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Country Report – Household Survey

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DTMA Country Report - Mali

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The Drought Tolerant Maize for Africa (DTMA) Project is jointly implemented by CIMMYT and 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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Acronyms and abbreviations

B&MGF	Bill and Melinda Gate Foundation
CILSS	Comité Inter Etats de Lutte Contre la Sécheresse au Sahel
CIMMYT	Centro International de Mejoramiento de Maiz y Trigo
CMDT	Compagnie Malienne pour le Développement des Textiles
CPS	Cellule de Planification et de Statistique
DTM	drought tolerant maize
DTMA	Drought Tolerant Maize for Africa
FGD	Focus Group Discussion
GPS	Global Positioning System
IITA	International Institute of Tropical Agriculture
LGA	Local Government Area
N/A	not applicable
NGO	Non-Governmental Organization
OPV	Open pollinated varieties
PCA	Principal Component Analysis

Executive summary

Maize is one of the three most important staple foods in Mali. Zones in the country with high potential for producing maize are limited to areas where the probability of drought risk is between 20 and 40%, meaning that recurring droughts have long handicapped maize production. In an attempt to alleviate drought stress on maize production, a household survey was conducted in the two Local Government Areas of Bougouni and Koutiala, both in the Sikasso Region, during the 2007/2008 production period. These two districts were selected following an environmental characterization of drought zones in Mali. The survey was mainly oriented towards maize based farming systems. Six sample villages were selected within each of the two districts. The sample population was defined as maize farming households. A total of 150 households were randomly selected and interviewed with structured questionnaires. Interviews were conducted by trained enumerators using a formal household survey.

The purpose of the study is to provide both quantitative and qualitative feedback from farmers to researchers and to the B&MGF on the impact that improved maize varieties developed in the past have had upon the livelihoods of households and to provide a detailed database for the projection of expected outcomes with the deployment of new drought tolerant maize varieties under the B&MGF drought tolerant maize project.

Both qualitative and quantitative analyses were used to extract from our set of variables those orthogonal linear combinations of the variables that best captured the common information. Most successful was the one proposed by Filmer and Pritchett (1998; 2001) called the Principal Component Analysis (PCA). To assess the variables affecting the adoption of improved maize varieties, the Tobit model was used.

The results show that 99% of household heads are male. The size of a household is 22 persons, on average. About 47% of the household's members are available for farm work. About 59% of household heads are illiterate, an important factor concerning the adoption of new technology. These household heads make decisions about 84% of farming activities; 86% of the households involved in the study belonged to at least one farmers' organization in order to have easy access to inputs. This high rate is largely due to a cotton development service that has been working with farmers in this zone since colonial times. The service provides credit and inputs to village associations, but access to inputs is not allowed to individual households.

In the survey area, in addition to dwellings, households generally have access to different assets such as bicycles, motorcycles, radios, tractors, wheelbarrows, animal-drawn plows, harrows, and scotch carts, private wells, tractor-drawn plows, and harrows, motor vehicles, solar energy, water pumps, diesel pumps, water tanks, cultivators, mobile phones, fixed phones, and television sets. Access to some of these assets, (motor vehicles, tractors, diesel pumps, water tanks, solar energy and generators) is limited to well endowed households. For the entire study area, the distribution of the wealth index ranking of households based on their productive capital assets indicates that 56.4% of households are poorly endowed. This tendency is corroborated by the study *Observatoire du développement humain durable au Mali* 2007/2008.

Land ownership is positively related to the wealth status of the households, with the well endowed group possessing a larger share of land, both in total area and by land use type. Because of increased input prices (fertilizer, seeds, and insecticide), the collapse of the cotton market, drought and declining soil fertility, farmers are having difficulty coping and farm acreage is becoming smaller over time. The average household acreage is currently about 18.71 ha, divided into abandoned, pasture, fallow, and cultivated lands. The determinants of cultivated farm size range in decreasing order as follows: family food needs, family labor availability, expected cereal prices, cash availability to purchase inputs, availability of farm equipment, cash availability to hire labor, current cereal prices and seed availability, pulling out of cotton production, drought and declining soil fertility. Livestock production is incorporated into livestock ownership. Like crop production, this activity also needs some land. The distribution of mean livestock ownership by wealth group indicates that the well endowed

households possess, on average, herds of 29 cattle, 10 goats, 11 sheep, 3 draft animals, and 6 pigs. The less endowed households have an average of 13 cattle, 4 goats, 5 sheep, 2 draft animals, and 2 pigs.

Among resource-poor households, access to credit is important at an appropriate time for farm activities and to cope with food shortages and other problems such as health care, wedding payments, and taxes. The results indicate that there is good access to credit in the study area, with 81.2% of households having access. More than half of the households (58.1%) have access to financial institutions for production credit and 66.7% have access for consumption credit. Other sources of financial assistance are relatives, NGOs, neighbors, moneylenders, and Government programs. Support in favor of consumption credit is obtained from neighbors and relatives in essentially the same proportion (37.5%). Access to field demonstrations is quite low in general in the study area. This indicates a need for an increase in field demonstrations. Field demonstrations are organized in descending order by the cotton development service (33%), seed companies (23%), extension services (13%), research institutions (12%), other development services (10%), and NGOs (9%).

In general in rural areas, the basic source of livelihood is producing crops, rearing livestock, and marketing the agricultural produce derived from these activities. Producing crops and raising livestock depend on an underlying condition of access to land, either by possessing it or getting it from others. Access to land is fundamental to crop and livestock production. According to the land area distribution among crops, the major crops grown are maize (26%), sorghum (23%), millet (20%), cotton (13%), groundnut (8%), rice (5%), and cowpea (3%). Some other minor crops such as potato, sesame, yam, and cassava are also cultivated by a few people. Most of these crops are produced either for family consumption or for sale or both. The farm family's land area distribution among crops is based on the family's needs or objectives.

Non-seed inputs used by household in the selected districts include NPK, urea, organic manure, herbicides, and insecticides. The different sources of crop inputs are *Compagnie Malienne pour le Développement des Textiles* (CMDT), traders, *Association Villageoise* (AV), Sasakawa Global 2000, cooperatives, and other producers.

Dembanyuman is the most common improved maize cultivar planted by households in the study districts, (50% of the cultivated area), followed by Sotubaka (41.5%). Crop seeds come from different sources but are most commonly collected from farm production (48%). Other sources are other producers (22%), National Seed Service (20%), cooperatives (18%), market (15%), and CMDT (13%). The adoption of improved maize cultivars is computed as the proportion of land allocated to improved maize varieties. At 5% level of significance, the Tobit regression model results show that the major factors influencing the adoption of improved maize varieties are the availability of family labor and household location. According to the results, factors such as the age of the household head, (Hhage), farm size (Fsize in ha), membership of farmers' associations/cooperatives (Fasst), and access to public or private extension services (Ext) have little or no influence on the adoption of an improved maize variety in the study area. Crop disposal results indicate that the greatest proportion goes to family consumption, followed by sales.

Households draw their income from farming (crop and livestock production and marketing) and off-farm activities. These range from grain, seeds, and fruit sales, animal and fish sales, and petty trading, to salaries, self-employment, and other sources of income. The expenditure patterns of households range from spending on basic food to tobacco, cola nuts, school fees, health care, clothing, and fuelwood, to social contributions, sending money to others, etc.

Farmers in the region commonly express the opinion that "life is not easy" and "life is a battle." The shocks experienced in the study areas include drought, flood, large increases in input prices, death or loss of livestock, illness or handicap of the household head or spouse, drastic decreases in crop prices, death of the household head or spouse, plant pests and diseases, livestock diseases, dangerous weeds, etc. While facing shocks, households in the study area also engineer positive livelihood outcomes, such as increasing agricultural

production, improving the health status of household members, increasing food security, reducing agricultural production risks, increasing access to land, improving revenue and reducing income risk, reducing trade risk, improving the formal education level of household members, and improving employment opportunities. These are strategies tending to alleviate the effect of shocks.

Local maize, open pollinated (OPV) maize, and hybrid maize are seen as the most risky crops in terms of yield fluctuation. When yield is below normal, the coping mechanism suggested for all crops is to increase the land area or keep it unchanged. The only situation where farmers do not increase the land area is when fertilizer is unavailable or expensive. In this situation, farmers tend to reduce the land area or keep it unchanged for all crops. Land area reduction is the coping mechanism least often employed to handle risk. The two most cited coping adjustments in the crop portfolio to mitigate selected production risks are diversification in general and cultivated variety diversification for all crops.

For the majority of households in the area, price does not seem to be the determining factor in the quantity of crops to be sold. Fewer than 50% of households in all cases cited this factor. The same behavior was observed in acquiring more credit if the selling price of OPV maize, hybrid maize, cotton, sorghum, or millet was attractive. In the case of attractive selling prices, households in both LGAs attempted to increase their input use or keep it unchanged. Very few seek to decrease their input use. If product prices decrease, the great majority of households are more likely to sell more assets. If local product prices increase, almost all said they would buy more assets.

1. Introduction

Mali is a landlocked country in West Africa with a total land area of 1,248,570 km^2. The population is estimated at 12 million. The country is administratively divided into eight Regions and one District (the capital city of Bamako); 49 Cercles; and 703 Communes. Agriculture is almost totally rain-fed. Although data are not available, it is generally accepted that most agricultural production is done on a basis of subsistence farming. It is also recognized that maize is among the most important staple foods in Mali. In fact, statistics from *Données de base de la CPS du Ministère de l'Agriculture (*MA 2007/2008) indicate that maize cultivation covers a total land area of 405,302 ha and the crop ranks as the third most important cereal in terms of area cultivated after millet (1.436.837 ha) and sorghum (1.067.585 ha) and before rice (377.041 ha). Presently, maize represents 15% of the total cereal production. This figure is expected to rise to 40% by 2012 if the presidential maize initiative is successful. In the meantime, millet will go from 5 to 7%, sorghum from 4 to 15%, and rice from 4 to 13%. These figures indicate the importance of maize in the country's strategy for food security and poverty reduction.

The most significant limitation on maize production in the country is drought. Zones with high potential for producing maize are limited to areas where the probability of drought risk is between 20 and 40%, meaning that recurring droughts have seriously handicapped maize production in the country as a whole.

In an attempt to alleviate drought stress on maize production, the Drought Tolerant Maize for Africa (DTMA) Project has been designed with the objectives of decreasing hunger and increasing the food and income security of resource-poor farm families in sub-Saharan Africa through the development and dissemination of drought tolerant, (DT) well-adapted maize varieties.

The purpose of the socio-economic component of this project is to provide quantitative feedback from farmers to researchers and to the B&MGF on the impact that improved varieties developed in the past have had upon the livelihoods of households and to provide a detailed database for the projection of expected outcomes with the deployment of new DT maize varieties under the DTMA project. To contribute to these, a household survey was conducted in two selected Local Government Areas (LGAs), Bougouni and Koutiala, both in the Sikasso Region during the 2007/2008 production period.

The rest of the report is organized as follows: Section 2 presents a description of the sample locations and the sampling and data collection procedures. Section 3 deals with the agroclimatic characterization of the sample locations; Section 4 is related to the demographic characterization of the sample households. Households' access to capital (human, natural, physical, financial, institutional, and social) is covered in Section 5. Households' livelihood strategies (crop production, livestock production, and marketing, income and expenditure profiles, and the impact of shocks on households' livelihood outcomes) are considered in Section 6. Production and price risk analysis (households' perceptions of production risks and their coping mechanisms) are considered in Section 7. Finally, Section 8 looks at the distribution of impact indicators by household wealth categories.

2. Methodology

Sampling and data collection

The process started with the identification of maize production zones in Mali to allow the environmental and socioeconomic characterization of drought zones to be used for the selection of localities.

A team of economists, plant breeders, agronomists, and extension agents proposed five LGAs: Kita and Diéma in Kayes Region; Koutiala and Bougouni in Sikasso Region; and Koulikoro in Koulikoro Region for DTMA community assessment and household survey sites. These represent the zones with a high potential for maize production in the country.

Table 1a. Household survey sample distribution among LGAs and villages.

Local Government Area	Village name	Households selected
Bougouni	Bougouni ville	15
	Kokélé	10
	Dalabani	6
	Ouré	15
	Faradiélé	15
	Flaboula	14
Koutiala	NGountjina	15
	Farakala	10
	Zangasso	15
	MPessoba	15
	NTosso	10
	Zandiéla	10
Total		150

Following the environmental characterization of drought zones, the LGAs of Bougouni and Koutiala, both in the Sikasso Region, were selected for community assessment and the household survey. Both districts are in the CMDT zone. This zone has a high potential for maize production and represents an area where the probability of drought risk is between 20 and 40%.

Inside the two LGAs, twelve villages (six in each LGA) were selected for household surveys (see Table 1a for the GPS coordinates of the villages and Table 1b for the physical features at LGA level).

The survey included the economic role of maize in farming systems and household livelihoods; the nature of the production and marketing risks faced by producers; access to information, seeds and credit input and maize produce markets; access to labor markets and the role of remittances; the adoption and non-adoption of improved maize varieties; and farmers' perceptions of the performance of traditional and improved maize vis-à-vis drought.

The total sample size was 150 households with 75 selected from each LGA. The number of households per village was determined based on the size (number of households) of each village, giving the sample distribution displayed in Table 1a.

The survey was conducted by three enumerators and covered the period between 8 August 2008 and 11 September 2008. In the course of the survey, we met three major difficulties. First, it was the rainy season so farmers were quite busy in the field. Secondly, two of the enumerators resigned after the completion of Bougouni LGA, and we had to hire and train two new agents. The third constraint was the length of the questionnaire, which took more than two hours to fill in—too much for a farmer during the cropping season.

3. Agroclimatic characterization of the survey locations

Mali is divided into four zones (Fig. 1): (i) northern Guinea zone; (ii) southern zone (north and south); (iii) Sahelian zone (north and south), and (iv) Saharan zone. Koutiala LGA is located in the northern Guinea zone with part of the LGA in the south of that zone, around latitude 12.1 °N and longitude 5.6 °E, with an average altitude of 366 m above sea level (masl) and an average annual rainfall of 895 mm (Table 1b). Bougouni LGA lies almost fully in the northern Guinea zone around latitude 11.8 °N and longitude 7.6 °E, with an average altitude of 388 masl and an average annual rainfall of 1100 mm (Table 1b). The GPS coordinates of household survey locations are given in Table 1c.

