Drought Tolerant Maize for Africa (DTMA) Project

Country Report – Household Survey

Characterization of Maize Producing Households in Nakasongola and Soroti Districts in Uganda

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CIMMYT MR
International Maize and Wheat Improvement Center

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

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

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Contents

Tables

Figures

Acronyms

DFID :	Department for International Development (United Kingdom)
DTMA:	Drought Tolerant Maize for Africa
Hh :	Household
MAAIF:	Ministry of Agriculture, Animal Industries and Fisheries
MEU :	Man-Equivalent Units
MFPED:	Ministry of Finance Planning and Economic Development
MT :	Metric ton
NGOs :	Non-Governmental Organizations
OPV :	Open Pollinated Varieties
PCA :	Principal Components Analysis
SSA :	Sub-Saharan Africa

Foreword and acknowledgement

Maize is Africa's most important cereal crop. It is particularly vital for more than 300 million people in sub-Saharan Africa (SSA) whose livelihoods are threatened by recurrent droughts responsible for crop failures. Considering the devastating impact of droughts on food security and economic development in SSA, effective solutions are of uttermost importance, especially as the situation is set to worsen as climate change progresses.

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

Developing, distributing and cultivating drought tolerant maize varieties is a highly relevant intervention in SSA to reduce vulnerability, food insecurity and the damage to local markets caused by food aid. However, for this to succeed, it needs to be embedded in the local reality. For this purpose, each of the participating countries was supported to conduct 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 characterizes the maize producing households in Nakasongola and Soroti Districts of Uganda.

This country study received financial support from the DTMA project. During the course of the study, the authors benefitted from constructive contributions from Roberto la Rovere, Girma Tesfahun Kassie and Olaf Erenstein, among others. The authors are responsible for any remaining errors and inferences.

1. Introduction

Maize is a major crop in Uganda, produced throughout the country both as a subsistence and commercial crop. The major production zones are in the west, east, north and south east. In 2008, Uganda produced 1.26 million metric tons (t) from 862,000 ha compared to 1.25 million tons in 2006 from 819,000 ha of planted area.

This country study is part of the DTMA project. It presents the findings of the household survey conducted in the Nakasongola and Soroti Districts in Uganda to complement an earlier community assessment in the same area (Mugisha et al, 2009).

While characterizing the maize producing households, the study assesses the adoption of improved maize varieties. This study is 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.

The rest of the report is organised as follows. The next section presents the sampling and data collection procedures followed by a brief description of the agro-climatic characterization of the survey locations. Section three presents the characterization of households in the study districts. Farm household livelihoods' strategies related to crop and livestock production, off-farm/non-farm activities that are sources of income, income and expenditure profiles of households, and impact of shocks on household livelihood outcomes are discussed in section four. Section five covers farmers' technology use in crop production, particularly maize varietal use. Section six presents some concluding remarks on the study.

2 Materials and methods

2.1 Sampling and data collection

A multistage sampling procedure involving a combination of purposive and simple random sampling methods were used to select the enumeration areas as well as the sample farmers. Maize farmers were selected from Nakasongola and Soroti Districts in central and eastern regions of Uganda, respectively. These districts represent the major maize growing areas in Uganda where majority of the households depend on the crop for their livelihoods. Both the districts are prone to drought, lying in the climatic zone characterized by unreliable and erratic rainfall distribution leading to frequent droughts. The districts lie in two distinct agro-ecological zones that vary in terms of rainfall patterns, farming systems, socio-economic background and to some degree, temperature and soil types. Nakasongola lies in the pastoral rangelands, while Soroti is situated in the Kyoga plains.

The target was to have almost equal number of households in each district. In Nakasongola District, 25 villages were randomly selected from all the eight sub-counties. At least two farm households were then randomly selected from each village making a total of 73 households. In Soroti District, six sub-counties were selected with a total of nine villages being randomly selected. At least eight households were then randomly selected from each village to make a total of 78 households in the district. The variation in the number of villages sampled in the two districts was because of the concentration of maize farmers in some sub-counties/villages. Whereas in Nakasongola maize farmers are widely scattered in all the villages, most maize farmers in Soroti are concentrated in a few villages. The details of the study areas are presented in Table 1. Primary data was collected using a structured questionnaire, which was administered through face to face interview with the respondents. The questionnaire captured household information including:

- General household information, including profile of the household head.
- Household composition: distribution of household members in age, gender, level of literacy and occupation.
- Household resources: ownership of selected capital assets (e.g., physical, natural).
- Institutional setting: access to input and output markets, development programs and extension trainings.
- Household livelihood strategies: crop and livestock production activities, input and output markets participation, off-farm income activities, household expenditure profiles, shocks on household livelihood outcomes.
- Household perception on risk: production and price risks and coping mechanisms.

The data were collected from June to August 2008 by trained enumerators under the supervision of researchers from the Faculty of Agriculture, Makerere University.

Table 1. Surveyed villages and sub-counties from Nakasongola and Soroti Districts.

Region	District	Area (km2)	Population	Selected sub-counties and villages	
				Sub-counties	**Villages**
Central	Nakasongola	3,250	142,800	Kalungi	Llima, Igazi, Ndaiga
				Lwampanga	Kijaluwo, Nakalikilya, Mbali & Namukago
				Nakiitoma	Wangoiro, Bijaabe, Kimature & Kasozi
				Wabinyonyi	Wantabya, Mitanzi, Malumu &Nayitonda
				Lyabyaata	Gaba, Kyawataka, Namiika
				Kalongo	Kigejjo
				Kakoge	Kittanswa, Ntuti, Kasambya, Buddu, Kyambogo & Kakoge
				Kaunji	Ndayiga, Kyambaka
Eastern	Soroti	9,149.5	369,789	Kateta	Kateta
				Olio	Odoku
				Kadunguru	Kachorombo, Kagwara port cell A
				Pingire	Agule
				Bugondo	Kabola
				Kyere	Abuket odo, Okunguro, Odoo

Source: Survey data, 2008.

2.2 Characterization of survey locations

Uganda is a landlocked country in East Africa (Figure 1). The country is on the equator and temperatures average about 21^0C (ranging from 15 to 30^0C). More than two-thirds of the country is 1,000 to 2,500 meters above sea level. The total geographical area of the country is 241,000 square kilometres, 75% of which is available for cultivation, pasture or both (MAAIF and MFPED, 2000). The remaining 25% constitute lakes, swamps and forests. Of the 17 million hectares available as arable land, only about 5 million hectares are currently under cultivation, which constitutes less than 30% of total arable land. Cultivable land is fairly evenly distributed throughout the country and the average landholding is 2.2 hectares. Uganda, with current population of 28.3 million (Population report, 2007), is divided into four regions, namely Central, Western, Eastern and Northern that together comprise 80 districts and 10 distinct agro-ecological zones (Figure 2).

The two survey districts experience varying agro-climatic conditions in terms of rainfall patterns, soil types and temperature which have favoured different vegetation and different farming systems. The major agro-climatic conditions common in the two districts are summarised in Table 2.

Nakasongola District

Nakasongola District lies in the central plateau at an altitude of between 1,000 and 1,400m above sea level (Rwabwogo, 2002). The landscape of the district is characterized by undulating plains. Much of the low lying areas are drained by seasonal streams into Lake Kyoga in the north, and has tributaries to rivers: Sezibwa in the east, Lugogo in the west and Kafu in north western (Nakasongola District Local Government, 2008). The vegetation type is characterized by open deciduous savannah woodland with short grasses. The district experiences high temperatures ranging from a minimum of 25^0C to a maximum of 35^0C during the dry season. It receives low and unreliable rainfall that ranges from 500mm to 1000mm per annum.

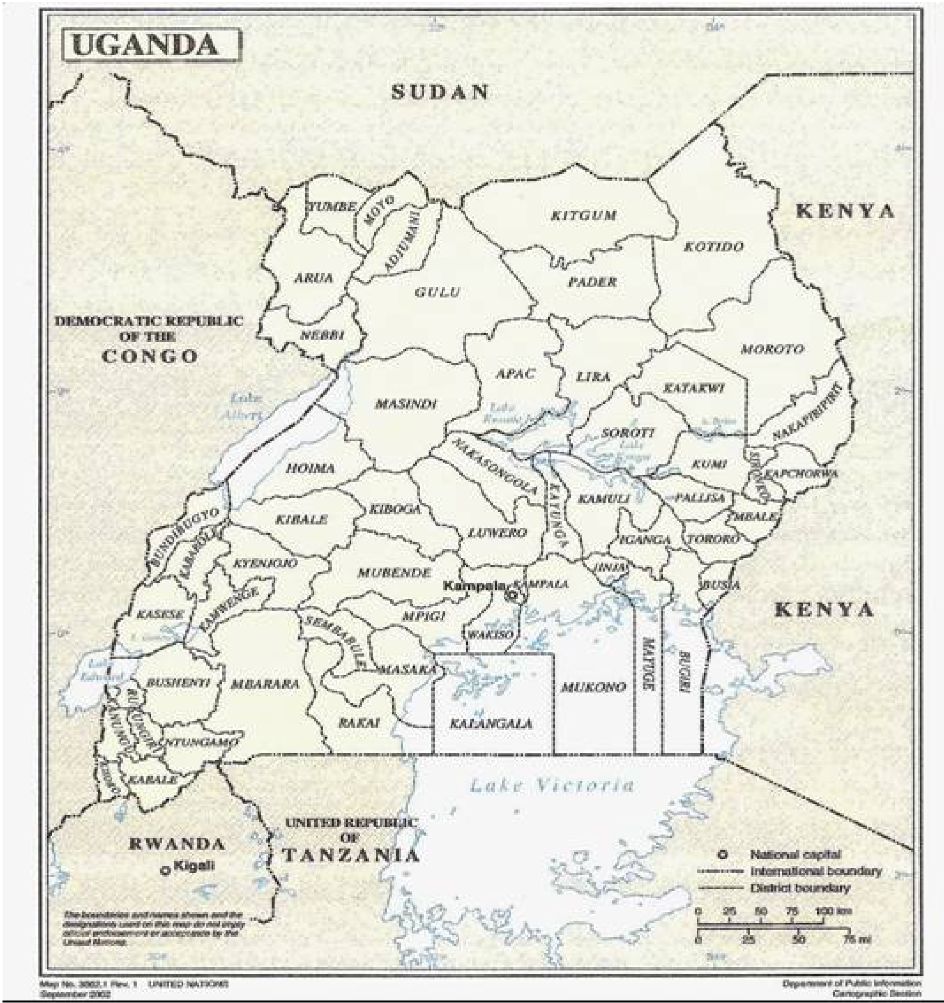

Figure 1: Map of Uganda and its districts.
Source: Mugisha, 2002

There are two rainy seasons: main season from March to May with peak in April and secondary season from September to December with a modest peak in November. June to August is the main dry season, while January to February is the secondary. Evaporation exceeds rainfall by a factor of about 6 during the dry months from June to August (Republic of Uganda, 2004).

