Characterization of Maize Producing Households in the Dry Savanna of Nigeria

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Drought Tolerant Maize for Africa (DTMA) Project
Country Report–Household Survey

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DTMA Country Report - Nigeria

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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

ADP	Agricultural Development Project
CBO	Community -based organization
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
DTM	drought tolerant maize
DTMA	Drought Tolerant Maize for Africa project
FGD	Focus group discussion
GIS	geographic information service
GPS	global positioning systems
GSPP	Government Starter Pack Program
IAR	Institute for Agricultural Research
IITA	International Institute of Tropical Agriculture
KASCO	Kano Agricultural Seed Company
KI	key informant
KNARDA	Kano Agricultural and Rural Development Authority
mm	millimeter
NAERLS	National Agricultural Extension and Research Liaison Service
NGO	Non-governmental organization
NPC	National Population Commission
NPK	nitrogen, phosphorus, potassium (fertilizer)
PCA	Principal components analysis
PE	poorly endowed
SSA	sub-Saharan Africa
WE	well endowed
WI	Wealth index

Executive summary

Maize is an important food security crop in the dry savanna zones of Nigeria. However, recurring droughts pose a continuous challenge to its production. In an attempt to address the drought problem on maize, a formal household survey of resource-poor farmers, targeted at major maize producing areas that are routinely affected by drought risk, was conducted in the 2005–2006 production period. The major objective of the household survey was to collect baseline data on farm households to construct indicators to be used in measuring changes in the adoption of improved drought tolerant maize varieties and the impact on adopting households in the selected locations.

The household survey was conducted in Rano district in Kano State and Malumfashi district in Katsina State, Nigeria. These areas are notable for maize production and represent the zone where the probability of drought risk is about 20–40%. Ten maize producing communities were selected in each of the districts, and between 15 and 22 households were randomly selected in each community. A total of 175 household heads were selected in each district for the study. Data were analyzed using descriptive statistics, principal component analysis for wealth ranking as a basic approach to categorizing rural households, and Tobit regression technique to determine the probability of adoption of improved maize and the extent of the use of the technology by adopting households.

Household livelihoods were centered on the availability of land for food crop production, as well as on livestock production and marketing. Major crops grown included cereals, mainly local maize, Hybrid maize, sorghum, and groundnut were also grown, with local, improved, and hybrid maize varieties constituting the first crops. Maize production was male dominated, although with an ageing population as a result of the reduced entry of younger farmers into the farming business. This reduction was due to out-migration by the youths to urban centers for better job opportunities, while those remaining engaged in the transport business (motor cycle riding), which was believed to be lucrative. This has led to the scarcity and high costs of farm labor. Though farm sizes were generally small, men had larger maize farms in the current season than women. Focus group discussions and key informants attributed this to the sociocultural background of the people, who considered farming the exclusive preserve of men, with access to farm productive resources limited to them.

Assets owned by households largely determined their wealth status and ability to take the risks associated with the adoption of innovations for their farm production activities. Assets which had a great impact on households included total farm size, total household size, the ownership of cultivable farm land, radios, the possession of motor cycles, television sets, mobile phones, draft animals, bicycles, wheelbarrows, and private wells, and the receipt of remittances, Households also owned local cows, bulls, heifers, calves, goats, pigs, sheep, and chickens. The numbers and types of livestock owned were important measures of household wealth. Based on the varying levels of different assets owned, the distribution of households within wealth categories showed that majority of the maize producers were poorly endowed, with about 62% categorized as worse-off. Access to credit facilities was limited, but a few benefited from programs from both governmental and non-governmental organizations such as Sasakawa Global 2000, Government Starter Pack Program and the Agricultural Development Projects. The package of benefits included seeds, fertilizer, food relief, and livestock breeding stock.

Drought was the most important shock that affected maize farms and hence household livelihoods. It was one of the major reasons why households sought an alternative means of livelihood. Local landraces, improved and hybrid maize, sorghum, and rice were ranked in that order as important crops that suffered most from drought stress. Three key livelihood strategies were usually employed by households: increasing agricultural production, and reducing risks to income and to health. To reduce food security risks, households stored food grain for longer periods, grew crops with differing maturity periods, replaced cash crops with food crops, increased the use of inputs for a higher yield, and engaged in dry season farming. The period from June

through August was noted for food shortages during the year. The most risky crops in terms of yield fluctuations were sorghum, hybrid maize, local landrace maize, cotton, improved open-pollinated varieties, groundnut, rice, onion, millet, pepper, cowpea, soybean, and beans, while cassava, sweetpotato, and teff were the least risky.