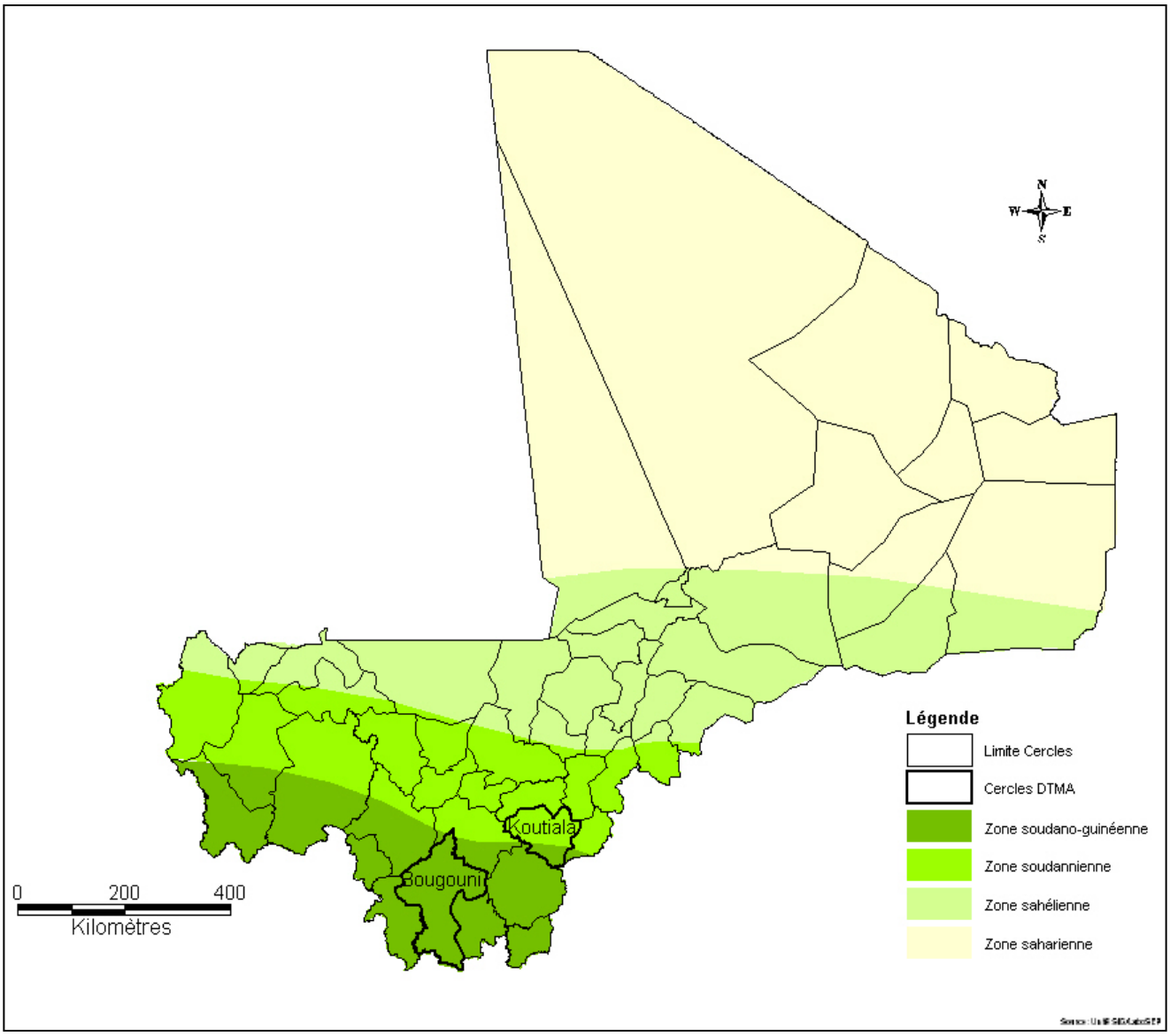

Figure 1. Survey districts and agroclimatic zones of Mali.

Table 1b. Physical features at LGA level.

Features	LGA Bougouni	LGA Koutiala
Lowest monthly rainfall (mm)	10.2	8
Highest monthly rainfall (mm)	283.2	241
Annual rainfall 2007 (mm)	1100	895
Average altitude	388 masl	366 masl
Latitude	11.8 °N	12.1 °N
Longitude	7.6 °E	5.6 °E
Minimum temperature (C)	13°	14°
Maximum temperature (C)	33°	38°

Source: Secondary data and key informants interview.

Table 1c. GPS coordinates of household survey locations in Mali.

N°	Bougouni	GPS coordinates	Koutiala	GPS coordinates
1	Bougouni ville	11.42051 °N 7.49161 °E	NGountjina	12.29859 °N 5.47186 °E
		Altitude 388 masl		Altitude 449 masl
2	Kokélé	11.52962 °N 7.54432 °E	Farakala	12.28552 °N 5.44906 °E
		Altitude 367 masl		Altitude 450 masl
3	Ouré	11.36418 °N 7.34559 °E	Zangasso	12.15705 °N 5.61838 °E
		Altitude 379 masl		Altitude 342 masl
4	Dalabani	11.38559 °N 7.45999 °E	NTosso	12.08483 °N 5.64185 °E
		Altitude 366 masl		Altitude 336 masl
5	Flaboula	11.37836 °N 7.54849 °E	Pessoba	12.66795 °N 5.71472 °E
		Altitude 401 masl		Altitude 337 masl
6	Faradiélé	11.34824 °N 7.63742 °E	Zandiéla	12.63831 °N 5.69908 °E
		Altitude 370 masl		Altitude 348 masl

Source**:** Community and household survey data (2008).

Monitoring visit of irrigated maize field, Saaba, Mopti.

Table 2. Descriptive statistics of sample households

Descriptive statistics		Bougouni (N = 75)	Koutiala (N = 74)	Overall (N = 149)
		Percentage of households		
Gender of the respondent	Male	98.7	100.0	99.3
	Female	1.3		.7
Farming activities decision-making	Household head	73.3	94.6	83.9
	Child	16.0	4.1	10.1
	Household head and children	0	1.4	0.7
	Brother and sister	10.7	0	5.4
Marital status of household heads	Single	1.3	1.4	1.3
	Married	97.3	98.6	98.0
	Divorced	1.3	0	0.7
Education of household heads	Illiterate	64.0	54.1	59.1
	Primary school	17.3	17.6	17.4
	Secondary school	5.3	6.8	6.0
	High school and university		1.4	0.7
	Non-formal education	13.3	20.3	16.8
Membership of farmers' association/cooperative	Yes	86.7	85.1	85.9

Source: Survey data analysis.

4. Demographic characterization of households

The household survey covered 150 households with 75 households selected from each LGA. At the data processing stage, one questionnaire belonging to NTosso village in Koutiala LGA was missing, meaning that data from 149 households were analyzed. The results showed that 88% of the respondents were household heads and 99% of them were male. The average size of a household was 22 persons. About 59% of the household heads were illiterate (64% in Bougouni and 54% in Koutiala). Household heads decided 84% of farming activities (Table 2), so the high rate of illiteracy could constrain the adoption of new technology. Only 17.4% of them attended primary school, 6% went to secondary school, and an additional 17% received non-formal education. The marital status of household heads was as follows: about 98% were married; 1.3% were single, and 0.7% were divorced. About 86% of them were members of farmers' organizations (associations or cooperatives).

5. Households' access to capital assets

Gafsi (2006) proposed a new approach to household analysis adapted to sustainability and the various needs and purposes that agriculture has to satisfy. Therefore, a major approach to strategic resources to be mobilized by the household was considered by incorporating a further two assets in addition to the classical assets:

- physical assets: bullocks, vehicles, tractors, bicycles, motorcycles, radios, televisions, drinking wells, etc.;
- human assets: family labor, non-family labor; and
- financial assets: cash credit, cash gifts, and remittances;

These were

- natural assets: farm land, cultivated, abandoned, and fallow; and
- social assets: social support networks and membership of farmers' associations.

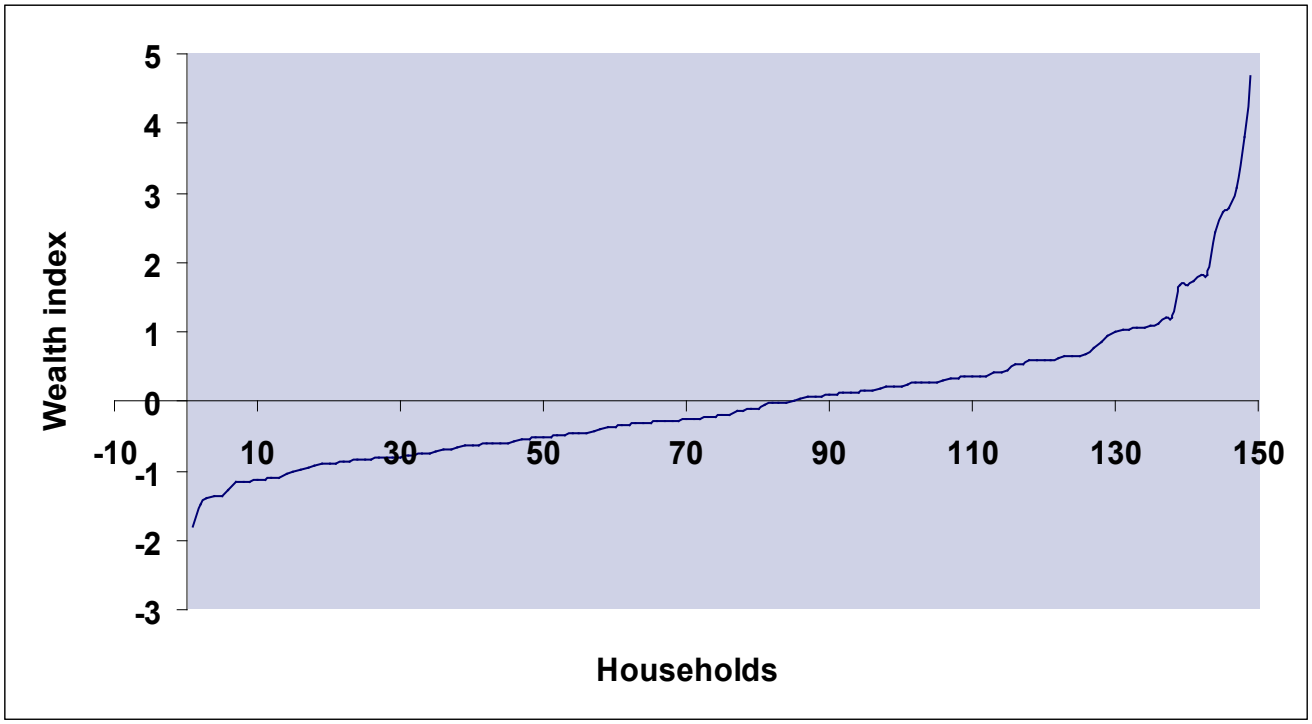

Figure 2. Distribution of households within wealth categories.
Source: Survey data analysis.

Chia (1987), analyzing the rationality of household management practices, revealed the importance of social and cultural assets in addition to economic assets in farmers' choices in terms of farmers' practices. These different assets contribute to production and hence to farmers' wealth status. They also give an indication of the farmers' capability to handle risk (Makan et al. 1994).

Our analysis is based on the five assets above. It is used to extract from our set of variables those orthogonal linear combinations of the variables that capture the common information. Most successful was the Principal Component Analysis (PCA) proposed by Filmer and Pritchett (2001). The results of the analysis are shown in Table 3a. For the total study area, the distribution of wealth index rankings of households indicates that 56.4% of the households are poorly endowed (WI<= 0) (Figs 2 and 3). By districts, the figure for poorly endowed households is 53% for Bougouni and 60% for Koutiala (Table 3a). These classifications are corroborated by those in the study *Observatoire du développement humain durable au Mali* in 2004.

Human capital

In the study area, the average household size is about 22 persons, almost 47.2% of whom are available for farm work on average (Table 3b). Only 48% of the total number of males in the households are available for farm work, while 67% of females are available. Nevertheless, the availability of the household labor force by gender of the household heads indicates an average of 7 months for the female headed households and 6 for the male headed (Table 3c).

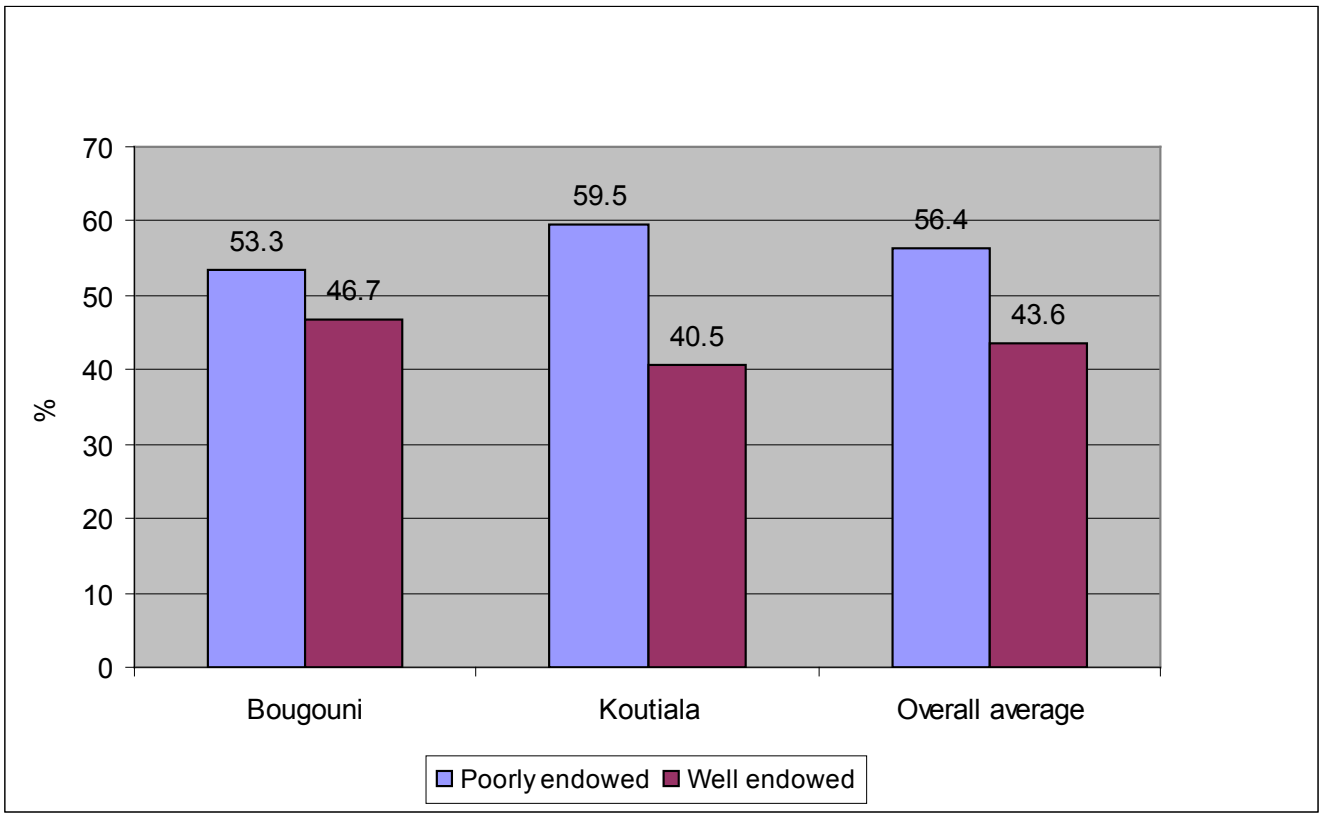

Figure 3. Distribution of wealth index ranking of households by district.
Source: Survey data analysis.