Soroti District

Soroti District is characterized by a diversity of geographical conditions that range from gently sloping hills, fresh waters and open grassland mixed with tropical woodland. The district is predominantly flat lying between 914 to 1800m above sea level (Republic of Uganda, 2004). Rainfall distribution has become unpredictable but the district receives moderate rainfall that ranges from 1000 to 1500mm.

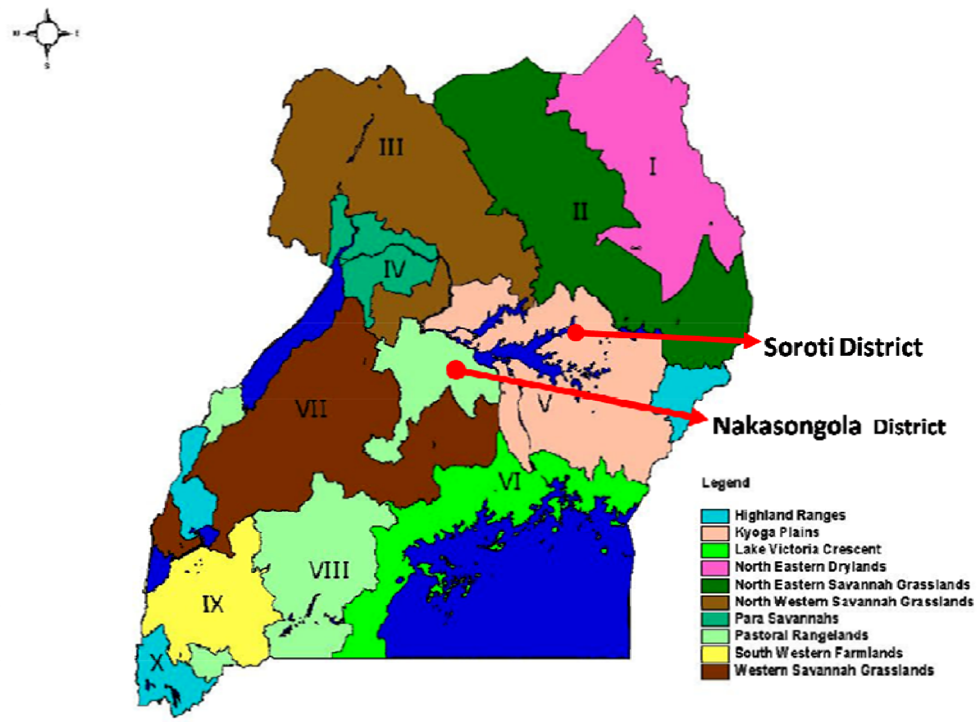

Figure 2: Map of Uganda showing the agro-ecological zones of the country and survey locations.

Source: adapted from Ministry of Agriculture, Animal Industries and Fisheries (MAAIF) and Ministry of Finance Planning and Economic Development (MFPED), 2000

Temperatures are relatively high with a minimum of 18^{0}C experienced during rainy periods to a maximum of 32.5^{0}C. The district experiences two rain seasons in a year: the long season from March to May and the short season from August to September. The main dry season is December to February and the secondary dry season is June and July. Evaporation exceeds rainfall by a factor of about 3 during the dry months of December to February. During the main rainy season, rainfall is greater and or about equal to evaporation.

Table 2. Agro-ecological description of survey districts.

Characteristic	**Nakasongola**	**Soroti**
Rainfall mm	500 – 1000	1000– 1500
Altitude (m above sea level)	100 – 1400	914– 1800
Soil conditions	Light soils that are moderate to poor in soil fertility	Light soils that are poor to moderate in soil fertility
Vegetation	Open deciduous savannah woodland with short grasses	Open grassland mixed with tropical woodland and swampy.
Farming systems, socio-economic characteristics and infrastructural factors	Mainly small holders with a lot of communal grazing. Agro-pastoral practices, low literacy levels, absentee land lords with squatter population, infrastructure and marketing systems are poor to moderate.	Small scale subsistence mainly annual crops with some pastoralism, moderate to low literacy levels, fairly well endowed with resources.

Source: Adapted from MAAIF and MFPED, 2000.

3 Household characteristics

3.1 Categorizing household access to capital assets

Farm households are endowed with different assets each of which can potentially contribute to their wealth status (Langyintuo and Mungoma, 2006). Access to or ownership of a range of assets determines the livelihood strategies and outcomes available to a given household. Zezza *et al.* (2008) classified household assets into seven major categories: human capital which comprises of education and household labour force; natural capital that involves land access; physical capital which includes ownership of assets such as livestock and machinery; public capital (access to public services and infrastructure such as schools, health clinics and electricity); social capital that involves participation in organizations, associations and links to other individuals and households both within and outside the community; financial capital (access to credit, insurance); and geographic capital (locational factors such as proximity to markets). Here we follow the more traditional categorization into five livelihood capitals: human, natural, physical, financial and social for simplicity.

There is a great variation in the levels of asset ownership among households both within the same locality and across different villages in the same district/region. Given such variation in type of assets owned by a given household, it is difficult to compare or rank households across space in terms of wealth. Hence, this calls for a search of a common denominator that enables one to compare households' asset bases, for example, households' labour endowments and access to public services and infrastructure. This approach eliminates distortions that would arise from using different measurement scales. To compare households across space in terms of wealth, this study used the Principal Components Analysis (PCA) method that was developed by Filmer and Pritchett (2001) and later used by Langyintuo *et al.* (2005). The method enables use of household resources to construct indices that are essential for aggregation of assets to obtain a composite index necessary for ranking households (see Annex 1 for details of PCA).

In this analysis, using SPSS, PCA was run on 20 selected capital indicators. Twenty components were extracted in the first stage of PCA but only the first eight were significant (based on the Kaiser criterion of an Eigenvalue greater than 1 - Table 3).

Table 3. Principal component analysis results (using standardized values of variables).

Component	Initial eigenvalues		
	Total	% of Variance	Cumulative %
1	4.71	23.53	23.53
2	2.13	10.66	34.19
3	1.85	9.25	43.45
4	1.37	6.87	50.32
5	1.32	6.61	56.93
6	1.23	6.15	63.07
7	1.15	5.77	68.84
8	1.10	5.51	74.35
9	0.89	4.49	78.84
10	0.78	3.92	82.75
11	0.67	3.35	86.09
12	0.59	2.95	89.04
13	0.53	2.66	91.69
14	0.43	2.17	93.87
15	0.33	1.65	95.52
16	0.29	1.45	96.97
17	0.23	1.17	98.15
18	0.22	1.11	99.24
19	0.14	0.69	99.94
20	0.01	0.06	100
Sum	**20**	**100**	

Source: Survey data, 2008.

The first component was chosen for use in constructing the index because it explained 23.5% of the total variance in the 20 components. The weights (scores) assigned to the indicators on component 1 are shown in Table 4. The impact of each variable on the overall index (column five) was calculated as the score divided by the standard deviation. The impact factor can be interpreted as follows: when a household moves from 0 to 1 on a particular indicator, its score on the overall index increases by the amount of the impact ratio for that indicator.

According to Filmer and Pritchett 2001, the assigned weights were then used to construct an overall wealth index, using the formula:

$$W_j = \sum_{j=1}^{k} \left[b_i (a_{ji} - x_i) \right] / s_i$$

Where: W_j is a standardized wealth index for each household; b_i represents the weights or scores assigned to the (k=20) variables on the first principal component; a_{ji} is the value of each household on each of the 20 variables; x_i is the mean of each of the 20 variables; and s_i represents the standard deviations. A negative index means that, relative to the communities' measure of wealth, the household is poorly endowed and hence worse-off while a positive figure signifies that the household is well-off. A zero value, which is also the sample mean, implies the household is neither well-off nor worse-off.

All households in the sample were then categorized according to their score on this combined standardized index (W_j). Cut-off points were established and used to classify the sample into three groups of wealth, that is, the poor, the average, and the rich (Figure 3).

Table 4. Summary statistics for variables entering the computation of first principal component.

Component/variables	Mean	Std. Deviation	Scoring factor	Impact*
Household labor force	8.19	2.93	0.050	0.017
Total cropped area	2.50	2.03	-0.065	-0.032
Total farm size	5.39	8.19	-0.007	-0.001
Own cows	6.85	8.53	-0.014	-0.002
Own small ruminants	5.72	7.85	-0.027	-0.003
Own fowls	17.19	53.26	-0.062	-0.001
Tropical livestock unit (TLU)	7.00	7.57	-0.042	-0.006
Own motorcycle	0.14	0.35	0.095	0.271
Own bicycle	0.93	0.67	-0.129	-0.193
Own animal plough	0.42	0.62	0.012	0.019
Own animal harrow	0.01	0.11	-0.084	-0.763
Own radio	0.93	0.67	-0.086	-0.410
Own mobile phone	0.63	1.18	0.011	-0.128
Access to input/cash credit	0.19	0.39	-0.160	0.009
Organization benefactor	3.18	4.97	0.171	0.034
Attended field days	2.25	3.93	0.362	0.092
Attended demonstrations	0.99	1.69	0.159	0.094
Discussed maize	1.74	4.74	0.333	0.070
Access to extension agents	2.20	2.95	0.198	0.067
Membership of association	0.44	0.49	0.022	0.045

Note: Impact = score divided by the standard deviation.
Source: Survey data, 2008.

As the first cut-off point we used the mean of wealth indices less than the sample mean of 0 (i.e. -0.6116), whereas for the second we used the mean of wealth indices greater than the sample mean (i.e. 1.0626). As a result, households with indices less than or equal to -0.6116 were in the category termed "poor", those between -0.6116 and 1.0626 were in the "average" category, and those with indices greater than 1.0626 were categorized as "rich".