The approach used in reducing agricultural production risks included crop diversification, early planting, intensifying labor and input use, accumulating production assets, using hybrid seeds, undertaking income generating off-farm activities, learning better practices of input use, and selling livestock. Risks associated with education were addressed by attending adult literacy classes and enrolling more children in formal and informal schools. Four main price risk coping strategies were adopted by households according to wealth groups. These were asset accumulation, participation in NGO and Government programs, forward contracting, and informal insurance. Households that were worse-off or just evolving in the well-off category predominantly adopted asset accumulation and participation in NGO and Government programs as price risk coping strategies. Forward contracting and informal insurance were the preferred price risk coping strategies of wealthier households. In forward contracting, the farmers made advance contracts with the buyer of their products and the sellers of their inputs. For informal insurance, they collected information about market prices to predict future price trends.

These were considered ways of maintaining wealth classes between the well endowed and the poorly endowed in the area. Wealthier households, however, tended to divert from agriculture to other economic activities as a means of livelihood.

About 68% of the sampled households were adopters of improved maize while 32% were non-adopters. Farm size, extension contact, distance to market, perception of yield potential, seed availability, and wealth index were the major factors that influenced the probability of adoption of improved maize varieties. Membership of associations was the only additional variable that significantly influenced the use of improved maize after adoption. The findings have economic implications for development programs aimed at promoting and targeting new technologies to specific wealth categories for the improved livelihood of the farming households.

1. Introduction

The objective of the Drought Tolerant Maize for Africa (DTMA) Project is to decrease hunger and increase the food and income security of resource-poor farm families in sub-Saharan Africa (SSA) through the development and dissemination of drought tolerant, well-adapted maize varieties.

Maize is the most important cereal food crop in SSA with more than 50% of all countries assigning over 50% of their cereal crop production area to maize. Over 650 million people in SSA consume on average 43 kg of maize/year (FAOSTAT 2006; 2003–2005). In Nigeria, for instance, maize is one of the two major crops that occupy about 40% of the land area under agricultural production, and accounts for about 43% of the maize grown in West Africa (Smith et al. 1997; Phillip 2001). Among different income groups, maize is a relatively more important source of both calories and protein for the poorer proportion of consumers, including HIV/AIDS-affected families, who cannot afford more expensive foods, such as bread, milk, or meat (Byerlee and Heisey 1997). Maize production, therefore, is of strategic importance for food security and the socioeconomic stability of countries and subregions in SSA. However, recurring droughts are a continuous challenge to the production of this important crop in Africa by drastically reducing yields and livelihoods. The development, deployment, and cultivation of drought tolerant maize (DTM) varieties, therefore, has the potential of reducing vulnerability, food insecurity, and the damage to local markets associated with food aid.

Based on the need to understand how and when DTM is used by farmers, the number of users over time, the provision of information for policy reform, as well as the need to measure impact, a formal household survey of resource-poor farmers was conducted during the 2005–2006 production periods. The survey was targeted at major maize producing areas that were frequently at drought risk. The general objective of the household survey was to collect baseline data on farm households and use them to construct indicators for measuring changes in the adoption of improved maize varieties and the impact on adopting households in selected locations. Specifically, the objectives were to identify the farmers' perceptions of and preferences for maize variety attributes, identify the factors that influenced the adoption of improved maize varieties, characterize maize production systems and gender mainstreaming, and assess the farmers' perceptions of risks and shocks and their coping strategies.

Maize farmer admiring the cobs in Malumfashi, Nigeria.

2. Methodology

Sampling and data collection

The household survey was conducted in Rano district in Kano State and Malumfashi district in Katsina State both located in the dry savanna zone of Nigeria. Based on geographic information service (GIS) data and information received through personal contacts with maize breeders from the International Institute of Tropical Agriculture (IITA) and Institute for Agricultural Research (IAR), the extension service units of Agricultural Development Projects (ADPs), other key informants, and past studies (Adejuwon 2006, Kamara et al. 2006, Onyibe et al. 2006, Jones 2006), this zone is characterized as prone to 20–40% drought risk. Based on the land area cultivated to maize production, one district was selected in each of the selected States. Preliminary visits were made to the Directors of Agriculture in the States' ADPs and the Ministries of Agriculture, chairmen of the district zonal offices, and district heads to inform them about the project and to request their assistance in selecting communities within the district. Ten high maize producing communities were then selected in each district. A list of household heads was obtained for each community with the help of the village community heads. Based on the number of households in each community, between 16 and 20 household heads were randomly selected from each community in Rano and between 15 and 22 household heads were selected in Malumfashi. A household in this context is defined as a group of persons living and working together, eating from the same pot, and with a nuclear head of family. A total of 175 household heads were selected in each district for the study. Only two maize growing female households were found and selected in Rano district and none was available in Malumfashi. The map of the country shows selected survey districts (Fig. 1.).