Table 3a. Distribution of wealth index rankings of households.

Districts	Bougouni (N = 75)	Koutiala (N = 74)	Total (N = 149)
Wealth categories	Percentage		
Poorly endowed	53	60	56
Well endowed	47	40	44

Source: Survey data analysis.

Table 3b. Household labor force availability.

Parameters	Persons/household	Persons available for farm work
Mean	21.7	10.39
Min.	4.0	1.0
Max	60.0	28.0
St dev	0.98	0.48
N	N =149	N =149

Source: Survey data analysis.

Table 3c. Household labor force availability by gender of the household head.

Gender	Months available for farm work		
	Minimum	Average	Maximum
Male	2.00	6.32	12.00
Female	7.00	7.00	7.00
Total	2.00	6.32	12.00

Source: Survey data analysis.

Drought tolerant hybrid maize plot, Sotuba, Mali.

Natural capital

In the study area, the average land holding for a household is 18.71 ha, divided into abandoned areas, pasture, tree, fallow, and cultivated lands (Table 4). The average holding of households in Bougouni district is 16.02 ha for the poorly endowed and 29.78 ha for the well endowed. In Koutiala, the poorly endowed own an average holding of 9.10 ha of land while the well endowed own an average of 23.47 ha (Table 4). In Bougouni LGA, 43% of the total land area is cultivated by the rich households and 39% by the poorly endowed farmers, while in Koutiala, the situation is 65% cultivated by the rich and 64% by the poor. This implies that in Koutiala LGA there is more pressure on land (land occupancy is high). Access to farm land by gender (Table 4) in the study area indicates that women have poor access to land in Koutiala LGA.

Figure 4 shows the proportional distribution of land types by wealth groups. Pasture and tree lands represent the smallest proportion, regardless of wealth group. The well endowed group in both locations possesses a higher total proportion of the land and also by land use type. In other words, land ownership is positively related to the wealth status of the household. With increased input prices (fertilizer, seeds, and insecticide), the collapse of cotton markets, drought, and declining soil fertility, some land is being abandoned.

Table 4. Land use by district.

Land category	Bougouni		Koutiala		
	Poorly endowed	Well endowed	Poorly endowed	Well endowed	Total
Abandoned plot	7.53	11.24	6.05	9.58	8.95
Fallow	6.59	9.04	3.27	5.72	6.42
Pasture land	8.17	15.00	0.75	2.00	7.50
Tree land	1.44	3.28	1.00	1.45	2.05
Cultivated land	6.28	12.75	5.82	15.29	9.48
Total land area	16.02	29.78	9.10	23.47	18.71

Source: Survey data analysis.

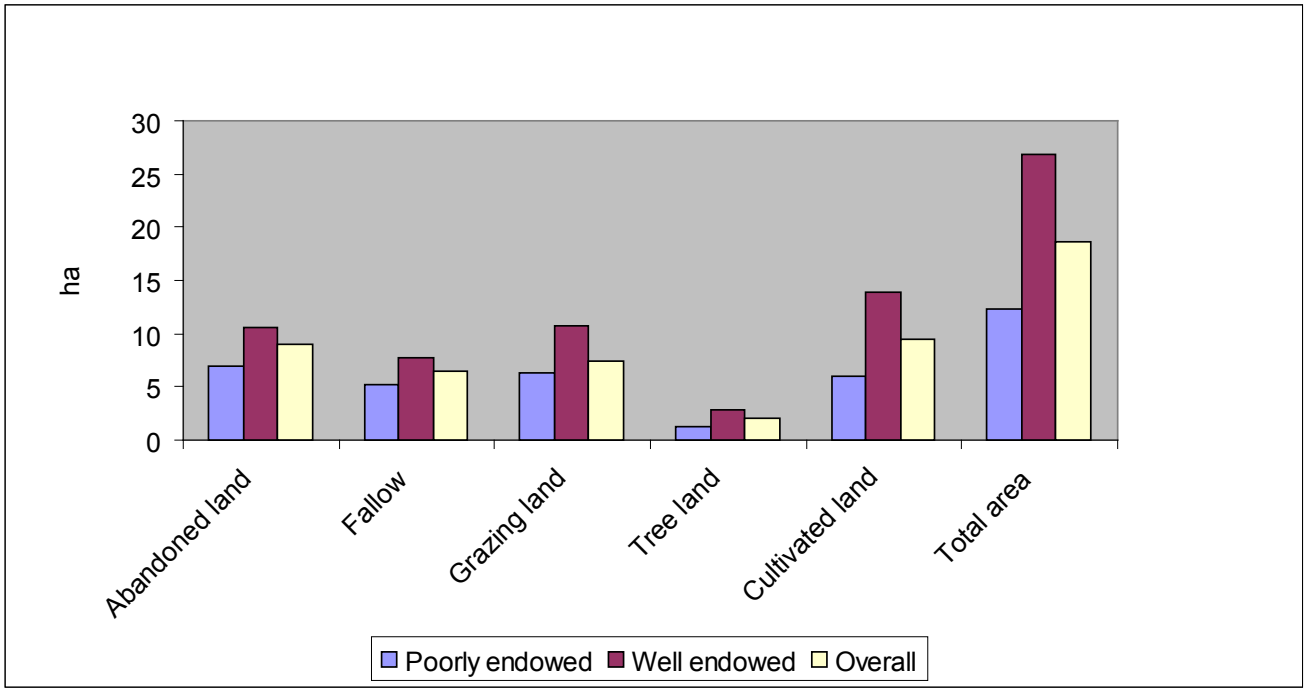

Figure 4. Proportional distribution of land types by wealth groups.
Source: Survey data analysis.

Concerning farm size variation between this season (2007) and last season (2008) (Fig. 5), 27.8% of respondents found their area remaining the same in Bougouni and 22.2% in Koutiala. About 36.1% in both LGAs declared they had increased their farm sizes. Those with reduced farm sizes represent 36.1% in Bougouni and 41.7% in Koutiala. According to focus groups, households are having difficulty in coping with increased input prices (fertilizer, seeds, and insecticide), the collapse of cotton markets, drought, and declining soil fertility.

Land available to households (Table 4) is divided into abandoned plots (9 ha), fallow (6.42 ha), pasture land (7.50 ha), tree land (2.0 ha), and cultivated land (9.5 ha). An average household can have access to a total of 18.71 ha.

Determinants of cultivated farm size range in decreasing order as follows: food needs, labor availability, expected cereal prices, cash availability to purchase inputs, availability of farm equipment, cash availability to hire labor, current cereal prices, and seed availability (Table 5). Therefore, before deciding on the amount of land to plant, the average farmer looks at the factors above to guide his decision.

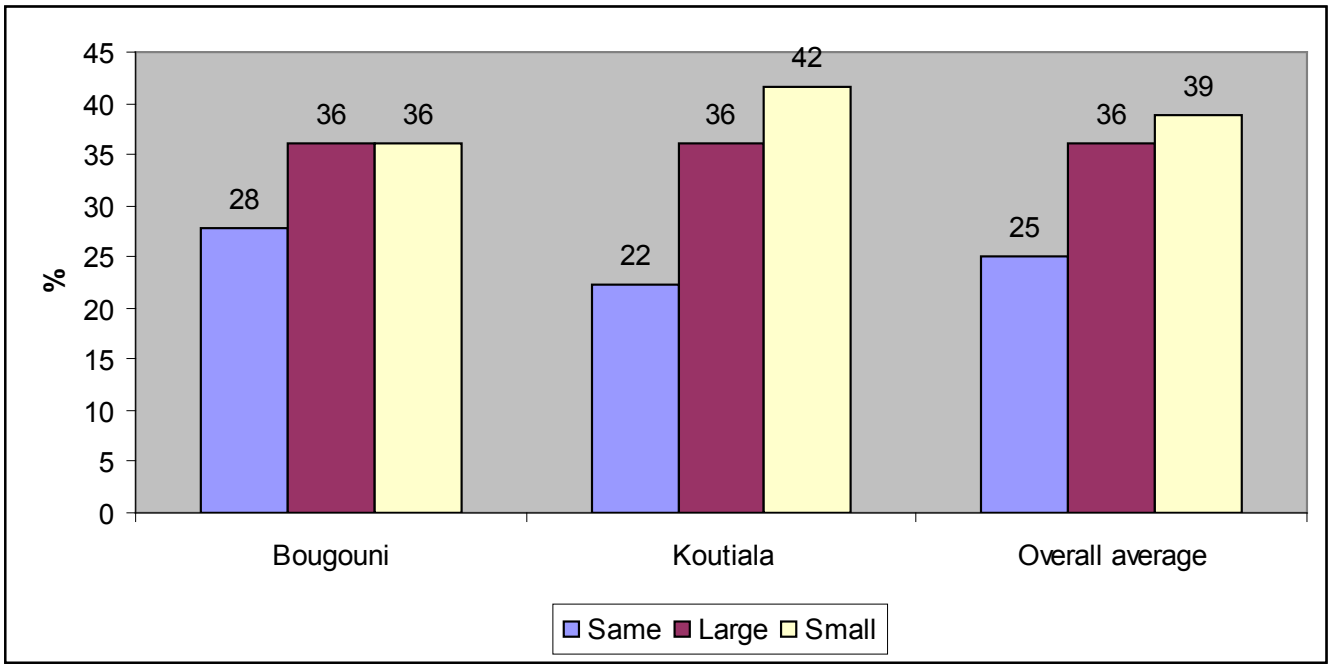

Figure 5. Dynamics of farm land area (ha).
Source: Survey data analysis.

Farmers' field day in Saaba, Mopti.

Table 5. Factors that influence farmers' choice of size of area to crop.

Determinants	Percentage of respondents N = 149
Food needs	29.1
Family labor availability	26.1
Good cereal price	16.0
Cash availability to buy inputs	14.0
Farm materials availability	6.3
Cash availability to pay hired labor	4.3
Current cereal prices	3.3
Seed availability	1.3

Source: Survey data analysis.

Table 6. Types of dwelling used by households.

Districts	Types of dwelling	Percentage
Bougouni	Mud brick house ,corrugated iron roof	44,3
	Mud brick house ,thatched roof	43,3
	Mud hut, thatched roof	10,4
	Cement block house, corrugated iron roof	1,5
	Mud hut, corrugated iron roof	1,5
Koutiala	Mud brick house, corrugated iron roof	33,3
	Mud hut, thatched roof	2,2
	Cement block house ,corrugated iron roof	32,3
	Mud brick house, thatched roof	84,6
	Straw hut, thatched roof	15,4

Source: Survey data analysis.

Physical capital

The different types of dwelling in the study area are listed in Table 6. A surprising result is that in Koutiala, the 84.6% of the well endowed group have brick houses with grass thatched roofs. In this group there is no house with an iron roof. Among the poorly endowed group in this LGA, 65.6% possess iron roofed buildings. In Bougouni LGA, 48.6% of the poorly endowed group have brick houses with iron roofs while 46.3% of the well endowed ones have houses with iron roofs. Also, 1.5% in this well endowed group in Bougouni LGA have mud huts with iron roofs, an uncommon combination.

Farmer inspecting a drought tolerant maize variety (Brico), Mafeya, Mali.

In addition to their dwellings, the households in the survey area have access to other assets, such as bicycles, motorcycles, radios, tractors, wheelbarrows, animal-drawn plows, harrows, and scotch carts, private wells, tractor-drawn plows and harrows, motor vehicles, solar energy equipment, water pumps, diesel pumps, water tanks, cultivators, mobile phones, fixed phones, and television sets (Table 7a). It must be noted, however, that access to some assets, such as motor vehicles, tractors, diesel pumps, water tanks, solar energy equipment, and generators, is limited to the well endowed households (Table 7b).

Table 7a. Proportional distribution of assets by district.

Assets	Bougouni	Koutiala	Overall Mean
Motor vehicle	1.0	1.0	1.0
Motorcycle	1.4	1.7	1.5
Bicycle	2.9	2.9	2.9
Tractor	1.0	1.0	1.0
Animal-drawn plow	2.1	2.4	2.2
Animal-drawn harrow	1.4	1.5	1.5
Draft animal	4.4	5.3	4.9
Wheelbarrow	1.2	1.3	1.3
Television set	1.1	1.1	1.1
Radio	2.5	2.5	2.5
Private well	1.2	1.1	1.2
Water pump	0.0	1.0	1.0
Diesel pump	1.0	0.0	1.0
Water tank	0.0	1.0	1.0
Generator	0.0	1.0	1.0
Mobile phone	1.7	1.8	1.8
Fixed phone	1.0	1.0	1.0

Source: Survey data analysis.

Table 7b. Proportional distribution of assets by wealth group.

District	Bougouni		Koutiala	
Categories	Poorly endowed	Well endowed	Poorly endowed	Well endowed
Assets	Average/household			
Motor vehicle	0.0	1.0	0.0	1.0
Motorcycle	1.2	1.5	1.2	2.2
Bicycle	2.3	3.6	2.1	4.1
Tractor	0.0	1.0	0.0	1.0
Animal–drawn plow	1.6	2.7	1.8	3.2
Animal-drawn harrow	1.1	1.7	1.0	1.9
Draft animal	3.3	5.6	3.4	7.6
Wheelbarrow	1.4	1.2	1.1	1.5
Television	1.0	1.2	1.2	1.1
Radio	1.9	3.1	1.6	3.7
Private well	1.0	1.5	1.0	1.3
Water pump	0.0	0.0	1.0	1.0
Diesel pump	0.0	1.0	0.0	0.0
Water tank	0.0	0.0	0.0	1.0
Generator	0.0	0.0	1.0	0.0
Mobile phone	1.6	1.8	1.4	2.1
Fixed phone	1,0	1,0	1,0	0,0
Solar energy	0,0	0,0	0,0	1,0

Source: Survey data analysis.

Table 8a. Household access to credit by district.

Access to credit	Bougouni (%)	Koutiala (%)	Average (%)
Yes	[1]88.0	74.3	81.2
No	12.0	25.7	18.8
Total	100	100	100

Source: Survey data analysis.

Table 8b. Amounts of credit by type.

Credit types	Bougouni	Koutiala	Average
	Average amount per household (FCFA		
Cash credit for production	141,853	709,286	398,113
Cash credit for consumption	110,875	110,769	110,810

Source: Survey data analysis.