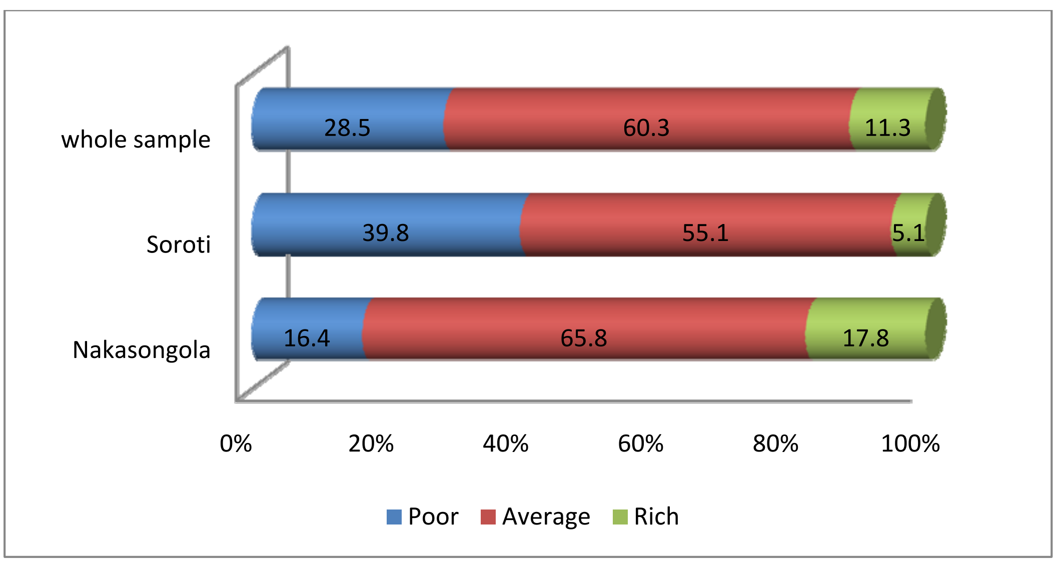

Figure 3: Distribution of households by wealth categories in the study districts.
Source: Survey data, 2008.

The distribution of households within wealth category according to the gender of the household head is illustrated in Table 5. The table reveals that irrespective of the gender of the household head, majority of the households fall in the "average" category of wealth index. It can also be observed that the proportion of the female headed households in the "poor" category were more than male headed ones.

Table 5. Distribution of households over wealth categories by district and gender of the household head.

Wealth category	Nakasongola		Soroti		Whole sample	
	Male (n=63)	**Female (n=10)**	**Male (n=70)**	**Female (n=8)**	**Male (n=133)**	**Female (n=18)**
Poor, n (%)	25(39.7)	4(40.0)	8(11.1)	2(30.0)	35(26.5)	6(33.3)
Average, n (%)	35(56.2)	6(60.0)	45(65.1)	5(60.0)	80(60.3)	11(60.0)
Rich, n (%)	3(4.1)	0.0	17(23.8)	1(10.0)	18(13.2)	1(6.7)

Source: Survey data, 2008.

3.2 Human capital

Selected demographic characteristics of the 151 sampled households are presented in Table 6, including household head age, gender, education level and marital status. The average household head was 44.5 years of age. On average, 10% of the household heads are female, being somewhat higher in Nakasongola (13.7%). The average size of the household was 8.3, with Nakasongola having somewhat larger households.

Table 6. Descriptive demographic statistics of sample households in the study districts.

Gender	Nakasongola (n=73)	Soroti (n=78)	Pooled sample (n=151)
Mean household size, n	8.7	7.9	8.3
Mean age of head of household	44.5 (22-77)	44.5 (22-80)	44.5 (22-80)
Mean Man-equivalent units (MEU/hh)	5.6 (1.7-14.4)	5.1 (1-12.9)	5.3 (1-14.40)
Sex of head of household, n			
- Male	63	70	133
- Female	10	8	18
Marital status, n (%)			
- Single	1(1.4)	3 (3.8)	4 (2.6)
- Married	63(86.3)	70 (89.7)	133 (88.1)
- Divorced	1(1.4)	5 (6.4)	1 (0.7)
- Separated	3(4.1)	-	3 (2.0)
- Widowed	5(6.8)	-	10 (6.6)
Education level n (%)			
- Illiterate	3 (4.1)	5 (6.4)	8 (5.3)
- Primary school	37 (50.7)	50 (64.1)	87 (57.6)
- Secondary school	29 (39.7)	18 (23.1)	47 (31.1)
- Post secondary	3 (4.1)	5 (6.4)	8 (5.3)
- Non-formal	1 (1.4)		1 (0.7)

Source: Survey data, 2008.

According to DFID (2000), human capital represents the skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives. It is enhanced by access to services that provide these, such as schools, medical services, and adult training. At the household level it varies according to household size, skill levels, leadership potential, health status, etc. and appears to be a decisive factor in order to make use of any other type of assets (Kollmair and Juli, 2002). Human capital thus is imperative for the efficient use of the household's assets.

It is recognized that labour is the most important of all the resources used in agricultural sector especially in Africa (Enete *et al.*, 2005). Household members are the most important sources of labour for farm work and family labour indeed contributes the most to the major field operations (Table 7). However, family labour is often inadequate to meet all labour requirements thus necessitating the use of hired and to a lesser extent communal labour during times of labour scarcity such as land preparation and weeding. The contribution of family labour in major field operations tends to be higher in Nakasongola. Very few households use soil fertility inputs (organic or inorganic fertilizers) and fertilization labour use was correspondingly low.

Table 7. Use of family labor in major field operations in the study districts.

Operation	Nakasongola (n=73)	Soroti (n=78)	Whole sample (n=151)
Land preparation, n (%)	51(69.9)	33(42.5)	71(47.3)
Planting, n (%)	63(85.7)	58(73.9)	120(79.4)
Weeding, n (%)	55(74.5)	50(63.4)	104(68.6)
Fertilization, n (%)	9(11.9)	5(6.2)	13(8.8)
Harvesting, n (%)	63(86.5)	52(67.6)	116(76.4)
Threshing, n (%)	69(94.5)	64(82.1)	133(87.8)

Source: Survey data, 2008.

There are great variations in total amount of labour available across households – both due to household size and demographics, as dependants below 16 years or above 60 years old often contribute little labour or at least cannot perform regular farm operations at similar rates of efficiency. To account for the differences in performance due to age, the man-equivalent unit (MEU)[1] as suggested by Runge-Metzger (1988) was used. The MEU's were computed based on every individual in the household and subsequently aggregated. The MEUs ranged from 1 to 14.4 with an average of 5.3 overall, being somewhat higher in Nakasongola (Table 8).

Table 8. Household labor force availability by district and gender of the household head.

Labor category (MEU)	Nakasongola (n=73)		Soroti (n=78)		Whole sample (n=151)	
	Male (n=63)	Female (n=10)	Male (n=70)	Female (n=8)	Male (n=136)	Female (n=15)
0-3, n (%)	3(4.8)	0	6(8.2)	0	9(6.6)	0(0
3.1-6, n (%)	16(25.4)	5(50)	15(21.9)	1(12.5)	32(23.5)	6(40)
6.1-9, n (%)	19(30.2)	2(20)	30(42.5)	5(62.5)	50(36.8)	4(26.7)
9.1-12, n (%)	14(22.2)	2(20)	15(21.9)	1(12.5)	30(22.1)	3(20)
>12, n (%)	11(17.5)	1(10)	4(5.5)	1(12.5)	15(11)	2(13.3)
Mean MEU	5.61 (1.7 – 14.4)		5.06 (1 – 12.9)		5.32 (1 – 14.4)	

Source: Survey data, 2008.

[1] Following Runge-Metzger (1988), MEUs were computed as follows: Household members less than 9 years = 0; 9 to 15 years or above 49 years = 0.7; and 16 to 49 = 1.

3.3 Natural capital

Natural capital comprises the natural resource stocks from which resource flows and services (such as land, water, forests, air quality, erosion protection, biodiversity degree and rate of change, etc.) useful for livelihoods are derived (Kollmair and Juli, 2002). The natural capital endowment of a given household is of special importance especially in rural areas where the majority of the population derive whole or part of their well being by engaging in natural resource based activities. Land is one of the most basic natural resources used in agricultural production and continues to assume its importance especially in Sub-Saharan African countries where majority of the small scale farmers aim to increase production by bringing more land under cultivation.

In Uganda, land is the primary asset for the average farm household in spite of the estimated decline in its share in total household asset portfolio from 57 to 51% between 1992 and 2000 (Deininger and Okidi, 2003). Increase in population has resulted in scarcity of land especially in rural areas leading to increased intensification of the available small holdings. Pender *et al.* (2003) note that human population is rapidly increasing throughout much of Uganda and is contributing to smaller farm sizes and rapid decline in extensive land uses such as fallow, grazing and forest/woodland, particularly in the less densely populated areas. With increased population growth and agricultural intensification, there is a trend towards land scarcity and an evolving individualization of land rights (Gray, 2007). In Uganda, land is predominantly held under the customary tenure system where farm households have acquired land through inheritance and are also able to pass it on to their children. Other common forms of land tenure include *leasehold* and *freehold* , whereas in the central region there also is a peculiar tenure system linked to the Buganda kingdom (*mailo*).

Land distribution and utilization among households

The overall average farm size is 5 ha (Table 9), but shows a marked variation both within and across the two study districts. In Nakasongola, land owned by surveyed households ranges between 0.4 and 36.8 ha, with an even wider range in Soroti (0.4 to 69 ha). Table 10 provides the farm size distribution by district and gender of the household heads. Crop cultivation is the main land use (56.5% in Soroti and 48.9% in Nakasongola) followed by land allotted to livestock rearing (36.5% in Nakasongola and 31.8% in Soroti, Table 9). The variations in farming systems and land use between the two districts can be explained by agro-ecological differences (Kakuru *et al.*, 2004). Nakasongola is mainly characterized by semi-arid and dry sub-humid conditions that are not favourable for crop cultivation but more for livestock rearing.

Fallowing has long been a preferred method of allowing land that has been under continuous cultivation to regain its soil fertility. However, due to increased population pressure which has led to land scarcity, the practice has progressively declined. Land reportedly abandoned and under fallow was small in both districts but somewhat higher in Nakasongola. To restore soil fertility, farmers have resorted to more intensive methods like manure application, agroforestry and, to a limited extent, use of artificial fertilizers. Findings revealed a variation in the intensity of land use patterns within and across the districts. Overall, 60% of the farmers reported to fallow their fields at least once, being higher in Nakasongola than Soroti. The number of years a given farmer fallows a piece of land ranges from 1 to 10 in Nakasongola and 1 to 3 in Soroti. Variations in the intensity of land use patterns across the two districts are consistent with land ownership. Therefore availability of more land for cultivation confers the farmer the luxury to rest some in case a decline in soil fertility is noticed.

