieties.**

Source: Survey data, 2007.

Table 35. Factors affecting adoption and use intensity of improved maize varieties.

Variable	Variable description	Parameter estimate		Robust standard errors	Marginal analysis: Expected use intensity	Marginal analysis: Probability of adoption
		(1)		(2)	(3)	(4)
Constant	Intercept	0.583	***	0.150	-	-
hsex	Sex of head, 1=male	0.307	***	0.100	0.192	0.185
hage	Age of head in years	-0.004	**	0.002	-0.003	-0.002
dmar	Marital status, 1=married	-0.208	**	0.090	-0.130	-0.126
hedus	Education of head, 1=secondary	0.074		0.052	0.046	0.045
maxed2	Most educated, 1=secondary	0.039		0.053	0.025	0.024
dhse	Main house, 1=modern roof	0.034		0.050	0.021	0.021
m16to59	Number of male members 16-59 years	-0.003		0.024	-0.002	-0.002
f16to59	Number of female members 16-59 years	0.036		0.025	0.023	0.022
farms	Farm size in ha	0.001	**	0.001	0.001	0.001
crpar	Cropped area in ha	-0.014		0.011	-0.009	-0.009
dcred	Credit access, 1=got credit	0.009		0.083	0.006	0.006
dforg	Farmer organizations, 1=member	0.134	***	0.050	0.083	0.081
dceo	Main extension source, 1=Ext officer	0.055		0.050	0.034	0.033
dsprice	Perception, 1=HYV seed has lower price	-0.040		0.067	-0.025	-0.024
davail	Perception, 1=HYV seed readily available	-0.064		0.056	-0.040	-0.038
dgprice	Perception, 1=HYV grain fetches higher price	0.106	*	0.057	0.066	0.064
dfpest	Perception, 1=HYV more tolerant to field pests	-0.064		0.060	-0.040	-0.039
dspest	Perception, 1=HYV more tolerant to store pests	-0.012		0.059	-0.007	-0.007
dearly	Perception, 1=HYV is earlier maturing	0.112		0.084	0.070	0.068
dyldpot	Perception, 1=HYV has higher yield potential	0.114	*	0.065	0.071	0.069
dylds	Perception, 1=HYV yields are more stable	0.077		0.100	0.048	0.047
dstress	Perception, 1=HYV tolerate soil/water stress	-0.016		0.073	-0.010	-0.009
dsize	Perception, 1=HYV has bigger cobs/grains	0.022		0.053	0.014	0.013
dpalat	Perception, 1=HYVs are more palatable	-0.033		0.056	-0.020	-0.020
dproces	Perception, 1=HYV better processing quality	0.003		0.058	0.002	0.002
dagaid	Aid, 1=Received agric aid in 2005/06	-0.070		0.110	-0.044	-0.042
dfdays	Field days, 1=attended in 2005/06	-0.107		0.065	-0.067	-0.065
dfdem	Demonstrations, 1=attended in 2005/07	0.034		0.088	0.021	0.020
dist10	District dummy, 1=Monze	-0.130	**	0.051	-0.081	-0.079
n		344				
Log pseudo likelihood		-218.2401				
R-squared		0.1098				
Goodness of fit F statistic		2.2700	***			
Sigma		0.4070	***			

Note: Significance: * = 10%, ** = 5%, *** = 1%. Dependent variable: Proportion of maize area under improved varieties (hybrids or improved OPVs).
Source: Survey data, 2007.

The results show that the probability and degree of adoption of improved maize varieties is directly related to the size of the farm holding, and participation in farmer organizations. One more hectare of land added to the farm raises the probability of adopting improved varieties by 0.001. For those who have already adopted the technology, an additional hectare is associated with a raised proportion of maize area allocated to improved technology by 0.001. Similarly, participation in farm organizations is associated with a higher probability of adoption by 0.08 while raising the average proportion among adopters of land allocated to improved varieties by 0.084.

The sex of the household head also matters in explaining adoption of improved maize varieties, as adoption favors male-headed households, which is consistent with *a priori* expectations. Being male-headed (relative to being female-headed) is associated with an increased probability of adoption by 0.19 while raising the proportion among adopters of the maize land area under improved practices. Another factor that helps to explain, significantly, the observed adoption patterns and levels is the decision makers' perceptions about the output market price and the new varieties' yield potentials. Those that perceive improved varieties as having larger yield potentials and likely to fetch higher grain prices (than landraces) were more likely to adopt the former.

Unlike all the factors we have discussed thus far, age of the household head is inversely related to adoption rates of improved varieties. While dropping the probability of adoption by 0.002, one more year (towards the age of the household head) also dampens, the proportion of maize area allocated to improved varieties by 0.003 among adopters. This is consistent with *a priori* expectations. Households with married heads are 13% less likely to adopt the improved varieties and, if they have adopted, 13% less proportion of land allocated to improved varieties. Furthermore, adoption rates and use intensities are on average significantly lower in Monze District than in Kalomo District by about 8%.

6 Conclusion

Drought affects livelihoods of maize producing households in drought-prone districts in Zambia. Households use various strategies to cope with droughts, including selling livestock, doing food for work and reducing food intake and expenditures. Maize varieties used by farmers include local landraces, improved OPVs and hybrids. Important maize variety attributes sought by farmers include early maturity, yield potential, tolerance to water stress, pest/disease resistance, better processing quality and cob/grain size. Various farmer characteristics, including gender, farm size and farmer group membership significantly influence their maize varietal adoption decisions. Well endowed households thereby pla85nt more improved varieties as compared to the poorly endowed households. Most farmers also perceive that the profitability of maize hybrids and OPVs is increasing, whereas that of local maize is constant. The marked differences in assets and technology use between household classes—be it well endowed versus poorly endowed or male-headed versus female-headed—pose considerable challenges to moving the poor households and female-headed households to a relatively wealthier category. This calls for targeting the key factors that could potentially improve their wellbeing.

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