Financial capital

For resource-poor households, access to credit is important to launch timely farming activities and to cope with food shortages and other problems such as health care, taxes, and wedding expenses. The results indicate good access to credit in the study area which is made possible by the presence of CMDT (Table 8a). In total, 81.2% of households have access to credit. Only 18.8% do not have access to it. The proportion by LGA is 88% for Bougouni and 74.3% for Koutiala. The average amount of production credit received by the households in the study districts ranged from 141.853 FCFA in Bougouni to 709.286 FCFA in Koutiala (Table 8b). The average for consumption is 110.875 FCFA in Bougouni and 110.769 FCFA in Koutiala and it is interesting to note that a higher proportion of credit is allocated to crop production.

Institutional and social capital

Households' access to institutional support in the study area is diverse (Table 9a). On average, more than half of the households (58.1%) have access to financial institutions where they can obtain production credit support and 66.7% can obtain consumption credit support. The proportion for credit support to production activities is 41.2% in Bougouni and 78.6% in Koutiala. Other sources of credit include relatives, NGOs, neighbors, money lenders, and Government programs. Besides financial institutions, the next most important support for production credit comes from relatives (29.4% in Bougouni and 7.1% in Koutiala) and NGOs with 17.6% in Bougouni. Support in favor of consumption (Table 9b), other than from financial institutions, comes from neighbors and parents in equal proportions (37.5%).

As shown in Table 10, attendance at field demonstrations in the study area is generally very low. Households who participate in field demonstrations constitute about 16.66% in Bougouni and 15.67% in Koutiala. Field demonstrations are organized by the cotton development service (33%), seed companies (23%), extension services (13%), research institutions (12%), other development services (10%), and NGOs (9%). There is a need for an increased number of field demonstrations for households to acquire information, share experiences with others, and to be made aware of the existence of improved varieties.

Table 9a. Sources of institutional support to households.

Sources of production credit	Bougouni (N = 17)	Koutiala (N = 14)	Total (N = 31)
		Percentage	
Financial institutions	41.2	78.6	58.1
NGOs	17.6	0	9.7
Neighbors	5.9	7.1	6.5
Money lenders	5.9	0	3.2
Government programs	0	7.1	3.2
Total	100	100	100

Source: Survey data analysis.

Table 9b. Households' sources of consumption credit.

Sources of consumption credit	Koutiala (N = 13)	Bougouni (N = 8)	Total (N = 21)
		Percentage	
Financial institutions	92.3	25.0	66.7
Neighbors	0	37.5	14.3
Relatives	0	37.5	14.3
Money lenders	7.7	0	4.8
Total	100	100	100

Source: Survey data analysis.

Table 10. Households' participation in field demonstrations by type of organizers.

Participation in field demonstrations organized by:	Bougouni (N = 74)	Koutiala (N = 35)	Total (N = 109)
		Percentage	
NGOs	11	6	9
Other development services	12	6	10
Research institutions	18	0	12
Extension services	8	22	13
Seed companies	12	46	23
Cotton development service	39	20	33
Overall	100	100	100

Source: Survey data analysis.

6. Household livelihood strategies

In general, livelihood in rural areas is based on producing crops, rearing livestock, and marketing the agricultural products derived from these activities. Producing crops or raising livestock requires the underlying condition of access to land, either by possessing it or getting it from others. According to key informants and FGD participants, the total area of arable land in their communities ranged between 2000 and 95,000 ha. The average size of cultivable land in the community is 6000 ha in Koutiala LGA and 48,333 ha in Bougouni LGA. Almost 100% of households own some land. The area of land owned by a typical household ranges between 7 and 18 ha in the study area. Households rented land from owners in all of the communities except Flaboula in Bougouni district and NGountjina in Koutiala district. In these places, land may become a limiting factor because of the observed decline in soil fertility.

Although access to land is important for crop production and rearing livestock, there are other conditions that ensure effectiveness in field operations. This section will include (i) crop production, comprising the distribution of farm lands among crops, input use by households (seeds and non-seed input), the adoption of improved maize and crop marketing decisions; (ii) livestock production and marketing; (iii) income and expenditure profiles of households including income from agriculture and off-farm activities (sources of household income) and expenditure profiles; and (iv) the impact of shocks on households' livelihood outcomes.

Crop production

Distribution of farm land among crops

Figure 6 gives the distribution of the farm land area among crops in the selected LGAs. The major crops grown are maize (26%), sorghum (23%), millet (20%), cotton (13%), groundnut (8%), rice (5%), and cowpea (3%). Most of these crops are produced either for family consumption, or for sale or for both purposes. The distribution of the farm family's land area among crops is based on family needs.

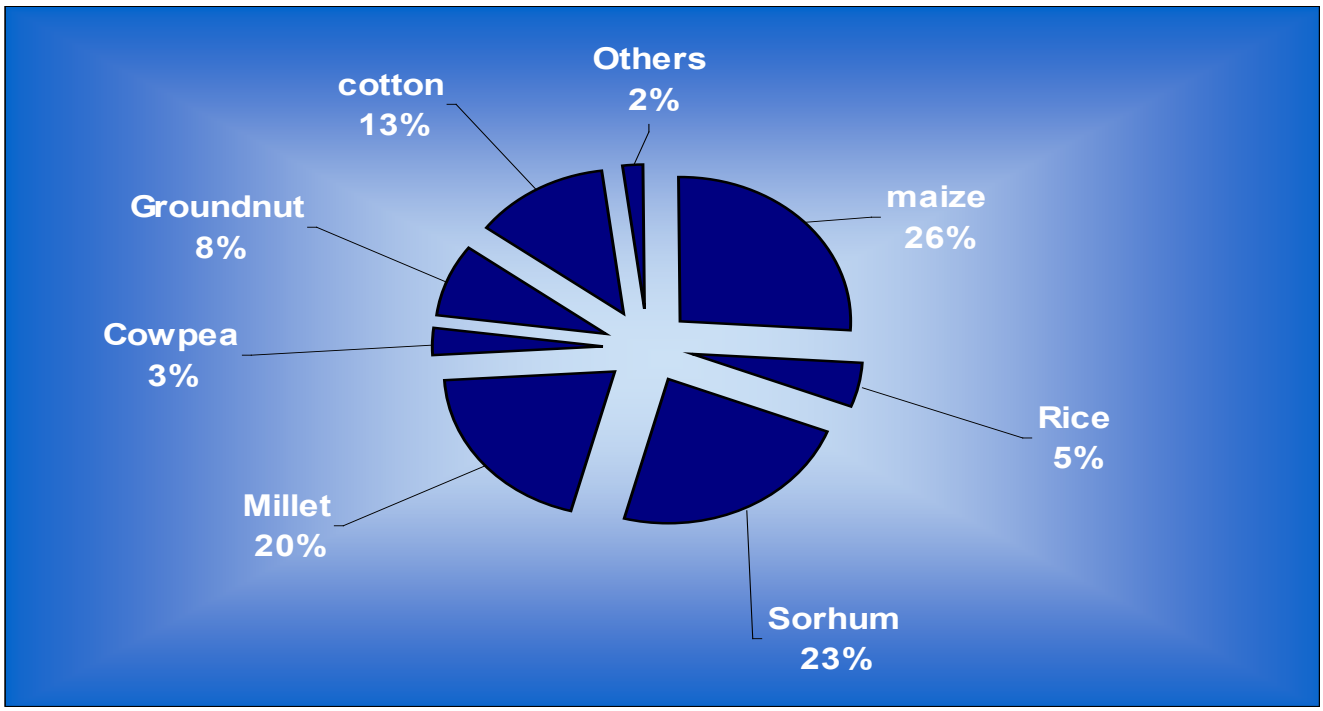

Figure 6. Crop land area allocation (%).
Source: Survey data analysis.

Input use by farm households

Non-seed inputs used by households in the selected districts include N.P.K (49.6% of households in Bougouni and 50.4% in Koutiala), urea (50.4% in Bougouni and 49.6% in Koutiala), organic manure (74.63% in Bougouni and 57.9% in Koutiala), herbicides (58.8% in Bougouni and 41.2% in Koutiala), and insecticides (52.3% in Bougouni and 47.7% in Koutiala) (Table 11). Figure 7 depicts the different sources of crop inputs. In the sample area, around 79% of crop inputs are obtained from CMDT. The other sources are traders, AV, Sasakawa global 2000, cooperatives, and other producers (Fig. 8).

Table 11. Non-seed input use by households in selected districts.

Non-seed inputs	Bougouni		Koutiala		Total	
	Mean (kg)	%	Mean (kg)	%	Mean (kg)	%
NPK	363.95	49.6	341.27	50.4	352.52	100.0
Urea	250.98	50.4	191.25	49.6	221.36	100.0
Herbicides	9.60	58.8	7.51	41.2	8.74	100.0
Insecticides	6.22	52.3	3.45	47.7	4.90	100.0
Organic manure	74.63	42.1	99.70	57.9	89.14	100.0

Source: Survey data analysis.

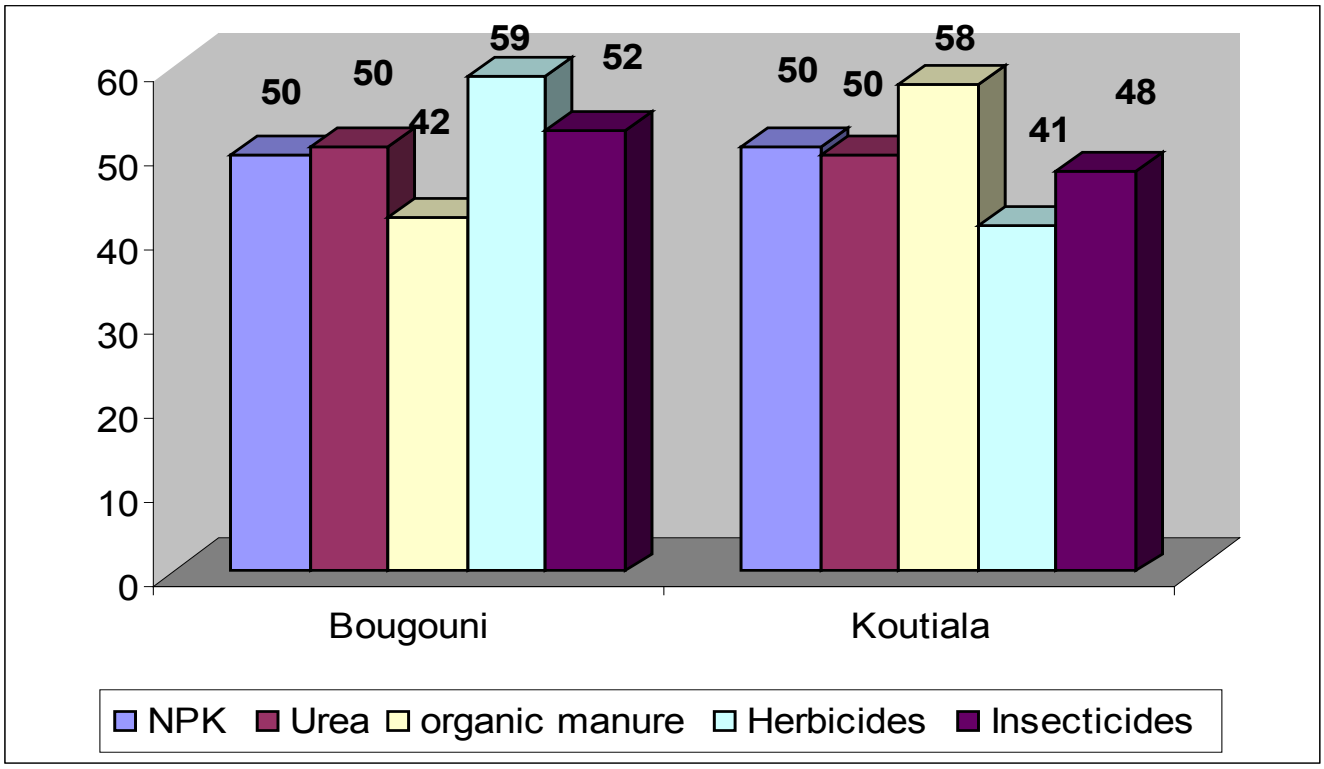

Figure 7. Non-seed inputs used (percentage of households by district and by input type).
Source: Survey data analysis.

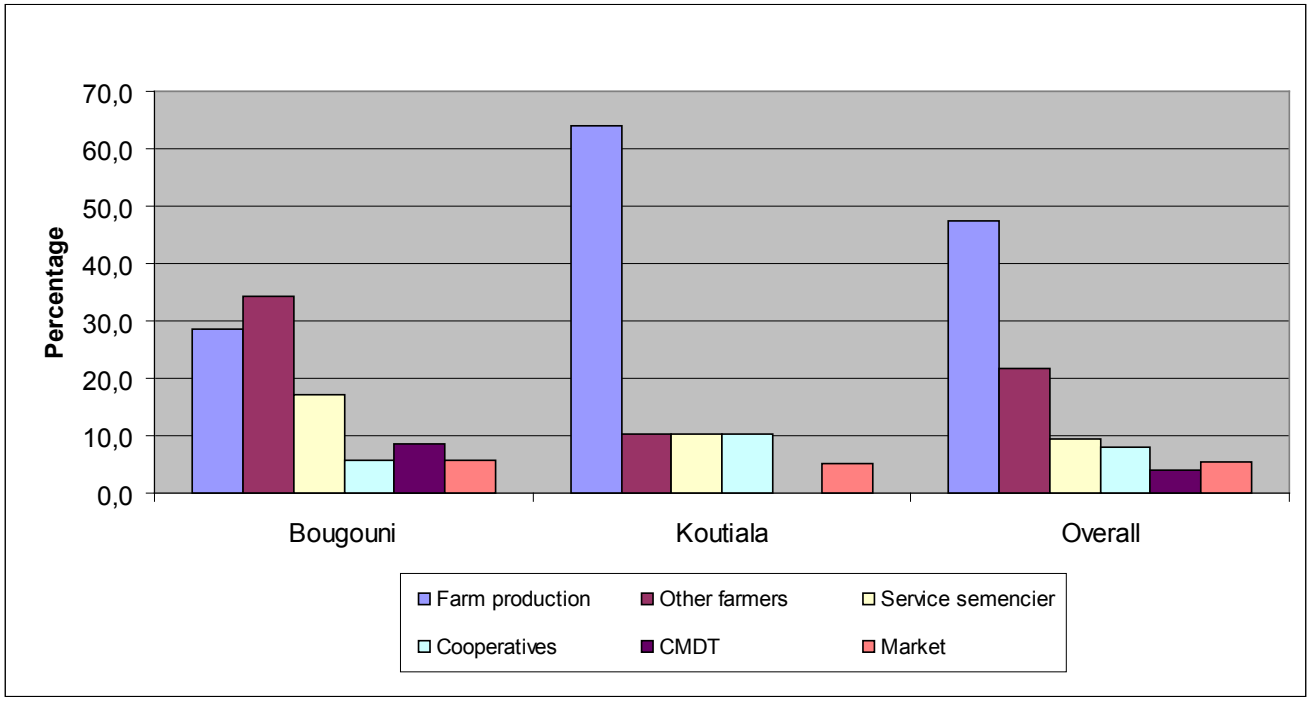

Figure 8. Sources of crop seeds (percentage of households by source of crop seeds).
Source: Survey data analysis.