Table 9. Land use by farm households in the study districts.

Land use type	Nakasongola (n=73)	Soroti (n=78)	Whole sample (n=151)
Mean farm size (ha)	5.87	4.85	4.97
Mean crop area (ha)	2.87	2.74	2.81
Average size of abandoned land (ha)	0.44	0.24	0.34
Average land size with pasture (ha)	2.14	1.54	1.84
Average land size under fallow (ha)	0.42	0.33	0.38
Mean years of fallow (years)	1.65	0.66	1.13
Proportion that fallow (%)	75.3	44.9	59.6

Source: Survey data, 2008.

Table 10. Farm size classes by gender and district.

Farm size range (ha)	Nakasongola (n=73)		Soroti (n=78)		Whole sample (n=151)	
	Male (n=63)	Female (n=10)	Male (n=73)	Female (n=5)	Male (n=136)	Female (n=15)
0 – 1, n (%)	1(1.6)	2(20)	5(6.8)	0	6(4.4)	2(13.3)
1.01 – 2, n (%)	9(14.3)	2(20)	23(31.5)	2(40)	32(23.5)	4(26.7)
2.01 – 3, n (%)	8(12.7)	0	16(26)	0	27(19.9)	0
3.01 – 4, n (%)	12(19)	1(10)	12(16.4)	1(20)	24(17.6)	2(13.3)
4.01 – 5, n (%)	6(9.5)	2(20)	3(4.1)	1(20)	9(6.6)	3(20)
>5.01, n (%)	27(42.7)	3(30)	11(15.1)	1(20)	38(27.9)	4(26.7)

Source: Survey data, 2008.

There is no clear pattern in terms of the dynamics of farm size: 45% of the households reported that the land size in the most recent season was larger than in preceding seasons, 44% indicated a decrease, while 11% reported no change across seasons. Farmers were asked for the factors associated with the cultivated farm size, specifically the land allocated to maize. Major factors included availability of family labour (23%), availability of cash to purchase inputs (17%), cash for hiring labour (13%) and food needs in the household (19%) (Table 11). Some factors showed a marked variation over the two districts: in Nakasongola family labour availability was particularly important whereas household food needs prevailed in Soroti.

Table 11. Factors influencing farm size in the study districts.

Factor	Nakasongola (n=73)	Soroti (n=78)	Whole sample (n=151)
Family labor availability, n (%)	29(39.7)	6(7.7)	35(23.2)
Cash availability to hire labor, n (%)	10(13.7)	10(12.6)	20(13.2)
Cash availability to purchase inputs, n (%)	11(15.1)	15(19.2)	26(17.2)
Current grain prices, n (%)	3(4.1)	12(15.4)	15(9.8)
Expected grain price after harvest, n (%)	8(11.0)	2(2.6)	10(6.6)
Food needs, n (%)	5(6.8)	24(30.8)	29(19.2)
Availability of seed, n (%)	3(4.1)	5(6.4)	8(5.3)
Other, n (%)	2(2.7)	1(1.3)	3(2.0)
Availability of draft power, n (%)	1(1.4)	1(1.3)	2(1.3)
Rainfall expectations, n (%)	2(2.7)	2(2.6)	4(2.6)

Source: Survey data, 2008.

3.4 Physical capital

Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods (Kollmair and Juli, 2002). The physical assets considered in this study include the farm household dwelling and the durable physical assets.

Table 12 shows types of dwellings owned by households in the study districts. Most common are brick houses, either with asbestos/iron roof (common in Nakasongola) or with thatch roof (common in Soroti). The variations in the types of dwellings could be attributed to differences in cultures and socio-economic characteristics. While iron roofs are treasured in Nakasongola and accorded a high status in the community, almost every household in Soroti irrespective of economic status at least has a grass thatched roof. However, due to population pressure, there is an increasing scarcity in the roofing materials (grass) thus forcing people to divert to iron sheets.

Table 12. Types of dwellings used by households in the study districts.

Type of dwelling, n (%)	Nakasongola	Soroti	Whole sample
Mud hut with grass thatch roof	8(11.0)	18(23.1)	26(17.2)
Mud hut with asbestos/iron roof	11(15.1)	1(1.3)	12(8)
Brick house with grass thatch roof	2(2.8)	30(38.5)	32(21.2)
Brick house with asbestos/iron roof	33(45.2)	13(16.7)	46(30.7)
Block house with asbestos/iron roof	1(1.4)	1(1.3)	2(1.3)
Pole and dagga with grass thatch	1(1.4)	0	1(0.7)
Pole & mud house with asbestos/iron roof	12(16.4)	1(1.3)	13(8.7)
Pole & mud house with grass thatch roof	4(5.5)	14(17.9)	18(12)

Source: Survey data, 2008.

Table 13 shows the ownership of durable physical assets. Important assets include bicycles (owned by 88.8% of the households), radio sets (by 80.1%), mobile phones (39.1%), draft animals (37.7%), and animal plough (37.1%). Generally, apart from draft animals and animal plough, the proportion of households owning different assets is higher in Nakasongola District.

Table 13. Durable physical asset ownership in study districts.

Asset ownership, n (%)	Nakasongola (n=73)	Soroti (n=78)	Whole sample (n=151)
Motor vehicle	5(6.8)	1(1.3)	6(3.97)
Motor cycle	16(21.9)	1(1.3)	17(11.3)
Bicycle	67(91.8)	67(85.9)	134(88.8)
Draft animals	12(16.4)	45(57.7)	57(37.7)
Animal plough	16(21.3)	39(50)	55(37.1)
Animal harrow	1(1.4)	4(5.1)	5(3.3)
Wheel barrow	20(27.4)	6(7.7)	26(17.2)
Television	1(1.4)	1(1.3)	2(1.3)
Radio	64(87.7)	57(73.1)	121(80.1)
Private well	40(55)	1(1.3)	2(1.3)
Water tanks	9(12.3)	4(5.1)	13(9.6)
Generator	1(1.4)	1(1.3)	2(1.3)
Mobile phones	42(57.5)	17(21.8)	59(39.1)
Other assets	3(4.3)	1(1.3)	4(2.7)

Source: Survey data, 2008.

3.5 Financial capital

Financial capital denotes the financial resources that people use to achieve their livelihood objectives. It comprises the important availability of cash or equivalent, which enables people to adopt different livelihood strategies (Kollmair and Juli, 2002). Improving access of the poor to financial services enables them to build up productive assets and enhance their productivity and potential for sustainable livelihoods (World Bank, 2001). Households can access financial capital through a number of ways notably, available stocks comprising cash, bank deposits or liquid assets such as livestock and crop produce. Another source is regular inflows of money comprising off-farm labour income, salary, and remittances from friends and relatives.

Liquidity is a particularly acute problem in farming where the bulk of the poor in developing countries continue to make their living (Winter-Nelson and Temu, 2005). Farmers may need credit to purchase the necessary inputs essential for agricultural production processes and also to cater for family needs and consumption expenses. Despite being home to the vast majority of the Ugandan population, rural areas have limited access to formal financial services. The study areas are no exception as only 17% of the households interviewed reported having access to cash credit in the previous year prior to the interview (Figure 4), with limited variation across the two districts. Input credit for agricultural operations is even more limited (6% during the cropping season prior to the interview), but relatively more common in Nakasongola.

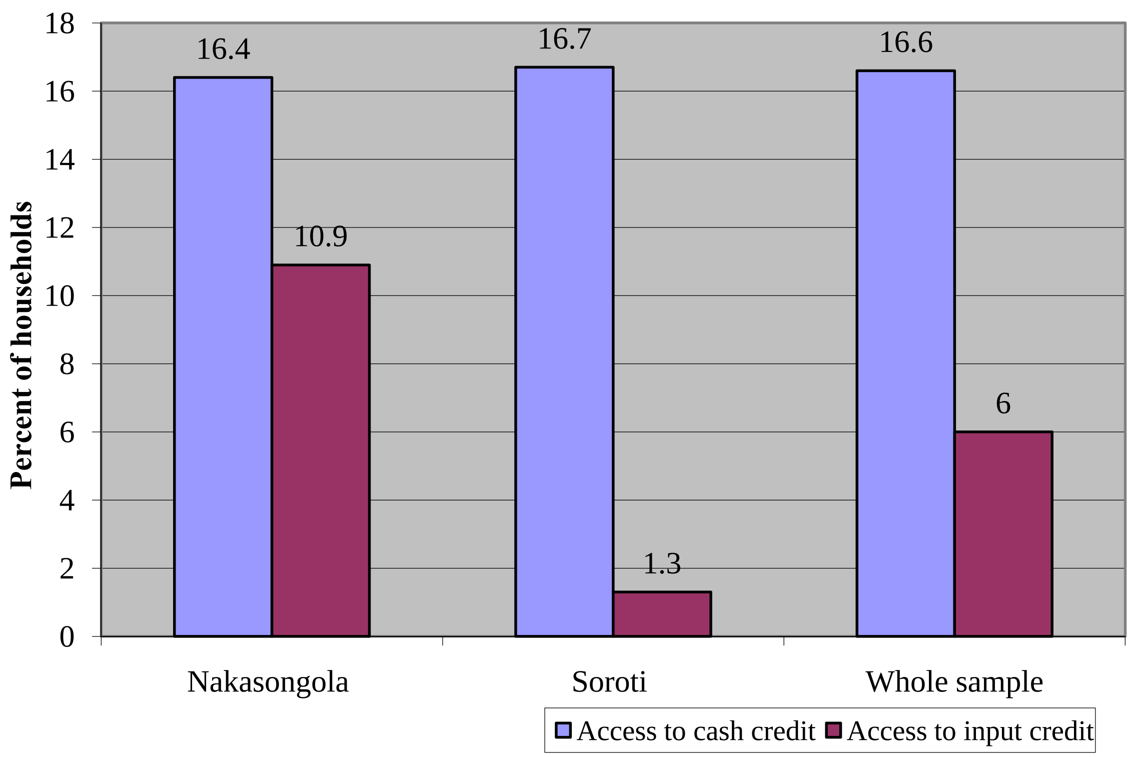

Figure 4: Households' access to credit in the study districts.

Source: Survey data, 2008.