Table 12. Improved maize variety adoption by household characteristics (% of HH)

HH characteristics		Adopter (N= 77)	Non adopter (N=72)
		52%	48%
District	Bougouni	61	39
	Koutiala	40	60
Association	Member	83	89
	Non member	17	11
Education	Illiterate	41	41
	Literate	59	59

Adoption of improved Maize varieties

The adoption of improved maize cultivars is represented by the proportion of farm land area allocated to these varieties. The adoption status is shown in Table 12 according to selected household characteristics.

In order to examine determinants of adoption of improved maize varieties in Mali, a Heckman selection regression model was estimated using STATA. The dependent variable was the adoption status and then intensity of adoption was examined using the proportion of land area allocated to improved maize varieties in each household.

Results of Heckman selection model showed that the major determinants of the adoption of the improved varieties were district (Bougouni) and yield potential of the improved varieties. Both variables had positive and significant influence ($p \leq 0.1$) on the adoption of improved varieties in the study districts. Compared to the Koutiala district, Bougouni has a significant positive effect on adoption of improved varieties (Table 14a). This is probably due to the increasing importance of maize in this traditional producing cotton area. Farmers' perception of the yield potential of the improved varieties is also found to have a significant positive effect on determining adoption of improved varieties by farmers (Table 13a). This is also expected as farmers' perception of yield potential is a good signal of profitability of growing a crop.

Table 13a. Factors influencing the adoption of improved maize variety.

Variables	Coefficients	Std. error	Z	P>|z|
District (Bougouni)	.205***	.077	2.69	0.007
Age	.003	.003	0.99	0.324
Education	.047	.086	0.54	0.588
Extension contact	-.171	.260	-0.66	0.511
Credit access	.0171	.092	0.19	0.852
Yield potential	.274***	.086	3.18	0.001
Wealth category	.062	.090	0.69	0.489
Farm size	.007	.007	1.03	0.302
Family labour	.001	.001	0.75	0.455
Constant	.242	.371	0.66	0.512
Sigma	.413	.028		
Log-likelihood	-103.40			
X^2	0.18			

Note; ***, ** and * denote statistical significance at 0.01, 0.05 and 0.1, respectively.

Table 13b. Determinants of households' intensity of adoption of improved maize varieties.

Variables	Coefficients	Std. error	Z	P>|z|
District (Bougouni)	-.703*	.422	-1.67	0.095
Age	-.004	.014	-0.30	0.763
Education	-.033	.427	-0.08	0.938
Extension contact	1.202	.734	1.64	0.102
Credit access	-.323	.571	-0.57	0.572
Yield potential	.553	.406	1.36	0.173
Wealth category	.004	.551	0.01	0.995
Farm size	.076	.060	1.26	0.206
Family labour	-.001	.001	-1.31	0.190
Constant	.474	1.506	0.31	0.753

Note; ***, ** and * denote statistical significance at 0.01, 0.05 and 0.1, respectively.

Other independent variables that were examined such as age, the level of educational attainment of household heads, extension contact, credit access, wealth category, and family labour were not found to have significant influence on the adoption of improved varieties in this case. This is probably due to the lack of variability among households on some of these variables. For example, being in the CMDT zone, all farmers producing cotton receive input as credit therefore only very few respondents did not report any credit. Another possible explanation of the lack of significance of some variable such as contact with extension is again linked to the fact that we are in CMDT zone and most all farmers have contact with extension through the program.

Even though being from Bougouni district had a positive influence on household adoption of improved maize varieties, its influence was negative on the intensity of the adoption of improved maize (Table 13b). Compared to the farmers in Koutiala, farmers in Bougouni allocated a smaller percentage of their land to improved maize varieties once they become adopters.

Crop marketing decisions

In both districts, farmers mostly harvested maize (local, OPV, and hybrid), sorghum, millet (Tables 14a and 14b), and other, minor crops (Tables 14c and 14d). Cotton is an important cash crop in the area and 100% is sold after harvest. For Bougouni LGA, the results show that, regardless of crop category, the greater proportion goes to family consumption, with millet at 72%, sorghum 59%, local maize 56%, OPV maize 45%, and hybrid maize 100%. The next most important use is for sale. The same trend is observed in Koutiala LGA with the consumption of local maize (73%), millet (53%), sorghum (49%), and OPV maize (41%), followed by sale. In

Table 14a. Disposal of maize crop harvested (Bougouni).

	Local maize		OPV maize		Hybrid maize		Sorghum		Millet	
	(kg)	%	(kg)	%	(kg)	%	(kg)	%	(kg)	%
Quantity consumed	42,805	55.6	142,605	45.1	1,600	100.0	36,628	59.4	28,308	71.9
Quantity sold	22,600	29.4	108,025	34.2	0	0.0	9,260	15.0	4,200	10.7
Quantity given out as gifts	5,960	7.7	25,055	7.9	0	0.0	5,890	9.5	3,580	9.1
Quantity reserved as seeds for next season	555	0.7	3085	1.0	0	0.0	1,097	1.8	1,062	2.7
Quantity stored	4,990	6.5	35,225	11.1	0	0.0	8,200	13.3	1,900	4.8
Quantity lost due to handling	90	0.1	2120	0.7	0	0.0	605	1.0	340	0.9
Quantity harvested	**77,000**	**100**	**316,115**	**100**	**1600**	**100**	**61,680**	**100**	**39,390**	**100**

Source: Survey data analysis.

Table 14b. Disposal of maize crop harvested (Koutiala).

	Local maize		OPV maize		Hybrid maize		Sorghum		Millet	
	(kg)	%	(kg)	%	(kg)	%	(kg)	%	(kg)	%
Quantity consumed	136,936	72.7	128,260	40.6	0	0.0	106,987	49.4	107,776	52.8
Quantity sold	12,380	6.6	69,862.5	22.1	0	0.0	31,850	14.7	27,425	13.4
Quantity given out as gifts	7,220	3.8	20,820	6.6	0	0.0	12,700	5.9	17,970	8.8
Quantity reserved as seeds for next season	1,600	0.8	10,752	3.4	0	0.0	3,083	1.4	3204	1.6
Quantity stored	28,524	15.2	2,845.5	0.9	0	0.0	61,975	28.6	47,555	23.3
Quantity lost due to handling	1,600	0.8	23,980	7.6	0	0.0	0	0.0	0	0.0
Quantity harvested	**188,260**	**100**	**256,520**	**0**	**0**	**0**	**216,595**	**100**	**203,930**	**100**

Source: Survey data analysis.

Table 14c. Disposal of other crops harvested (Bougouni).

Crop use	Groundnut		Cowpea		Yam		Cassava		Rice		Fonio		Sesame	
	(kg)	%	(kg)	%	(kg)	%	(kg)	%	(kg)	%	(kg)	%	(kg)	%
Quantity consumed	8,246	16.7	3,074	69.8	2,090	68.5	0	0.0	2,811	35.9	1,136	45.4	15	3.2
Quantity sold	34,910	70.8	820	18.6	360	11.8	700	70.0	4,000	51.0	850	34.0	345	73.1
Quantity given out as gifts	1,057	2.1	250	5.7	600	19.7	300	30.0	250	3.2	200	8.0	0	0.0
Quantity reserved as seeds for next season	4,509	9.1	147.5	3.3	0	0.0	0	0.0	329	4.2	114	4.6	12	2.5
Quantity stored	575	1.2	115	2.6	0	0.0	0	0.0	450	5.7	200	8.0	0	0.0
Quantity lost due to handling	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	100	21.2
Quantity harvested	49,297	100	4,406.5	100	3,050	100	1,000	100	7,840	100	2,500	100	472	100

Source: Survey data analysis.

Table 14d. Disposal of other crops harvested (Koutiala).

	Groundnut		Cowpea		Rice		Sesame	
	(kg)	%	(kg)	%	(kg)	%	(kg)	%
Quantity consumed	3162	24.9	1788	57.5	3885	41,7	41	82.0
Quantity sold	7578	59.7	866	27.8	2000	21,5	0	0.0
Quantity given out as gifts	532	4.2	200	6.4	870	9.3	0	0.0
Quantity reserved as seeds for next season	1327	10.5	127	4.1	445	4.8	9	18.0
Quantity stored	90	0.7	130	4.2	2120	22.7	0	0.0
Quantity lost due to handling	0	0.0	0	0.0	0	0.0	0	0.0
Quantity harvested	12689	100.0	3111	100.0	9320	100.0	50	100.0

Source: Survey data analysis.

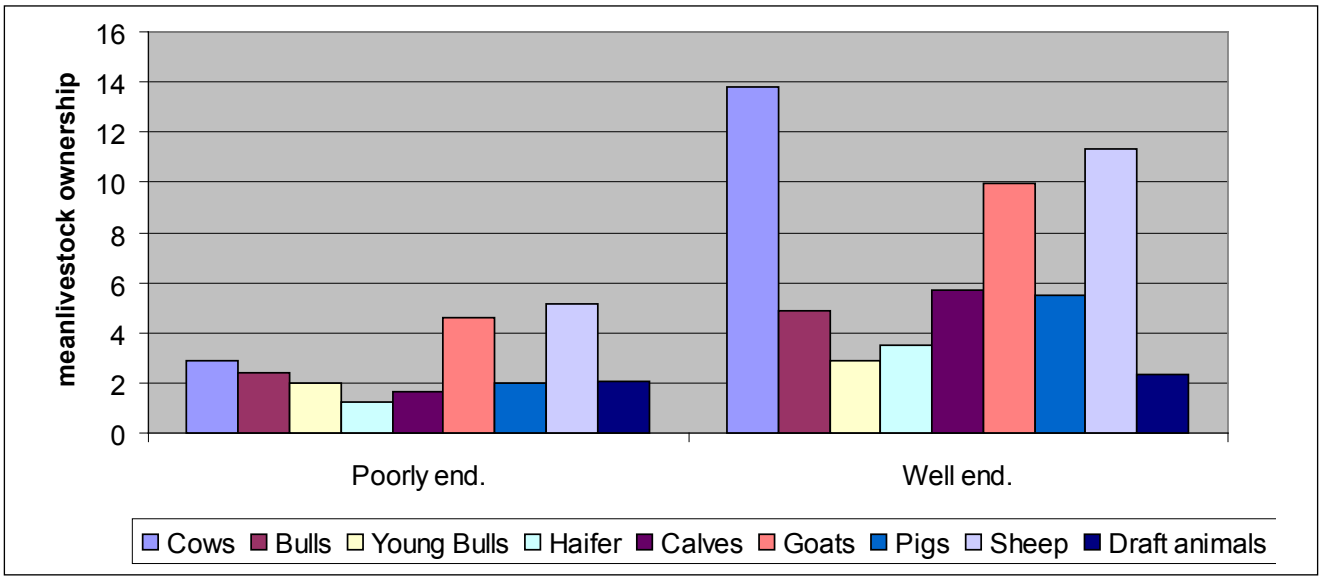

Figure 9. Distribution of mean livestock ownership by wealth group.
Source: Survey data analysis.

Table 15: Livestock marketing.

Wealth rank	Bougouni		Koutiala		Total
	Poorly endowed	Well endowed	Poorly endowed	Well endowed	
Cows, bulls sold (mean)	2	1	1	3	2
Goats sold (mean)	1.86	3.33	2.50	4.25	2.86
Sheep sold (mean)	1.00	3.00	2.67	4.25	3.00
Draft animals sold (mean)	10.00	1.00	1.00	1.00	2.80

Source: Survey data analysis

both districts, the highest quantity sold is for OPV maize with 34.2% in Bougouni and 22% in Koutiala. Some quantities are also stored and some given out as gifts. It is important to note the total absence of hybrid maize in Koutiala.

Livestock production and marketing

Livestock production is incorporated into livestock ownership. Like crop production, this activity also has land requirements. Figure 9 shows livestock ownership by wealth categories, and Table 15 depicts the average livestock sales by households in the study area.

Income and expenditure profiles of households

Households draw their income from farming (crop and livestock production and marketing) and off-farm activities. These range from grain, seeds, and fruit sales to animal and fish sales, petty trading, and other miscellaneous sources. The expenditure patterns of households range from spending on basic food, tobacco, and cola nuts, school fees, health care, clothing, and fuelwood to making social contributions and sending money to others.

Income from agriculture and off-farm activities

Income collected from agriculture and off-farm activities includes money from grain/seed sales, fruit sales, animal/fish sales, trade, salaries, self-employment, foreign income, and other sources (Table 16a).

Table 16a. Sources of households' overall income.

	Bougouni				Koutiala				Overall	
Wealth rank	Poorly endowed		Well endowed		Poorly endowed		Well endowed			
Sources of income (FCFA) / statistics	Total	%	Total	%	Total	%	Total	%	Total	%
Grain/seed sales	4,820,350	25.0	23,389,675	45.6	4,867,450	30.9	11,031,050	43.2	44,108,525	39.5
Fruit sales	650,000	3.4	3,484,000	6.8	1,140,000	7.2	1,552,500	6.1	6,826,500	6.1
Animal/fish sales	2,647,750	13.7	4,904,750	9.6	2,219,000	14.1	4,185,000	16.4	13,956,500	12.5
Trade	2,819,500	14.6	6,009,000	11.7	2,163,400	13.7	4,224,000	16.5	15,215,900	13.6
Salaries	1,355,000	7.0	1,505,000	2.9	1,545,000	9.8	1,019,000	4.0	5,424,000	4.9
Self-employment	485,000	2.5	3,204,000	6.3	3,036,500	19.3	2,341,000	9.2	9,066,500	8.1
Foreign income	1,270,000	6.6	2,450,000	4.8	410,000	2.6	1,045,000	4.1	5,175,000	4.6
Other sources of income	5,212,195	27.1	6,294,320	12.3	373,000	2.4	135,000	0.5	12,014,515	10.7
Total	**19,259,795**	**100**	**51,240,745**	**100**	**15,754,350**	**100**	**25,532,550**	**100**	**111,787,440**	**100**

Source: Survey data analysis.

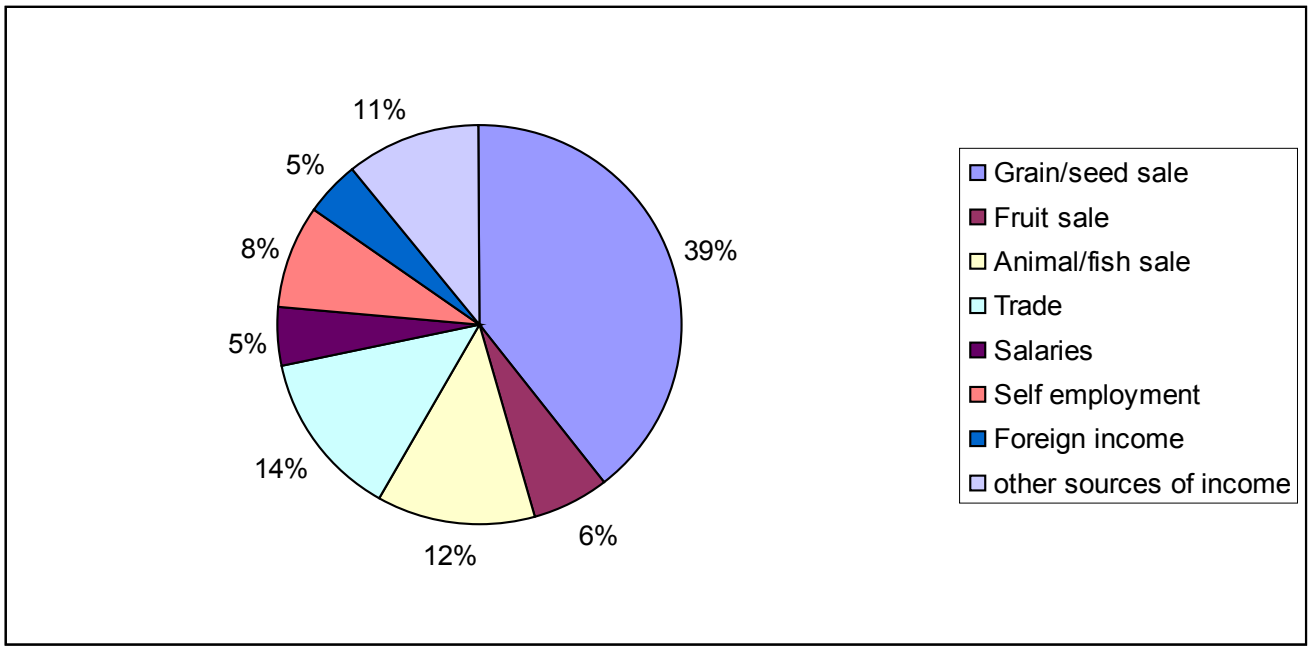

Figure 10a. Sources of households' overall income.
Source: Survey data analysis.

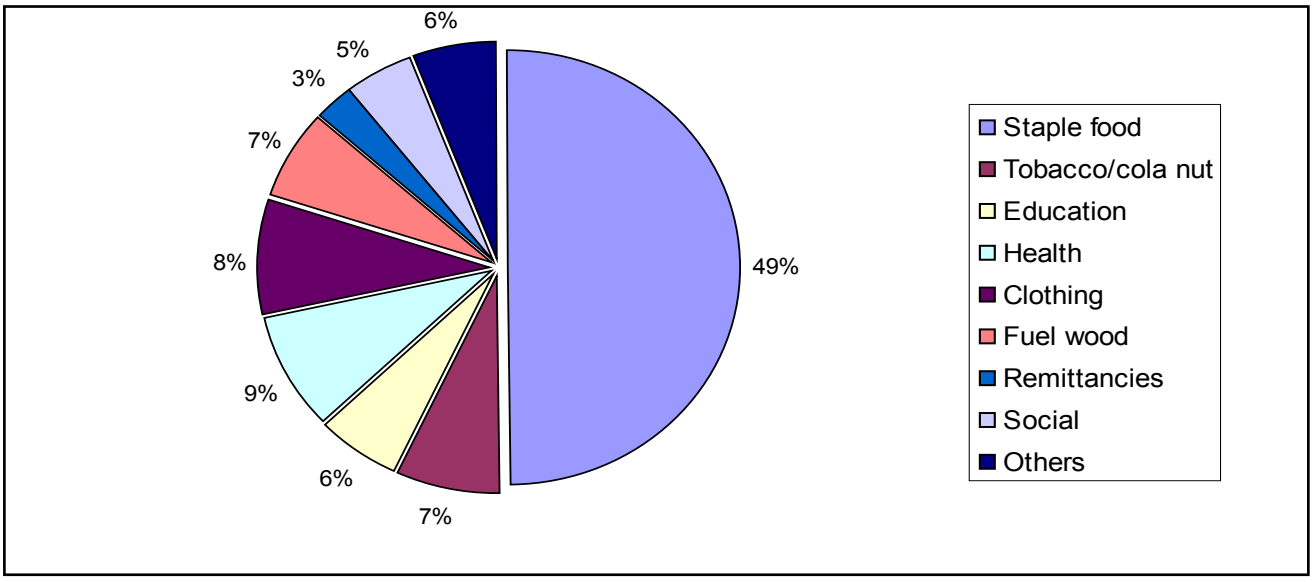

Figure 10b: Expenditure patterns of households.
Source: Survey data analysis.

It appears that grain and seed sales contribute up to 40% of the total household income in the area followed by petty trade (14%), animal and fish sales (13%), and self-employment (8%) (Fig.10a). In Bougouni district, grain and seed sales account for 25% of the income of the poorly endowed households and for 46% of the income of the well endowed households; while in Koutiala, it rises to 31% for the poorly endowed and is 43% for the well endowed. Almost all households are engaged in off-farm activities: 99% of resource-poor farmers and 97% of well endowed farmers.

Drying maize under the sun in Tamala, Mali.

Expenditure profiles

In general, at the household level, expenditures cover all the necessities of life (Fig. 10b). This study area is no exception to the rule. The expenses encompass staple food, tobacco and cola nuts, educational fees, medical expenses, clothing, fuelwood, paraffin (kerosene), remittances to relatives, social contributions (donations, gifts, ceremonies), and miscellaneous spending (Table 16b). The results show the predominance of staple foods in household expenditure in the study area (50%). Likewise, in each LGA and across wealth categories, staple food expenses account for 62% for the rich households and for 47% for the resource-poor households in Koutiala. In Bougouni, the figures are 30% for the rich households and 34% for the poor. Medical and clothing expenses come next. Medical expenses account for 16% for the poorly endowed and 15% for well endowed in Bougouni, while clothing comes in at 13% for the poor and 10% for the rich.

Impact of shocks on household livelihood outcomes

Farmers in the region commonly express the opinion that “life is not easy” and “life is a battle.” Farming life is made of difficulties, and making a living means finding solutions to these difficulties. In the study area, households are facing many shocks (Table 17). These include flood, large increases in input prices, drought, the death or loss of livestock, the illness or handicap of the household head or spouse, drastic decreases in crop prices, the death of household head or spouse, landslide, frost or hailstorm damage, plant pests and diseases, livestock diseases, and damaging weeds.

Table 16b. Expenditure patterns of households.

	Bougouni				Koutiala				Total	
	Poorly endowed		Well endowed		Poorly endowed		Well endowed			
Expenditures (FCFA)	Total	%	Total	%	Total	%	Total	%	Total	%
Staple foods	9,261,620	33.6	11,536,050	29.7	16,916,275	47.3	64,297,900	62.3	102,011,845	49.7
Tobacco and cola nuts	1,470,750	5.3	2,253,150	5.8	4,794,200	13.4	6,356,500	6.2	14,874,600	7.2
Educational fees	2,180,050	7.9	3,677,000	9.5	1,790,950	5.0	4,294,000	4.2	11,942,000	5.8
Medical expenses	4,315,500	15.7	5,667,500	14.6	2,384,000	6.7	5,652,000	5.5	18,019,000	8.8
Clothing	3,513,000	12.8	4,025,000	10.4	3,557,000	9.9	6,122,000	5.9	17,217,000	8.4
Fuel (wood, paraffin/kerosene)	1,741,250	6.3	3,471,950	8.9	2,336,000	6.5	6,486,000	6.3	14,035,200	6.8
Remittances to relatives	1,555,000	5.6	1,340,000	3.5	575,000	1.6	2,375,000	2.3	5,845,000	2.8
Social contributions (donations, gifts, ceremonies)	1,415,500	5.1	2,922,000	7.5	1,685,500	4.7	3,517,000	3.4	9,540,000	4.6
Other spending	2,087,950	7.6	3,917,500	10.1	1,710,000	4.8	4,145,000	4.0	11,860,450	5.8
Total expenditure	27,540,620	100	38,810,150	100	35,748,925	100	103,245,400	100	205,345,095	100

To cope with these shocks, the households in the study area have sought several livelihood outcomes (Table 18), including increasing agricultural production (78% in Koutiala and 45% in Bougouni), improving the household's health status, increasing food security, reducing agricultural production risk, increasing access to land, improving revenue and reducing income risk, reducing trade risk, improving the formal educational level of the household's members, and creating employment opportunities.

Table 17. Perceived shocks to household livelihoods.

Perceived shocks	Bougouni (N = 73)	Koutiala (N = 73)	Total (N = 146)
		Percentage	
Too much rain or flooding	26.0	26.0	26.0
Large increases in input prices	23.3	16.4	19.9
Drought	6.8	28.8	17.8
Death or loss of livestock	8.2	8.2	8.2
Illness or handicap of household head or spouse	15.1	1.4	8.2
Drastic decrease in crop prices	2.7	8.2	5.5
Death of household head or spouse	9.6	0.0	4.8
Destruction of crops by animals	2.7	2.7	2.7
Landslide	0.0	1.4	0.7
Frost or hailstorm damage	0.0	1.4	0.7
Plant pests and diseases	0.0	1.4	0.7
Livestock diseases	0.0	1.4	0.7
Dangerous weeds	1.4	0.0	0.7
Large decreases in input prices	1.4	0.0	0.7
Theft of property (other assets)	1.4	0.0	0.7
Burning of assets	1.4	0.0	0.7
No change in rainfall	0.0	1.4	0.7
Total	100	100	100

Source: Survey data analysis.

Table 18. Important household livelihood outcomes.

Livelihood outcomes	Bougouni (N = 73)	Koutiala (N = 73)	Total (N = 146)
		Percentage	
Increase agricultural production	45.2	78.1	61.6
Improve health status of household members.	15.1	6.8	11.0
Increase food security	6.8	5.5	6.2
Reduce agricultural production risk	8.2	1.4	4.8
Increase access to land	8.2	0.0	4.1
Improve revenue and reduce income risk	4.1	4.1	4.1
Reduce trade risk	2.7	1.4	2.1
Improve formal education level of household members	4.1	0.0	2.1
Improve employment opportunities	2.7	1.4	2.1
Improve social status	1.4	1.4	1.4
Increase asset flows to household	1.4	0.0	0.7
Total study area	100	100	100

Source: Survey data analysis.

7. Production and price risk analysis

Any single economic or productive activity has some degree of risk associated with it, and the risk is high in the case of rain-fed crop production. In addition to rainfall, other factors such as techniques (plowing, seeding, weeding, fertilization, use of herbicide, insecticide, and fungicide) can influence crop production positively or negatively. One should also consider prices (input and output), human factors and environmental conditions.

In the study area, major crops grown include food crops (maize, rice, sorghum, millet, wheat, cowpea, etc.) and cash crops (cotton and groundnut). As discussed in an earlier section on livestock production and marketing, livestock ownership in the area includes cattle, sheep, goats, and pigs. Perceived risks include persistent drought, postharvest attacks, high input prices, low product prices, livestock diseases, the destruction of crops by animals, damaging weeds, grasshopper invasions, birds, the death of animals, and plant pests and diseases.

Households' perception of production risks and their coping mechanisms

Tables 19a, 19b, and 19c show the households' perception of production risks and their coping strategies. In both LGAs, with higher proportions in Koutiala, crops in terms of yield fluctuation are considered to be local maize (73%), OPV maize (77%), and hybrid maize (83%). When the yield is below normal, the coping mechanisms suggested for all crops are to increase the land area or keep it unchanged. The respective proportions of land area increase are 82.4% for hybrid maize, local maize 58%, sorghum 50%, millet 46%, OPV maize 40%, and cotton 31%. The only situation where people do not go for an increase in land area is when fertilizer is unavailable or expensive. In this case, farmers tend to reduce or keep land area unchanged for almost all crops. Land area reduction is the least cited coping mechanism when risk is being handled (Tables 19b, and 19c).

Table 19a. Major crop and livestock production risks that farmers face.

How risky is…		Bougouni		Koutiala	
		Frequency	%	Frequency	%
Local maize in terms of yield fluctuation?	More risky	16	48.5	30	73.2
	Risky	5	15.2	9	22.0
	Less risky	12	36.4	2	4.9
OPV maize in terms of yield fluctuation?	More risky	28	41.8	36	76.6
	Risky	16	23.9	8	17.0
	Less risky	23	34.3	3	6.4
Hybrid maize in terms of yield fluctuation?	More risky	6	40.0	15	83.3
	Risky	3	20.0	1	5.6
	Less risky	6	40.0	2	11.1

Source: Survey data analysis.

Table 19b. Farmers' strategies for coping with risk in Bougouni LGA.

Risk	Coping strategy	Local maize	OPV maize	Hybrid maize	Cotton	Sorghum	Millet
Expected price is more than normal	Reduced land area		1.5		6.5		20.5
	Unchanged land area	23.1	11.8	35.3	22.6	24.5	79.5
	Increased land area	76.9	86.8	64.7	71.0	75.5	
Yield is less than normal	Reduced land area	3.8	13.2		35.5	9.6	11.4
	Unchanged land area	38.5	47.1	17.6	33.9	40.4	43.2
	Increased land area	57.7	39.7	82.4	30.6	50.0	45.5
Yield is more than normal	Reduced land area				4.8	1.9	2.3
	Unchanged land area	30.8	27.9	35.3	41.3	34.6	38.6
	Increased land area	69.2	72.1	64.7	54.0	63.5	59.1
Fertilizer is available at an affordable price	Reduced land area				7.9	9.6	9.1
	Unchanged land area	19.2	8.8	17.6	23.8	32.7	27.3
	Increased land area	80.8	91.2	82.4	68.3	57.7	63.6
Fertilizer is less available and at a higher price	Reduced land area	26.9	57.4	23.5	60.3	7.7	11.4
	Unchanged land area	61.5	33.8	58.8	28.6	59.6	59.1
	Increased land area	11.5	8.8	17.6	11.1	32.7	29.5
Farm credit is available and affordable	Reduced land area				7.8	5.8	4.5
	Unchanged land area	19.2	16.2	11.8	25.0	28.8	36.4
	Increased land area	80.8	83.8	88.2	67.2	65.4	59.1
Price is less than normal	Reduced land area		2.9	5.9	59.3	3.7	4.4
	Unchanged land area	50.0	50.0	29.4	18.5	46.3	52.9
	Increased land area	50.0	47.1	64.7	22.2	50.0	42.6

Source: Survey data analysis.