Households reported various credit sources, including formal financial institutions, neighbours, money lenders, relatives and NGOs (Table 14). Onumah (2003) notes that the development of rural financial systems is hampered by the high cost of delivering financial services to small, widely dispersed customers as well as a difficult financial terrain characterized by high and covariant risks, missing markets for risk management instruments and lack of suitable collateral. To bridge this gap in accessibility of financial services in rural areas, other providers of credit have emerged. However, their coverage is also limited and some like the money lenders charge high interest rates and transaction fees. Input credit was predominantly provided by NGOs and this was higher in Nakasongola. For example, Save the Children supplied maize seeds and cassava cuttings on credit.

Table 14. Credit sources for farm households in the study districts.

Type of credit accessed	Source of credit n (%)	Nakasongola(n=73)	Soroti(n=78)	Whole sample(n=151)
Cash credit	Financial institutions	3(4.1)	6(7.7)	9(5.9)
	Money lenders	2(2.7)	1(1.3)	3(1.9)
	Neighbors	1(1.4)	3(3.8)	4(2.6)
	Relatives	2(2.7)	1(1.3)	3(1.9)
	NGO	1(1.4)	2(2.6)	3(1.9)
	Government program	1(1.4)	1(1.3)	2(1.3)
	Local group/cooperative	1(1.4)	1(1.3)	2(1.3)
Input credit	NGO	6(8.2)	1(1.3)	7(5.9)
	Relatives	1(1.4)	-	1(0.7)

Source: Survey data, 2008.

3.6 Institutional and social capital

Social capital – the households' access to institutional or social support - is crucial asset as it complements other forms of capital in improving livelihoods. Durlauf and Fafchamps (2004) broadly describe social capital as entailing three main underlying ideas: (1) social capital generates positive externalities for members of a group; (2) these externalities are achieved through shared trust, norms, and values and their consequent effects on expectations and behaviour; (3) shared trust, norms, and values arise from informal forms of organizations based on social networks and associations. In this study different forms of social support were examined, including membership to farmer organizations or associations and participation in government or NGO support programs.

In Nakasongola, about half of the households belonged to a farmer organization, whereas in Soroti this was over a third (Table 15). In Nakasongola, farmers had also been members of the organization for a longer period.

Table 15.Farmer organization membership and extension in the study districts.

	Nakasongola	Soroti	Whole sample
Membership (%)	49.3	35.9	42.4
Years of membership (mean)	3	1.5	2.3

Source: Survey data, 2008.

Farmers receive support from a number of development organizations and institutions whose origins may be divergent but share similar goals towards improving living standards in the areas (Table 16). The number of organizations operating in Nakasongola was far higher than those in Soroti with all organizations in Soroti also present in Nakasongola. The government provided an important source of support to the locals. This underscores the fact that despite the increasing importance of NGOs in rural development initiatives in Uganda, the government still retains an important role.

Table 16. Institutional support to farm households in the study districts.

	Nakasongola (n=73)	Soroti (n=78)	Whole sample (n=151)
No. of extension visits per season	5.0	3.5	4.5
Source organization %			
- World vision	19.2	1.3	8.6
- Sasakawa Global 2000	6.8	-	3.3
- Catholic Relief Services	1.4	-	1.3
- Government Starter Park	21.9	-	4.6
- World Food Programme	5.5	1.3	1.9
- Agric. Dev't Projects	32.9	23.1	3.3
- Save the Children	34.3	-	16.6
- Kulima	2.8	-	1.3
- Land 0 Lakes	1.4	-	0.7
- Government	43.8	20.5	10.6
- Others	39.7	14.1	11.9

Source: Survey data, 2008.

The glaring differences in the number of organizations operating in the two districts can be attributed to the differing levels of development. Although both regions share a history of instability due to civil wars but now enjoy peace, Nakasongola's situation has been compounded by unfavourable weather conditions characterized by long droughts. As a result the district is one of the poorest in the country which has triggered the intervention of NGOs and other development agencies to improve the situation.

Although the overarching goal of all the mentioned organizations/institution is to improve the standards of living of the poor, different organizations differ in the specific areas and modes of intervention. The common areas of intervention include agriculture, health, education, environmental management and natural resource conservation, and other development initiatives. This study focused on those that are specifically involved in agriculture. Table 17 shows farmers' access to field demonstrations in the two districts surveyed. NGOs are leading in the provision of field demonstrations followed by agricultural extension services. Other sources of field demonstrations are companies that targeted specific crops such as cotton and tobacco in Nakasongola.

Table 17. Farmer access to field demonstrations in the study districts.

Source, n (%)	Nakasongola (n=73)	Soroti (n=78)	Whole sample (n=151)
Agric extension services	18(24.7)	13 (16.7)	31(20.5)
Agricultural research institute	1(1.4)	2(2.6)	9(1.9)
NGO	20(27.4)	1(1.3)	21(13.9)
Seed company	1(1.4)	-	1(0.7)
Cotton company	1(1.4)	-	1(0.7)
Tobacco company	1(1.4)	-	1(0.7)
Other agric dev't agency	2(2.8)	2(2.6)	4(2.6)

Source: Survey data, 2008.

4 Household livelihood strategies

A wide range of livelihood strategies exist in rural areas from which farm households derive a living. The purpose of this section is to examine different livelihood activities that include among others crop production, livestock production, fishing and other off-farm activities which provide income to the rural households.

4.1 Crop production and marketing

In Uganda, crop production accounts for more than 70% of total employment within the agricultural sector itself (Egesa and Abdalla, 2005). Food crops account for 65% of the agricultural output while more than 20% is from livestock. A variety of food crops are grown in Uganda that include: cereals, mainly maize, rice, sorghum, millet, wheat, and barley; legumes such as beans, groundnuts, simsim (sesame), soybeans, and peas; root crops/tubers such as cassava, sweet and Irish potatoes; and other horticultural crops such as tomatoes, green leafy vegetables, cabbages, and onions. In addition to food crops, farmers also grow cash crops. Major cash crops grown include coffee, cotton, tea, tobacco, sugarcane and other horticultural crops such as flowers.

Distribution of farmland among various crop enterprises

The majority of Ugandan farmers are small-scale practising mixed farming. Figure 5 shows the distribution of land among different crops in the survey area of Uganda. Maize, cassava and groundnut dominate in terms of land area allocation followed by sweet potatoes, sorghum and finger millet. Other crops include cotton, coffee, beans, bananas and horticultural crops like vegetables such as tomatoes, onions, and egg plants.

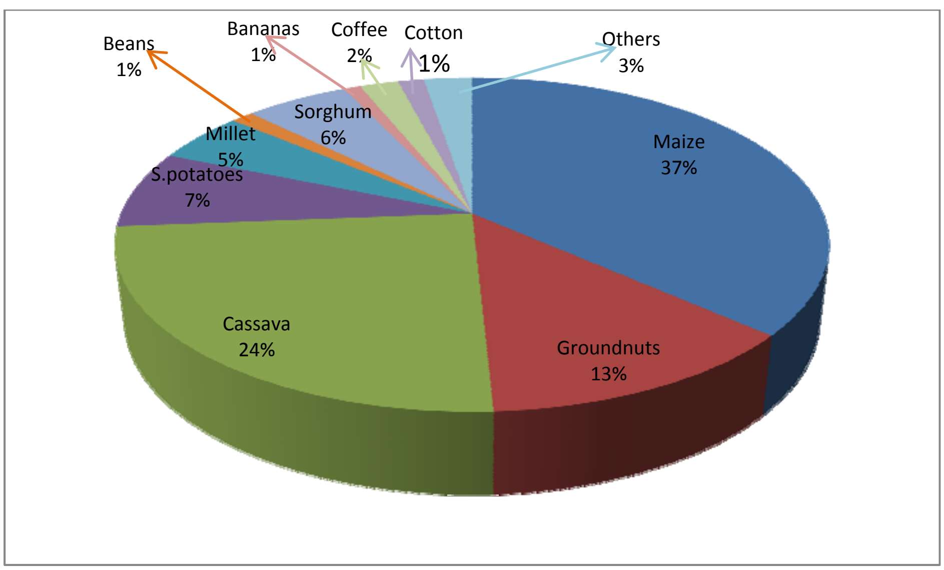

Figure 5: Distribution of land area among crops in the whole sample.

Source: Survey data, 2008.

Maize is thus the leading crop grown in the survey regions. Being a major staple food crop across all regions of the country, maize production has also been the target of support from both government and NGOs. Sserunkuuma (2005) observes that maize production has been actively promoted by several programs and organizations (such as Sasakawa Global 2000) as a package of improved seeds and fertilizer which has caused its expansion to all zones of Uganda. The increase in land area allocated to maize production can be attributed to the extensive nature of crop cultivation in Uganda that is characterized by limited use of chemical fertilizers. Kasenge *et al.* (2001) note that over the past three decades, an average land area of 384,000 hectares has been allocated to maize and production has averaged 522,000 tons with a grain yield of 1.3 tons per hectare. The overall trend of production, area and yield during this period shows that yield has stagnated or declined, and the growth in maize production has primarily been due to area expansion (Kasenge *et al.*, 2001). Figure 6 shows the disaggregated land use in the selected survey districts. There was a relatively similar distribution across the major crops, albeit that the proportion of land allocated to the first three crops - maize, cassava and groundnuts - was higher in Nakasobgola. In addition to maize, there are other cereals mainly millet and sorghum which are allocated a significant share of land in Soroti District. This is attributed to differences in farming systems and cultural practices. While millet is considered the second most important staple after maize in Soroti and is synonymous with household food security, that role is assumed by cassava in Nakasongola District.

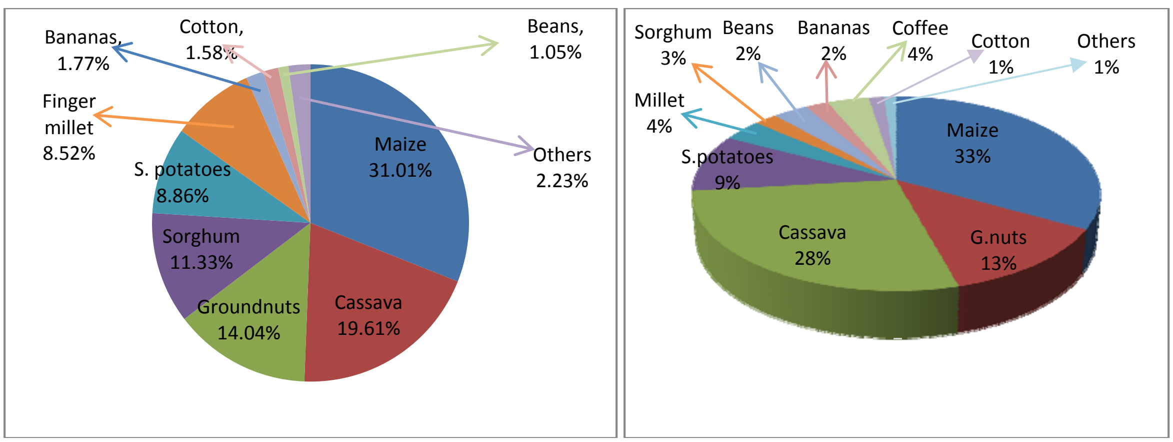

Figure 6: Distribution of land area among crops in Soroti (left) and Nakasongola districts (right).
Source: Survey data, 2008.