Table 19c. Farmers' strategies for coping with risk in Koutiala LGA.

Risk	Coping Strategy	Local maize	OPV maize	Hybrid maize	Cotton	Sorghum	Millet
Expected price is more than normal	Reduced land area	2.4	2.3		5.8	1.6	1.6
	Unchanged land area	31.7	30.2	35.3	21.2	33.3	32.8
	Increased land area	65.9	67.4	64.7	73.1	65.1	65.6
Yield is less than normal	Reduced land area	22.5	15.9	12.5	32.7	14.9	15.9
	Unchanged land area	57.5	65.9	87.5	46.2	20.9	63.5
	Increased land area	20.0	18.2		21.2	3.0	20.6
Yield is more than normal	Reduced land area	2.4	2.3		3.8	44.8	3.2
	Unchanged land area	43.9	47.7	58.8	39.6	50.7	49.2
	Increased land area	53.7	50.0	41.2	56.6	1.5	47.6
Fertilizer is available at an affordable price	Reduced land area		2.3			3.0	3.2
	Unchanged land area	39.0	34.9	64.7	38.5	48.5	46.0
	Increased land area	61.0	62.8	35.3	61.5	48.5	50.8
Fertilizer is less available and at a higher price	Reduced land area	46.3	51.2	29.4	64.7	28.8	27.0
	Unchanged land area	48.8	41.9	52.9	29.4	56.1	57.1
	Increased land area	4.9	7.0	17.6	5.9	15.2	15.9
Farm credit is available and affordable	Reduced land area				1.9		
	Unchanged land area	34.1	37.2	50.0	34.6	48.5	49.2
	Increased land area	65.9	62.8	50.0	63.5	51.5	50.8
Price is less than normal	Reduced land area	7.3	11.6	5.9	30.6	4.8	11.4
	Unchanged land area	70.7	62.8	82.4	46.9	68.3	68.2
	Increased land area	22.0	25.6	11.8	22.4	27.0	20.5

Source: Survey data analysis.

Table 20a. Adjustment in maize crop portfolio to mitigate selected production risks (maize).

Production risk	Strategy	Bougouni	Koutiala	Total
		Percentage		
Most important strategies to reduce local maize production risk	Diversification	42.4	63.4	54.1
	No diversification	6.1	7.3	6.8
	Asset accumulation		2.4	1.4
	Participation in NGO or Government programs	12.1	2.4	6.8
	Others to specify	15.2	2.4	8.1
	Cultivated crop variety diversification	21.2	19.5	20.3
	Buy fertilizer	3.0	2.4	2.7
Most important strategies to reduce OPV maize production risk	Diversification	26.5	55.6	38.1
	No diversification	10.3	8.9	9.7
	Asset accumulation	1.5		0.9
	Participation in NGO or Government programs	11.8	6.7	9.7
	Others to specify	16.2	2.2	10.6
	Cultivated crop variety diversification	30.9	26.7	29.2
	Respect agricultural calendar	2.9		1.8
Most important strategies to reduce hybrid maize production risk	Diversification	23.5	27.8	25.7
	No diversification	11.8	5.6	8.6
	Participation in NGO or Government programs	35.3	5.6	20.0
	Respect agricultural calendar	11.8	5.6	8.6
	Cultivated crop variety diversification	17.6	55.6	37.1

Source: Survey data analysis.

The two most important adjustments in the crop portfolio to mitigate selected production risks for all crops are diversification in general and in cultivated crop variety (Tables 20a and 20b).

In terms of yield fluctuation, local maize, OPV maize, and hybrid maize are all seen as most risky by a high proportion of households regardless of wealth category (Table 20c). Strategies used to mitigate production risks include activity diversification, (mentioned at 70% for local maize, 40% for OPV maize, and 41% for hybrid maize), and crop variety diversification (mentioned at 20% for local maize, 33% for OPV maize, and 37% for hybrid maize (Table 20d). Sometimes, participation in Government programs can also help.

Households' perceptions of price risks and their coping mechanisms

Table 21a shows that the majority of households in the area did not deem price to be a factor in determining the crop quantity to be sold. The same behavior is observed in acquiring more credit if the selling price of OPV maize, hybrid maize, cotton, sorghum, and millet was attractive (Table A3a). When the selling price of crops is attractive (Table 21b), households in both LGAs want to increase their input use or keep it unchanged. Very few tended to decrease their input use. If product prices decrease, the great majority of households are more likely to sell more assets (Table A3b). The proportions are local maize at 86%, OPV maize 76%, hybrid maize 80%, cotton 86%, sorghum 74%, and millet 69%. If local product prices increase, almost all the households said they would buy more assets (Table A3d).

Table 20b. Adjustment in other crops portfolio to mitigate selected production risks (cotton, millet, and sorghum).

Production risk	Strategy	Bougouni	Koutiala	Total
		Percentage		
Most important strategies to reduce cotton production risk	Diversification	23.8	21.3	22.7
	No diversification	7.9	19.1	12.7
	Asset accumulation	11.1	8.5	10.0
	Participation in NGO or Government programs	17.5	19.1	18.2
	Others to specify	15.9	6.4	11.8
	Cultivated crop variety diversification	17.5	23.4	20.0
	Respect agricultural calendar	4.8		2.7
	Buy fertilizer	1.6	2.1	1.8
Most important strategies to reduce sorghum production risk	Diversification	35.5	38.1	36.8
	No diversification	11.3	31.7	21.6
	Participation in NGO or Government programs	11.3	7.9	9.6
	Others to specify	9.7	3.2	6.4
	Cultivated crop variety diversification	29.0	19.0	24.0
	Respect agricultural calendar	3.2		1.6
Most important strategies to reduce millet production risk	Diversification	32.1	37.7	35.1
	No diversification	9.4	32.8	21.9
	Participation in NGO or Government programs	13.2	8.2	10.5
	Respect agricultural calendar	13.2	1.6	7.0
	Cultivated crop variety diversification	32.1	19.7	25.4

Source: Survey data analysis.

Table 20c. Production risk by wealth groups (maize).

Varieties	Risks	Poorly endowed	Well endowed	Total
Risk of local maize yield fluctuation	Most risky	56.8	70.0	62.2
	Risky	15.9	23.3	18.9
	Least risky	27.3	6.7	18.9
Risk of OPV maize yield fluctuation	Most risky	59.4	52.0	56.1
	Risky	20.3	22.0	21.1
	Least risky	0.0	0.0	0.0
Risk of hybrid maize yield fluctuation	Most risky	68.4	57.1	63.6
	Risky	10.5	14.3	12.1
	Least risky	21.1	28.6	24.2

Source: Survey data analysis.

Table 20d. Maize production risk coping strategies adopted by wealth groups.

Varieties	Strategies	Poorly endowed	Well endowed	Total
		Percentage		
Most important strategy to mitigate local maize production risk	Diversification	43.2	70.0	54.1
	No diversification	11.4		6.8
	Asset accumulation		3.3	1.4
	NGO or Government programs	9.1	3.3	6.8
	Others	4.5	13.3	8.1
	Variety diversification	27.3	10.0	20.3
	Buying fertilizers	4.5		2.7
Most important strategy to mitigate OPV maize production risk	Diversification	37.1	40.4	38.6
	No diversification	12.9	5.8	9.6
	Asset accumulation		1.9	0.9
	NGO or Government programs	9.7	9.6	9.6
	Others	6.5	5.8	6.1
	Variety diversification	33.9	32.7	33.3
	Follow crop production schedule		3.8	1.8
Most important strategy to mitigate hybrid maize production risk	Diversification	11.1	41.2	25.7
	No diversification	11.1	5.9	8.6
	NGO or Government programs	22.2	17.6	20.0
	Follow crop production schedule	5.6	11.8	8.6
	Variety diversification	50.0	23.5	37.1

Source: Survey data analysis.

Demonstration plot of Jorobana, a drought tolerant variety, in Faso Kaba seed farm, Tamala, Mali.

Table 21a. Factors determining crop quantity to be sold.

Price risk	Bougouni	Koutiala	Total
	Percentage		
Price of local maize as a determinant factor in determining crop quantity to be sold	33.3	21.2	26.7
Price of OPV maize as a determinant factor in determining crop quantity to be sold	43.8	31.1	38.5
Price of hybrid maize as a determinant factor in determining crop quantity to be sold	41.2	31.3	36.4
Price of cotton as a determinant factor in determining crop quantity to be sold	28.1	19.1	24.0
Price of sorghum as a determinant factor in determining crop quantity to be sold	35.1	26.2	30.3
Price of millet as a determinant factor in determining crop quantity to be sold	44.7	21.0	31.2

Source: Survey data analysis.

Table 21b. Adjustment in input use to mitigate selected price risks.

Price risk		Bougouni	Koutiala	Total
		Percentage		
Change in fertilizer and other input use if the selling price of local maize was attractive	Increase	69.0	79.4	74.6
	Same	27.6	20.6	23.8
	Decrease	3.4		1.6
Change in fertilizer and other input use if the selling price of OPV maize was attractive	Increase	73.1	80.0	75.5
	Same	23.9	20.0	22.5
	Decrease	3.0		2.0
Change in fertilizer and other input use if the selling price of hybrid maize was attractive	Increase	63.2	56.3	60.0
	Same	26.3	25.0	25.7
	Decrease	10.5	18.8	14.3
Change in fertilizer and other input use if the selling price of cotton was attractive	Increase	59.4	67.9	63.2
	Same	37.5	30.2	34.2
	Decrease	3.1	1.9	2.6
Change in fertilizer and other input use if the selling price of sorghum was attractive	Increase	42.9	54.7	49.2
	Same	55.4	42.2	48.3
	Decrease	1.8	3.1	2.5
Change in fertilizer and other input use if the selling price of millet was attractive	Increase	48.9	46.0	47.3
	Same	48.9	50.8	50.0
	Decrease	2.1	3.2	2.7

Source: Survey data analysis.

Plant hybrid maize, Sanankoroba.

Kids among yellow drought tolerant maize cobs.

Table 22a. Adjustment in crop portfolio to mitigate selected price risks in maize.

Strategies		Bougouni	Koutiala	Total
		Percentage		
Strategies to reduce or eliminate local maize price risk	No answer	8.1	10.5	9.3
	Asset accumulation	5.4	50.0	28.0
	Participate in NGO/Government programs	29.7	13.2	21.3
	Contract		2.6	1.3
	Others to specify	8.1		4.0
	Storage	48.6	23.7	36.0
Strategies to reduce or eliminate OPV maize price risk	No answer	10.6	15.6	12.6
	Asset accumulation	4.5	28.9	14.4
	Participate in NGO/Government programs	12.1	6.7	9.9
	Contract	4.5		2.7
	Others to specify	3.0		1.8
	Storage	65.2	48.9	58.6
Strategies to reduce or eliminate hybrid maize price risk	No answer	11.8		5.6
	Asset accumulation	11.8	10.5	11.1
	Participate in NGO/Government programs	35.3	5.3	19.4
	Contract	5.9	5.3	5.6
	Storage	35.3	78.9	58.3

Source: Survey data analysis.

Table 22a indicates that the strategies commonly used to reduce or eliminate maize price risk include asset accumulation, participation in NGOs or Government programs, contract pricing, and storage. Among them, storage seems to be the most important strategy with 36% for local maize, 59% for OPV maize, and 58% for hybrid maize. As it is for maize, storage remains the most important strategy used to reduce or eliminate price risk for cotton (24%), sorghum (47%), and millet (46%). Other strategies used include asset accumulation, participation in NGO or Government programs, contract pricing, and storage (Table 22b).

Table 22b. Adjustment in crop portfolio to mitigate selected price risks in cotton, millet, and sorghum.

Strategies		Bougouni	Koutiala	Total
		Percentage		
Strategies to reduce or eliminate cotton price risk	No answer	13.1	12.8	13.0
	Asset accumulation	8.2	36.2	20.4
	Participate in NGO/Government programs	13.1	12.8	13.0
	Contract	47.5	2.1	27.8
	Others to specify	3.3		1.9
	Storage	14.8	36.2	24.1
Strategies to reduce or eliminate sorghum price risk	No answer	9.5	21.9	15.7
	Asset accumulation	4.8	37.5	21.3
	Participate in NGO/Government programs	15.9	7.8	11.8
	Contract	1.6	3.1	2.4
	Others to specify	3.2		1.6
	Storage	65.1	29.7	47.2
Strategies to reduce or eliminate millet price risk	No answer	7.4	22.6	15.5
	Asset accumulation	5.6	32.3	19.8
	Participate in NGO/Government programs	18.5	9.7	13.8
	Contract	1.9	3.2	2.6
	Others to specify	3.7		1.7
	Storage	63.0	32.3	46.6

Source: Survey data analysis.

Figure 11 indicates by wealth category the degree of risk attached to price fluctuation for local maize, OPV maize, and hybrid maize. About 70% of well endowed households found local maize least risky while 57% of the same wealth category found hybrid maize most risky. For about 48% of poorly endowed households, local maize is least risky, and 63% of the same category found hybrid maize most risky. The risk in price fluctuation is perceived to be the same for hybrid maize, regardless of wealth category.

8. Summary impact indicators by household wealth category

Our approach to identifying strategic resources to be mobilized by the household incorporates natural and social assets in addition to the classical assets (physical, human, financial). Social and cultural assets are also important to farmers' choices in terms of farm management practices. These different assets contribute to production and hence to the farmer's wealth status. They also give an indication of the farmer's capability to handle risk.

Principal Component Analysis (PCA) was used to extract from our set of variables those orthogonal linear combinations of the variables that capture the common information most successfully. For the total study area, the distribution of wealth index ranking of households indicates that 56.4% of the household are poorly

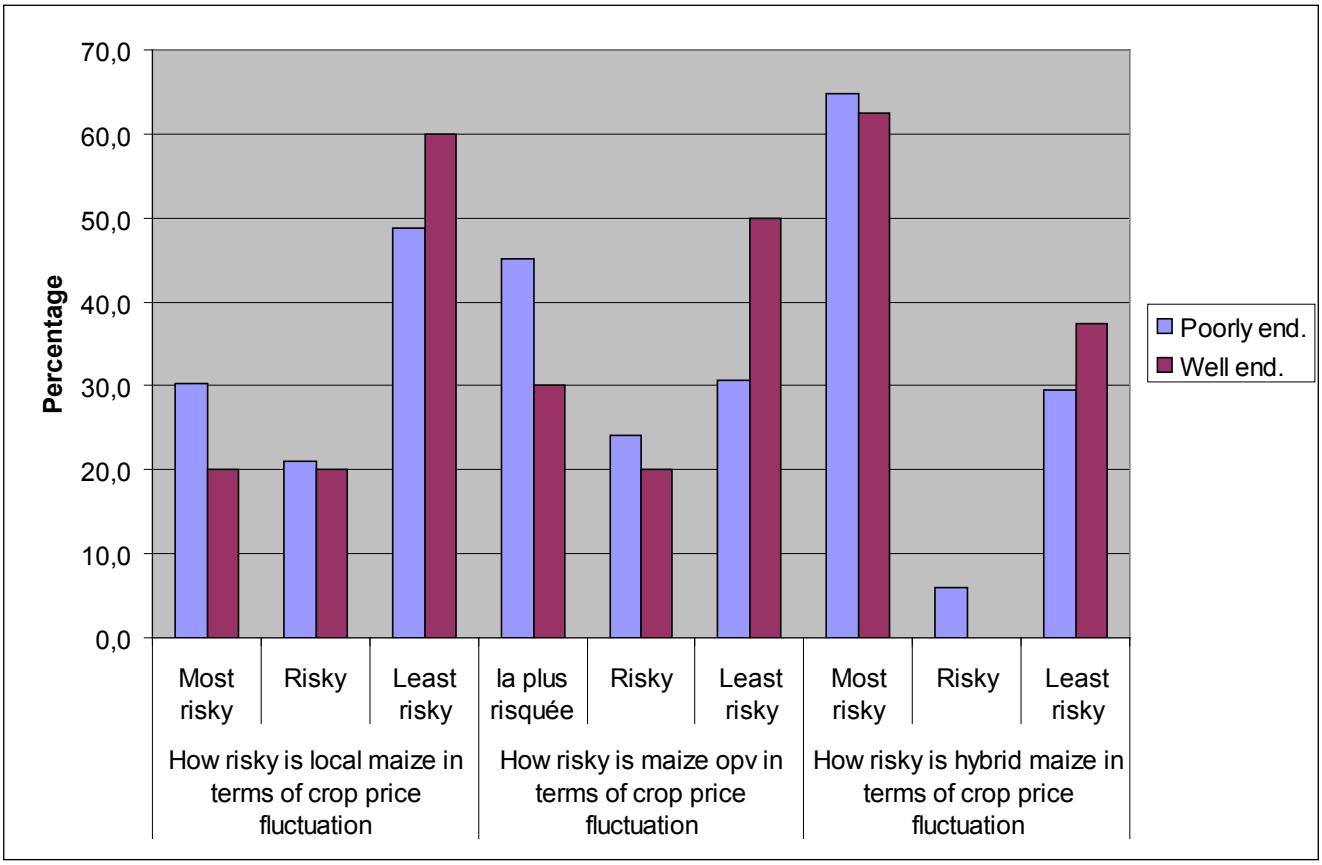

Figure 11. Price risk by wealth group.

Source: Survey data analysis.

endowed. These tendencies are corroborated by those in the study *Observatoire du Développement Humain Durable au Mali.* The list of variables considered here does not include access to drinking water, electricity, health, and education which are also important social measures of wealth.

In general in rural areas, livelihood is based on the production of crops and livestock and marketing of the products derived from these activities. Producing crops or livestock depends on an underlying condition of access to land, either by possessing it or getting it from others. A typical household's land holding ranges in size from 7 to 18 ha in the study area. In these areas, land may become a limiting factor because of the quality of the soil, with an observed decline in fertility. Although access to land is important for crop and livestock production, some other conditions are also required for the activities to be successful.

In the study area, we have minimized gender consideration because only one household head out of the 149 in the survey was female. The average household contains around 22 persons, 47.2% of which are available for farm work, on average. It happens that only 48% of the males in the household are available for farm work, while 67% of the females are available. Nevertheless, the availability of the household's labor force by gender of the household head indicates an average of 7 months for females and 6 months for males.

Determinants of cultivated farm size range in decreasing order as follows: family food needs, family labor availability, expected cereal prices, cash availability to purchase inputs, availability of farm equipment, cash availability to hire labor, current cereal prices, and seed availability.

The major crops grown include maize, sorghum, millet, cotton, groundnut, rice, and cowpea. Some other minor crops are grown, such as potato, sesame, yam, and cassava. Most of these crops are produced either for family consumption, for sale, or both. The farm family's distribution of land area among crops is based on the family's needs or objectives.

For resource-poor households, access to credit is important to launch farming activities at an appropriate time and to cope with food shortages and other problems such as health care, taxes, and marriage expenses. The results indicate good access to credit in the study area (81.2% of households have access to credit). It is important to note that the maximum amount of credit is devoted to production.

Households' access to institutional support in the study area is diverse. On average, more than half of the households (58.1%) have access to financial institutions for production credit and 66.7% for consumption credit. Other sources are relatives, NGOs, neighbors, moneylenders, and Government programs. Access to field demonstrations is very low in the study area. Field demonstrations are organized in descending order as follows; cotton development services (33%), seed companies (23%), extension services (13%), research institutions (12%), other development services (10%), and NGOs (9%). This indicates a need for an increase in the number of field demonstrations for households to be informed, share experiences with others, and become aware of the existence of improved varieties.

Life is full of difficulties, and making a living means finding solutions to those difficulties. In the study area, shocks experienced by households include drought, large increases in input prices, the death or loss of livestock, the illness or handicap of the household head or spouse, drastic decreases in crop prices, the death of the household head or spouse, plant pests and diseases, livestock diseases, and dangerous weeds.

When facing shocks, households in the study area experience several livelihood outcomes such as increased agricultural production, improved health status of household members, increased food security, reduced agricultural production risk, increased access to land, improved revenue and reduced income risk, reduced trade risk, improved formal educational level of household members, and improved employment opportunities. These are strategies tending to alleviate the effect of shocks.

Harvesting hybrid maize at Finkolo, Mali.

9. Conclusion

Data analysis showed that about 60% of the population are poorly endowed in the study districts. Ownership of assets such as motor vehicles, solar energy, water pumps, diesel pumps, water tanks, and tractors is limited. The poorly endowed households in Bougouni and Koutiala look very much identical in terms of assets ownership. However, among the entire population (comprising both the well-endowed and the poorly endowed) fewer individuals own assets such as motor vehicle, tractor, television set, water pump, water tank and generator.

The most important institutional support for the population is the local micro-finance institutions, individuals have to depend on relations and the local NGOs to make up for the shortfall in the contributions of the formal sector and government. Government and the private sector would need to make more investment and expand the formal sector in the two districts to mitigate poverty and enhance livelihood of farmer households. Access to field demonstrations was generally low in the study areas. Less than 20% of household participated in field demonstrations in 2010. This outcome shows a need for increased numbers of field demonstrations.

In Bougouni and Koutiala, the major organizers of field demonstration were the Cotton Development Service, followed by research institutions and seed companies. Field demonstrations need to be increased because they are good avenues for showcasing the characteristics of production technologies that can enable farmers to make adoption decisions; they also help to train farmers on the methods and economic benefits of improved crop management practices as well as the economic benefits in the efficient use of farm inputs.

Data analysis indicated access of farmers to micro-credit in the study area. More than 55% of the households had access to micro-financial institutions where they can obtain production credit support and also obtain consumption credit support. More households obtained consumption credit support to the detriment of production credit support. Access to micro-credit and low interest rate is important for agricultural productivity because farmers need to buy inputs such as inorganic fertilizer and pesticides to enhance crop yields and reduce pre-harvest losses. Government would need to intervene with special loan packages with extended gestational period to stimulate borrowing for production.

Major shocks experienced by households include drought, large increases in input prices, the death or loss of livestock, the illness, handicap, or death of the household head or spouse, drastic decreases in crop prices, plant pests and diseases, livestock diseases, and damaging weeds. All these have negative effect on agricultural productivity. To cope with these shocks, the households in the study area have sought several livelihood outcomes including increasing agricultural production (78% in Koutiala and 45% in Bougouni), improving the household's health status, increasing food security, reducing agricultural production risk, increasing access to land, improving revenue and reducing income risk, reducing trade risk, improving the formal educational level of the household's members, and creating employment opportunities. However, to complement the coping strategies of the people, government would need to create enabling environment that would attract more private sector investment into the agricultural sector, especially in the area of the supply and distribution of farm inputs. There is also the need to make veterinary services available to farmers, provide healthcare facilities for humans and good roads to access both input and output markets in order to enhance the coping strategies of farmer households and stimulate agricultural productivity.

The average land owned by households ranged from 7 to 18 ha. The distribution of the farm family's land area among crops is based on the family's needs. The major crops grown include maize, sorghum, millet, cotton, groundnut, rice, and cowpea. Most of these crops are produced either for family consumption, or for sale or for both purposes. Determinants of cultivated farm size range in decreasing order were household food needs, labor availability, expected cereal prices, cash availability to purchase inputs, availability of farm equipment, cash availability to hire labor, current cereal prices, and seed availability Therefore, before deciding on the

amount of land to plant, the average farmer looks at the factors above to guide his decision. Maize production is higher than the production of other cereals such as sorghum and millet. A larger quantity of maize is also traded than sorghum and millet. The major limiting factor to agricultural productivity is the declining soil fertility and low use of inorganic fertilizer. Problem of poor soil fertility is most acute in Flaboula in Bougouni district and NGountjina in Koutiala district. Currently, about half of the households in the Bougouni,and Koutiala are applying inorganic fertilizer and the average rate of application is very low. Government needs to improve farmers' access to both input and output markets to stimulate agricultural productivity.

The adoption status of the improved maize variety indicates a total of 52% of adopters and 48% of non-adopters. According to the wealth status of households, 59% of those well endowed are adopters and 54% of those poorly endowed. This situation can be improved by an increase in field demonstrations and intensive promotion of the improved maize variety. The regression model indicated the availability of family labor as an important factor for the adoption of an improved maize variety. Location was also found to influence adoption. There is the need for greater investment in labour saving technologies in maize production such as the use of tractor in land preparation, and use of herbicide in weed control.

In the study areas, the two most important adjustments in the crop portfolio to mitigate selected production risks for all crops were diversification in general and in cultivated crop variety. In terms of yield fluctuations, local maize, OPV maize, and hybrid maize were all seen as most risky by a high proportion of households regardless of wealth category. Strategies used to mitigate production risks include activity diversification, (mentioned at 70% for local maize, 40% for OPV maize, and 41% for hybrid maize), and crop variety diversification (mentioned at 20% for local maize, 33% for OPV maize, and 37% for hybrid maize). Occasionally, participation in Government programs was also beneficial.

Cobs of hybrid maize (Sama), Sotuba, Mali.

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Appendices

A1. Distribution of wealth index (WI) ranking of households (WI < 0: poorly endowed; WI > 0: well endowed).

Wealth categories	Bougouni (N = 75)	Koutiala (N = 74)	Total (N = 149)
	Percent		
Poorly endowed	53.3	59.5	56.4
Well endowed	46.7	40.5	43.6

Source: Survey data analysis

A2. Maize cultivars planted by households in selected districts.

Maize cultivars	Koutiala (N = 74)	Bougouni (N = 73)	Total (N = 147)
	Percentage		
Dembanyuman	64.8	35.6	50.3
Sotubaka	24.3	58.9	41.5
Zanguerenin	6.8	0.0	3.4
Tjémantjé	0.0	2.7	1.4
Namsa	0.0	1.4	0.7
TZE	0.0	1.4	0.7
Zanblara	1.4	0.0	0.7
Tux	1.4	0.0	0.7
Zavié	1.4	0.0	0.7
Total	100	100	100

Source: Survey data analysis

A3a. Major crop and livestock price risks and mitigating behaviors (1).

Price risk		Bougouni	Koutiala	Total
		Percentage		
Would you acquire more credit if the selling price of local maize was attractive?	Yes	78.6	50.0	62.9
Would you acquire more credit if the selling price of OPV maize was attractive?	Yes	75.0	70.3	73.3
Would you acquire more credit if the selling price of hybrid maize was attractive?	Yes	72.2	50.0	61.8
Would you acquire more credit if the selling price of cotton was attractive?	Yes	70.3	60.4	65.8
Would you acquire more credit if the selling price of sorghum was attractive?	Yes	54.4	37.9	45.5
Would you acquire more credit if the selling price of millet was attractive?	Yes	51.1	34.4	41.4

Source: Survey data analysis

A3b. Major crop and livestock price risks and mitigating behaviours (2).

Price risk		Bougouni	Koutiala	Total
		Percentage		
What would happen to your assets if local maize prices decrease?	Sell some assets	86.2	85.7	85.9
	Same	10.3	14.3	12.5
	Buy more	3.4		1.6
What would happen to your assets if OPV maize prices decrease?	Sell some assets	80.9	67.6	76.2
	Same	17.6	21.6	19.0
	Buy more	1.5	10.8	4.8
What would happen to your assets if hybrid maize prices decrease?	Sell some assets	78.9	81.3	80.0
	Same	15.8	12.5	14.3
	Buy more	5.3	6.3	5.7
What would happen to your assets if cotton prices decrease?	Sell some assets	78.1	96.2	86.3
	Same	18.8	1.9	11.1
	Buy more	3.1	1.9	2.6
What would happen to your assets if sorghum prices decrease?	Sell some assets	76.8	70.8	73.6
	Same	19.6	27.7	24.0
	Buy more	3.6	1.5	2.5
What would happen to your assets if millet prices decrease?	Sell some assets	72.3	66.7	69.1
	Same	23.4	30.2	27.3
	Buy more	4.3	3.2	3.6

Source: Survey data analysis.

A3c. Major crop and livestock price risks and mitigating behaviors (3).

Price risk		Bougouni	Koutiala	Total
		Percentage		
What would happen to your assets if local maize prices increase?	Same	6.9	22.2	15.4
	Buy more	93.1	77.8	84.6
What would happen to your assets if OPV maize prices increase?	Sell some assets	5.9	13.2	8.5
	Same	5.9	18.4	10.4
	Buy more	88.2	68.4	81.1
What would happen to your assets if hybrid maize prices increase?	Sell some assets	5.3	25.0	14.3
	Same		6.3	2.9
	Buy more	94.7	68.8	82.9
What would happen to your assets if cotton prices increase?	Sell some assets	3.1	7.5	5.1
	Same	7.8	1.9	5.1
	Buy more	89.1	90.6	89.7
What would happen to your assets if sorghum prices increase?	Sell some assets	1.8	4.6	3.3
	Same	5.3	23.1	14.8
	Buy more	93.0	72.3	82.0
What would happen to your assets if millet prices increase?	Sell some assets	4.3	4.9	4.6
	Same	8.5	24.6	17.6
	Buy more	87.2	70.5	77.8

Source: Survey data analysis.