Crop marketing decisions

Farm households dispose of the output from crops grown for household consumption, sale, given out to friends and relatives, and reservation for seed (Table 18). Selling accounts for the largest proportion of the harvests, followed by consumption, and then reserved for seed. Some quantity is also lost during harvest and storage.

The observed pattern of crop output disposal underlines the importance of the crop to the wellbeing of the household. Apart from coffee and tobacco that were purely grown for cash, other crops serve the dual purpose of earning cash income for the household and providing food.

Table 18. Household disposal of crop harvested in survey area (% proportion).

Crop	Consumed (%)	Sold (%)	Given out (%)	Reserved as seed (%)	Lost (%)
Maize	15.9	75.9	4.1	2.1	1.8
Cassava	34.6	56.9	5.9	1.7	0.7
Groundnuts	23.7	63.8	3.8	7.2	1.5
Sorghum	31.5	57.1	6.4	5.1	0
Millet	29.5	42.8	5.4	17.6	4.7
Sweet potatoes	44.4	41.9	13.7	0	0
Beans	20.5	69.7	2.8	6.9	0
Coffee	0	98.2	0	0	1.8
Tobacco	0	97.3	0	0	2.7

Source: Survey data, 2008.

Comparing the various dual purpose crops households grow, maize has the largest share of the harvests sold (Table 18). The other crops in order of merit were beans, groundnuts, sorghum, cassava, sweet potatoes and lastly millet. Sweet potatoes and millet have low market potential in the study area but of high importance in terms of household's food needs (food security). The findings confirm the general obervation that the majority of farmers in Uganda are subsistance and semi-commercial who produce both for home consumption and sale.

4.2 Livestock production

The major livestock kept in both districts are cattle, poultry, and small ruminants (Table 19). The cattle and small ruminants are a major source of income in both districts. This study considered all categories of cows including local and improved cattle. The small ruminants included sheep, goats, and pigs, since they are the major ones kept in both districts. In Nakasongola District, only 1.5% of the cattle kept are consumed compared to 19% which was sold, while for Soroti District there was no consumption of cattle, and the percentage sold was 21%. Similarly, in Nakasongola and Soroti, only 6 and 3% of small ruminants were consumed respectively, and 39 and 56% of the total sold. Results further indicate that in both districts, the largest proportion of poultry is for consumption. Generally, Nakasongola has a larger number of livestock than Soroti District.

Table 19. Livestock production, consumption and sales.

	Number owned			Proportion consumed		Proportion sold	
	Entire sample n = 151	Nakasongola n=73	Soroti n=78	Nakasongola	Soroti	Nakasongola	Soroti
Cattle	9.27 (11.98)	11.07 (13.85)	7.58 (9.73)	0.015 (0.07)	0	0.19 (0.57)	0.21(1.35)
Small ruminants	4.85 (5.19)	5.01 (6.52)	4.70 (3.56)	0.06 (0.15)	0.03(0.14)	0.39(0.82)	0.56(1.56)
Poultry	17.34 (52.00)	24.44 (73.03)	10.69 (13.75)	0.41 (0.66)	0.66 (2.85)	0.23(0.40)	0.26(0.60)

Note: Figures in parentheses are standard deviations.

Source: Survey data, 2008.

4.3 Income and expenditure profiles of households

Selected sources of income for the sampled households are presented in Table 20. These include income from crops, livestock, employment, and other sources. Income from employment included that from paid employment and self employment. Results show that crop sales contribute the highest amount to total household income in both districts. This is not surprising given the great degree to which people depend on agriculture for their livelihood. Crops contribute 51 and 64% to the total annual household income in Nakasongola and Soroti Districts, respectively.

This is followed by livestock with 19 and 20% for the respective districts. Other sources of income include remittances, hired-out land and pension.

Table 20. Sources of income for households in 2007/08.

	Average income ('000 Uganda Shillings)			Proportional contribution	
Income source	**Entire sample n = 151**	**Nakasongola n=73**	**Soroti n=78**	**Nakasongola n=67**	**Soroti n=78**
Crops	915.10	1,013.69	822.85	0.51 (0.32)	0.64 (0.30)
Livestock	392.62	425.10	365.14	0.19 (0.23)	0.20 (0.25)
Employment	262.92	300.83	227.44	0.14 (0.25)	0.06 (0.19)
Other sources	95.70	141.23	53.08	0.08 (0.21)	0.03 (0.09)

Note: Figures in parentheses are standard deviations.
Source: Survey data, 2008

For both districts, the highest household expenditure goes to the purchase of agricultural inputs. Results show that 30 and 20% of total expenditure is spent on seed, fertilizer, herbicides, insecticides, and manure by households in Nakasongola and Soroti, respectively (Table 21). Close to expenditure on agricultural inputs are educational expenses (30% for Nakasongola and 28% for Soroti). Items classified under "other expenses" include firewood, paraffin, remittances, clothing, social contributions, transport, housing rent, repairs, building materials, and improvements. Aggregated, these consume 24 and 25% respectively of the total household income for Nakasongola and Soroti Districts, respectively. Other items on which households are found to spend include food, and medical expenses.

Table 21. Household expenditure in 2007/08.

	Expenditure ('000 Uganda Shillings)			Proportion of expenditure	
Expenditure item	**Entire sample n=151**	**Nakasongola n=73**	**Soroti n=78**	**Nakasongola n=73**	**Soroti n=78**
Food and beverage	164.32	95.74	228.49	0.08 (0.14)	0.18 (0.15)
Educational fees	639.47	948.99	349.79	0.30 (0.27)	0.20 (0.18)
Medical expenses	117.17	142.27	93.68	0.06 (0.09)	0.08 (0.07)
Agricultural inputs	325.45	401.13	254.61	0.30 (0.29)	0.28 (0.19)
Other expenses	346.34	437.93	260.62	0.24 (0.18)	0.25 (0.14)
Total expenditure	**1,592.74**	**2,026.06**	**1,187.20**		

Note: Figures in parentheses are standard deviations.
Source: Survey data, 2008.

4.4 Outlook of livelihoods

Agricultural production is generally characterized by a high degree of risks stemming from natural and economic conditions such as natural adversities (for example, pests and diseases), climatic factors not within the control of agricultural producers, and adverse changes in both input and output prices (World Bank, 2005). Agricultural risk can be categorized into two main types namely, production risk which is characterized by high variability of production outcomes, and price risk resulting from volatility of the prices of agricultural output and inputs.

Household perception about production risk

The degree to which crops can withstand variations in climate and other biological conditions differs. While changes in agricultural conditions can trigger big fluctuations in the yields of some crops (considered risky crops), they may only trigger mild yield effects in other crops. The estimated level of risk in the farming business was about 4 years of crop failure in the last 10 years, and was slightly higher in Nakasongola (about 5 years) than in Soroti (3 years). As Figure 7 indicates, crop failure is attributed to drought (as reported by 89%), floods (by 56%), plant pests and diseases (by 44%).

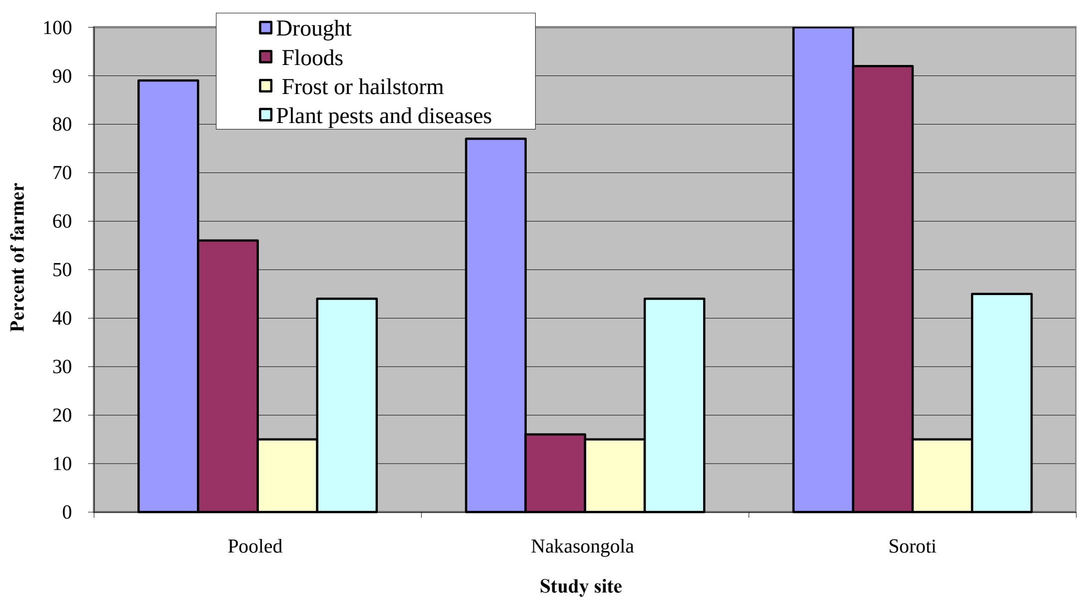

Figure 7: Major risks faced in crop production.

Source: Survey data, 2008.

To get the perception of farmers on the risk nature of the different crops that they grow, farmers were asked to rank how risky the crops are in terms of yield fluctuations. The crops were ranked along a continuum of decreasing riskiness from most risky to least risky (Table 22). In decreasing order of riskiness, improved Open Pollinated Varieties (OPVs) of maize were the most risky, followed by groundnuts. Local land race maize emerged as third risky while beans ranked the fourth risky crop. Cassava and sweet potatoes were ranked less risky crops emerging fifth and sixth risky respectively.

Table 22. Farmers' perception on riskiness of crops in terms of yield fluctuations in study area (%).

Crop	Most risky	More risk	Just risky	Risky	Less risky	Least risky
Local land race maize	12.4	20.2	18.53	6.5	4.6	2.0
Improved OPV maize	29.51	15.7	16.3	9.2	9.2	2.0
Vegetables	7.5	12.3	3.5	2.6	0.7	0.7
Millet	0.7	2.0	6.5	17.6	12.4	3.9
Sorghum	1.3	8.5	11.8	12.4	4.6	2.0
Beans	0.7	11.8	9.8	22.44	4.6	2.0
Groundnuts	20.3	22.22	12.2	15.7	6.5	2.0
Cowpeas	2.0	1.3	2.0	3.3	2.0	5.7
Cassava	5.9	3.3	13.1	20.8	25.55	12.2
Banana	1.3	0.7	1.3	2.0	0.7	0.7
Sweet potato	4.6	2.6	5.9	6.5	9.2	12.76
Coffee	0.7	1.3	0.7	2.6	2.6	0.7

Source: Survey data, 2008.

Household perception about price risk

Apart from fluctuations in crop yields that expose farmers to production risk, farmers also face price risk resulting from fluctuations in prices of crop output across seasons. The price risk experienced by farmers varies across different crops. Variations in prices for some crops are very high but relatively stable for others. The study sought farmers' perception on riskiness of crops in terms of price fluctuations as indicated in Table 23. Farmers ranked improved OPV maize as the most risky followed by local land race maize, groundnuts and cassava in that order (Table 23). Sweet potatoes were ranked as less risky and sorghum as the least risky crop. Crops like maize, groundnuts, and cassava experience high variations in price because households heavily rely on them for income as these are mainly grown for sale and yet they are seasonally produced. Others such as sweet potatoes and sorghum are low price risky (with low price fluctuations) because they are mainly for subsistence purposes.

Table 23. Farmers' perception on riskiness of crops in terms of price fluctuations in study area (%).

	Most risky	More risk	Just risky	Risky	Less risky	Least risky
Local land race maize	25.5	23.52	7.2	2.6	0.7	2.3
Improved OPV maize	45.81	19.6	6.5	3.3	2.0	2.0
Hybrid maize	2.6	3.3	2.0	0.7	7.8	2.6
Vegetables	0.7	9.8	1.3	2.6	0.7	1.3
Millet	0.7	1.3	9.2	17.6	9.2	5.2
Sorghum	1.3	8.5	13.7	12.4	3.9	7.96
Beans	2.6	11.8	15.7	11.1	3.3	3.3
Groundnuts	5.2	15.7	23.53	19.6	20.3	3.3
Cowpeas	0.7	4.6	3.9	10.5	1.3	0.7
Cassava	13.1	18.3	17.6	26.84	15.3	0.7
Banana	1.3	0.7	2.6	2.6	9.2	0.7
Sweet potato	0.7	1.3	2.0	5.9	18.35	6.5
Coffee	0.7	2.0	5.9	8.5	0.7	1.3

Source: Survey data, 2008.

Adjustment in crop portfolio to mitigate production and price risks

In the face of the above production and price risks, farmers make adjustments in their crop portfolio to mitigate these risks. Table 24 shows how farmers respond to changes in yields and prices of both inputs and outputs. When the price of output is less than normal, farmers maintain the same area allocated to the crop as for the previous season. As expected, when the price of a crop is higher than normal, farmers respond by increasing the size of land allocated to the crop. The response to the situation when yields are less than normal is mixed: some farmers increase the amount of land allocated for some crops while for others, the size of land allocated remains the same. For the majority of the crops, when the yields are higher than normal, farmers increase the size of land allocated to the crops. Farmers are motivated by the increased yields and perhaps obtain higher revenues from crops and therefore have the capacity to purchase or hire more inputs to increase their output.

Table 24. Adjustment in crop portfolio by households in study area to mitigate price and yield risks.

	Percentage response (%) from specific adjustments in crop portfolio											
Crop	Price less than normal			Price higher than normal			Yield less than normal			Yield higher than normal		
	↓se	Same	↑se	↓se	↑se	Same	↓se	↑se	Same	↓se	↑se	Same
Local maize	27.5	26.8	6.5	4.6	15.0	41.8	15.7	28.8	16.3	3.3	24.2	34.0
Improved maize	21.6	47.7	11.8	3.3	70.6	7.2	10.5	22.9	48.5	3.3	56.9	20.3
Sorghum	14.4	23.5	2.6	3.3	30.7	6.5	9.2	5.2	26.8	2.6	23.5	14.4
Millet	16.3	26.1	3.3	3.9	36.6	5.9	8.5	8.5	28.8	2.0	24.8	19.6
Groundnut	22.9	52.3	9.2	3.9	62.1	18.3	11.8	21.6	51.6	2.6	49.7	32.0
Beans	10.5	25.5	3.9	1.3	25.5	13.1	6.5	21.6	11.8	2.6	20.9	15.7
Cassava	21.6	62.7	9.8	4.6	72.5	17.0	11.8	21.6	60.8	2.6	58.2	33.3
Sweet potato	13.1	13.1	2.6	3.3	22.2	3.3	5.9	5.9	17.0	10.5	28.8	18.3

Note: [1]"↓se" stands for decrease; "↑se" stands for "increase".

Regarding changes in use of purchased inputs such as fertilizer, farmers reported that they would maintain the same area whether the fertilizer was readily available and affordable or less available and unaffordable (Table 25). This is basically because of limited use of fertilizers by most farmers. Farmers' response to changes in availability and/or cost of fertilizer in production is very inelastic. Credit is another essential input in agriculture as it enables farmers to purchase or hire inputs necessary for increasing output. When credit is readily available and affordable, farmers increase the amount of land allocated to different crops. This is because credit facilitates the purchase of inputs and hiring of labour necessary for timely performance of crucial farming activities.

Table 25. Adjustment in crop portfolio by households in study area to mitigate price and yield risks.

Crop	Fertilizer is available and affordable			Fertilizer is less available and unaffordable			Credit is readily available and affordable		
	decrease	same	increase	decrease	increase	same	decrease	increase	same
Local maize	0.7	34.0	26.8	5.9	2.6	52.9	2.0	34.0	24.8
Improved maize	0.7	33.3	46.4	2.6	5.9	71.9	0.7	49.0	31.4
Sorghum	1.3	29.4	9.8	0.7	1.3	38.6	21.6	41.2	19.6
Millet	2.0	32.7	11.1	1.3	0.7	44.4	21.6	0.7	24.2
Groundnut	0.7	55.6	28.1	3.3	3.3	77.8	2.6	49.7	34.6
Beans	1.3	22.9	15.7	2.6	2.0	35.3	17.0	39.9	22.9
Cassava	2.0	67.3	24.2	3.3	4.6	86.3	2.6	51	43.1
Banana	3.3	2.0	5.2	3.9	1.3	5.2	2.6	5.2	2.6
Sweet potatoes	0.7	20.3	7.8	0.7	4.6	3.9	3.9	4.6	0.7

Source: Survey data, 2008.

5 Technology use in crop production

Agricultural production involves use of various inputs which among others include land, labour and capital. Capital may involve the physical investments that facilitate production such as farm machinery and equipment. Farmers also need the financial capacity to acquire complementary inputs necessary for increasing agricultural output. In Uganda such inputs include hoes, ox-ploughs, harrows, fertilizers, pesticides, herbicides, spraying equipment, animal drugs and improved seeds, planting materials and breeds. Here we examine the use of some of these purchased inputs, in particular improved seeds, fertilizers, pesticides, herbicides, manure and mulch. Table 26 illustrates the use of non-seed inputs by households in the study areas of Uganda. Generally, it can be noted that apart from sweet potato vines and cassava cuttings, the proportion of farmers that use other non-seed inputs is very low in both districts. The glaring differences in the proportion of farmers that use sweet potato and cassava planting materials as compared to other non-seed inputs can be attributed to the fact that the latter are purchased inputs that usually are paid in cash and often unaffordable to the farmers. Use of manure is also very low though it is not a purchased input probably because of lack of livestock by households. These findings corroborate well with low use rates of inorganic fertilizers that have been reported in other studies carried out in some parts of Uganda. Nkonya, *et al.* (2003) reported that adoption of inorganic fertilizers is very low (used on less than 2% of plots in the Lake Victoria crescent region of central Uganda), while use of organic methods of soil fertility management is also limited (e.g., use of manure or compost on 18% of plots, mulch on 8%).

Table 26. Non-seed input use by households in the study districts of Uganda.

Input n (%)	Nakasongola (n=73)	Soroti (n=78)	Whole sample (n=151)
Sweet potato vines	39(53.4)	53(67.8)	92(60.6)
Cassava cuttings	56(76.5)	54(69.5)	110(73.0)
Basal NPK	1(1.37)	0	1(0.66)
Urea (top dress)	0	0	0
Herbicides	5(6.85)	1(1.28)	6(6.62)
Insecticides	4(5.48)	10(12.8)	14(9.27)
Manure	2(2.74)	0	2(1.32)

Source: Survey data, 2008.

Farmers obtain seeds and other planting materials from various sources some of which may be located within their communities while others can be sourced far away from their location. To understand where farmers obtain seeds and other planting materials, respondents were asked to state sources of seeds planted the previous season. As illustrated in Figure 8, majority of the farmers obtain seeds from agricultural input dealers' shops in the community that account for half of the maize seed acquisitions. The remaining half of maize seed sources are spread over a range of alternative suppliers. The ministry of agriculture and seed companies were uncommon for other cereals and legumes.

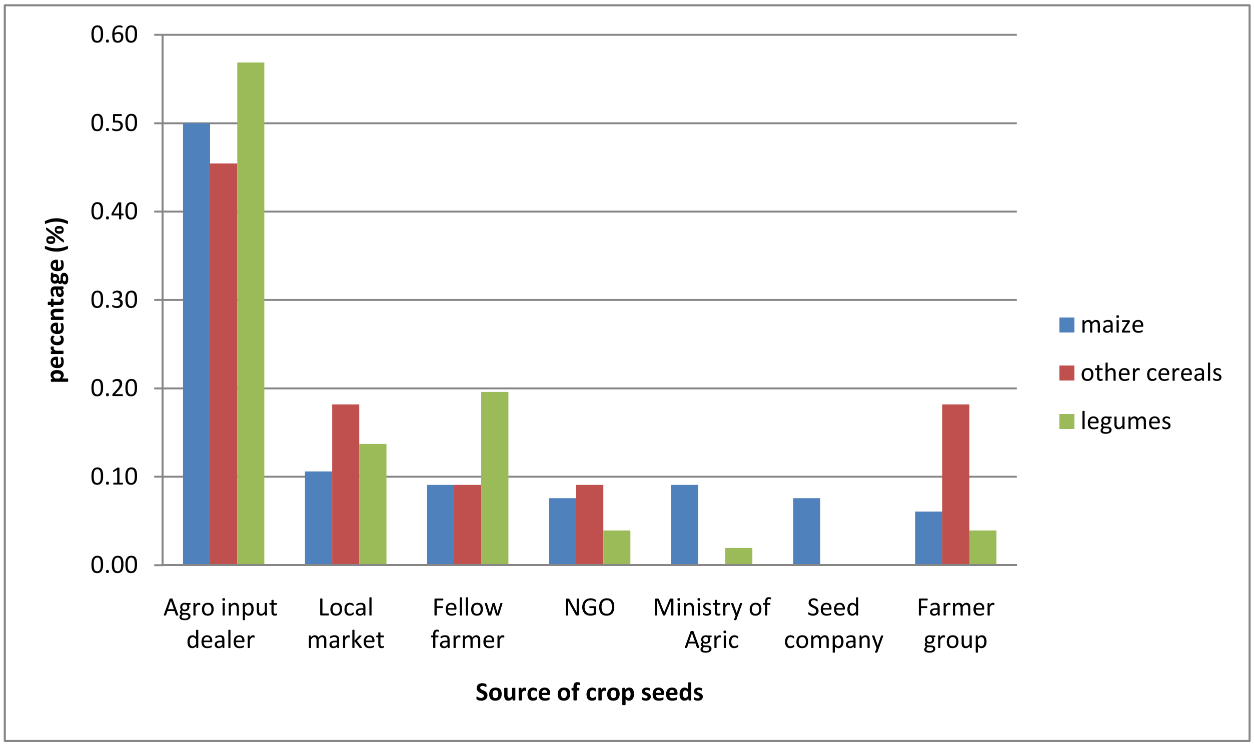

Figure 8: Sources of crop seeds in selected districts of Uganda.

Source: Survey data, 2008.

Improved maize varieties grown

The level of adoption of improved maize varieties was defined as the percentage of farmers who had ever grown improved varieties in the last five years. The intensity of adoption was measured as the proportion of maize area under improved varieties. The survey shows high adoption rates in both study districts: 88 and 77% of maize farmers in Nakasongola and Soroti, respectively (Table 27). High adoption rates can be attributed to the highly successful campaign at developing and disseminating improved maize varieties especially the popular *Longe* series. The level of dis-adoption was low: only about 2% in Soroti and 1% in Nakasongola. Maize is a staple food, and farmers have had enough time to experiment with the improved varieties. Although the majority of maize farmers interviewed grow improved varieties, the intensity of adoption of the varieties is low. Results show an average adoption intensity of 24%. An average maize farmer in Soroti and Nakasongola, respectively, planted 26 and 22% of their maize area with improved maize.

Table 27. Level and intensity of adoption of improved maize seed.

	Nakasongola (central)	Soroti (eastern)	Pooled sample
Level of adoption in 2008 season (%)	89	79	84
Level of adoption in the last five-year (%)	88	77	82
Level of dis-adoption (%)	1	2	2
Average intensity of adoption (%)	22	26	24

Source: Survey data, 2008.

The improved maize varieties had higher farmer reported mean yields (2.942 tons/ha/season) compared to the local varieties (1.694 tons/ha/season). The most common maize varieties planted in Soroti are *Longe* 1 (reported by 48% of adopters) followed by *Longe* 5 (32%) and *Longe* 4 (by 20%). On the other hand, *Longe* 5 and 4 are the dominant varieties planted in Nakasongola (as reported by 43 and 41% of the adopters respectively). The varieties are preferred by the farmers because they are resistant to drought, early maturing and high yielding (Table 28). Other preferred attributes include resistance to pests and diseases, large cob size, resistance to lodging, and large grains (Table 28). The other varieties grown include the hybrid DK.

Table 28. Improved maize varieties adopted by farmers and their desired attributes.

	Nakasongola (n=60)		Soroti (n=60)		Pooled (n=120)	
Adopted varieties	**Frequency**	**Percent**	**Frequencey**	**Percent**	**Frequency**	**Percent**
Longe 5	26	43	19	32	45	38
Longe 1	9	15	29	48	38	31
Longe 4	25	42	12	20	37	31
Desired attributes						
High yield potential/more cobs per plant	48	80	60	100	108	90
Early maturity	42	70	57	95	99	83
Drought resistance	44	73	44	73	88	73
Pest/disease resistance	16	27	5	8.3	21	18
Large cob size	19	32	20	33	39	33
Large grains/heavy grains	13	22	13	22	26	22
Resistance to lodging	2	3.3	5	8.3	7	5.8
Tasty green maize	11	18	4	6.7	15	13

Source: Survey data, 2008.

The few farmers who do not grow improved maize varieties cite high cost of seed (42%), limited knowledge/awareness of improved varieties, unavailability of improved seed, and satisfaction with current varieties as reasons for non-adoption (Table 29). The high cost of purchased seeds can be attributed to the high transaction costs involved in marketing seeds and other agricultural inputs in general in Uganda. IFDC (1999) reports that high transaction costs pervasive in the input market industry are due to low volume of purchases, high transport costs and high interest rates on borrowed capital.

Table 29. Reasons for not using improved maize seed.

	Nakasongola		Soroti		Pooled	
Reason	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
Limited knowledge/awareness of improved varieties and their benefits	1	12.5	4	22.2	5	19.3
Unavailability of improved seed	0	0	4	22.2	4	15.4
High cost of improved seed	5	62.5	6	33.3	11	42.3
Satisfied with the local varieties	1	12.5	3	16.7	4	15.4

Source: Survey data, 2008.

The underlying survey data have been used to analyze the determinants and effects of adoption of improved maize seed in a seperate paper (Mugisha and Diiro, 2010).

6 Conclusion

The study shows a high level of adoption (about 80%) but low intensity of adoption (22%) of improved maize varieties despite their marked yield advantage over local varieties. The reported yield is, however, less than one fifth of the expected yield. The yield gap can be attributed to recycling of seed of improved maize and to limited use of yield-enhancing inputs as well as other risks associated with crop production. Increased use of improved maize varieties will help to increase yields and underscores the need to enhance dissemination of improved agricultural technologies and knowledge. This calls for multifaceted interventions to enhance household access to both better knowledge (through extension services and advisory services) and technologies in order to increase agricultural productivity and contribute to rural development.

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Annex 1: Constructing wealth indicators using Principal Components Analysis approach

Following Filmer and Pritchett (2001), the indices are scaled from 0 to 1 as follows:

$$i = \frac{x_l - x_{\min}}{x_{\max} - x_{\min}} \qquad \text{----------------------- (1)}$$

where *i* is the index, x_l is the level, while $x_{\min}$ and $x_{\max}$ are the minimum and maximum values of x, respectively, taken from the actual data collected. Once scaled (or normalised), the indicators can be added together without the element of distortion which would be introduced by widely differing value ranges. The challenge, however, is in identifying the relevant weights to give to each indicator. According to Filmer and Pritchett (2001), four possible approaches to this problem are:

1. Constructing a set of weights based on a common factor which can be applied to all the indicators (for example, market or shadow prices);
2. Assigning weights based on qualitative or subjective judgment;
3. Avoiding the need for weights by running a multivariate regression analysis with all the indicators as unconstrained variables; or
4. Allowing the weights to be determined mathematically, using principal components analysis.

In this analysis, it was not possible to find a common factor which could meaningfully be applied to all the indicators. Therefore, option one was not applied. Option two was found inappropriate given the highly imperfect markets for most commodities and services in the study area to allow the use of shadow pricing. The third approach, multivariate regression, is statistically unsatisfactory because the variables to be included are not independent of each other suggesting that the resulting multicollinearity would produce misleading regression coefficients. The fourth technique, Principal Components Analysis (PCA), was used to construct an overall index of household wealth which combined all the indicators selected after the initial round of analysis. This section gives a brief description of the theory of PCA used in construction of household wealth indices.

PCA is a technique for extracting 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 that is common to all the variables. Suppose we have a set of *K* variables, a_{1j}^* to a_{kj}^*, representing the ownership of *K* assets by each 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 households and s_1^* is its standard deviation. These selected variables are expressed as linear combinations of a set of underlying components for each household j:

$$a_{1j} = v_{11}A_{1j} + v_{12}A_{2j} + \ldots\ldots + v_{1k}A_{kj}$$

$$a_{k1j} = v_{k1}A_{1j} + v_{k2}A_{2j} + \ldots\ldots + v_{kk}A_{kj} \qquad \forall_j = 1,\ldots\ldots, j \quad \text{------------ (2)}$$

Where the *A*'s are the components and the *v*'s are the coefficients on each component for each variable (and do not vary across households). Because only the left-hand side of each line is observed, the solution to the problem is indeterminate. Principal components overcomes this indeterminacy by finding the linear combination of the variables with maximum variance, usually the first principal component A_{1j}, and then finding a second linear combination of the variables, orthogonal to the first, with maximal remaining variance, and so on. Technically the procedure solves the equations $(R-\lambda I)vn = 0$ for λn and vn, where R is the matrix of correlations between the scaled variables (the *a*s) and vn is the vector of coefficients on the *n*th component for each variable. Solving the equation yields the characteristic roots of R, λn (also known as eigenvalues) and their associated eigenvectors vn. The final set of estimates is produced by scaling the vns so the sum of their squares sums to the total variance, another restriction imposed to achieve determinacy of the problem.

The scoring factors from the model are recovered by inverting the system implied by the equation above, and yield a set of estimates for each of the K principal components:

$$A_{1j} = f_{11}a_{1j} + f_{12}a_{2j} + ... + f_{1k}a_{kj}$$

$$A_{k1j} = f_{k1}a_{1j} + f_{k2}a_{2j} + ... + f_{kk}a_{kj} \quad \forall_j = 1,...., j \text{ ---------- (3)}$$

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

$$A_{1j} = f_{11}(a^*_{1j} - a^*_1)/(s^*_1) + ... + f_{1k}(a^*_{kj} - a^*_k)/(s^*_k) \text{ -------------- (4)}$$

The critical assumption of PCA is that, the undefined 'common information' is in fact determined by the underlying phenomenon that the index is trying to measure (in this case, wealth), which unfortunately cannot be statistically verified since it depends on the correct identification of the relevant variables or indicators, and is therefore largely a matter of judgment. One of the advantages of PCA is that it estimates the contribution of each variable to the underlying common phenomenon, and thus enables us to rank the indicators according to their importance in determining a household's level of wealth.