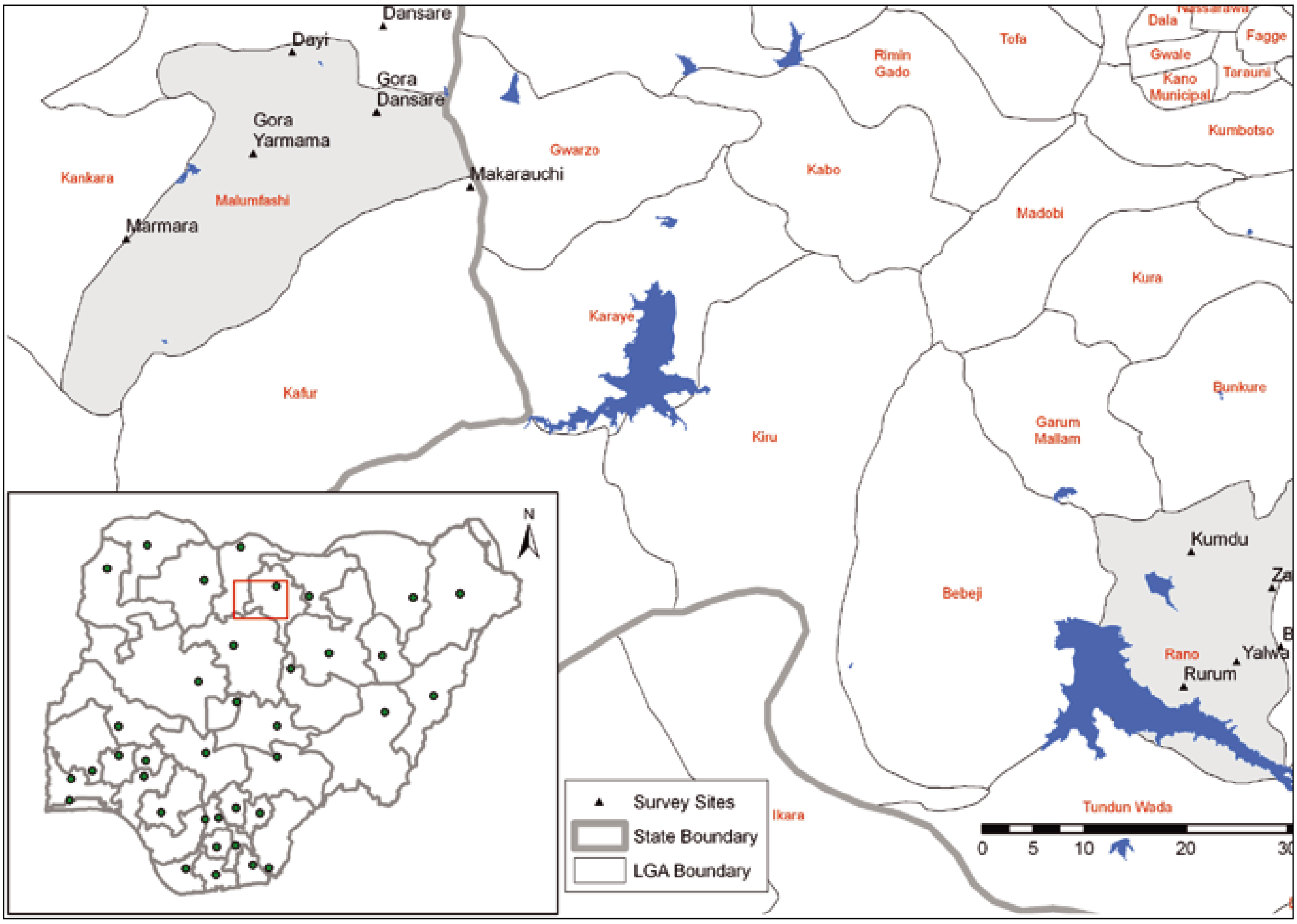

Figure 1. Country map showing selected survey districts.

Primary data were collected using a household survey questionnaire. The questionnaire, targeted at maize farmers, was structured into nine sections. Data were collected on general household characteristics, composition, and resources; institutional settings; agricultural production activities with particular reference to the adoption and production of maize varieties; perceptions of drought risk; agricultural marketing decisions; income and expenditure profiles; households' livelihoods diversity; strategies to cope with drought; poverty and food security status. Four enumerators, based in the survey locations, were recruited and trained to administer the DTMA household survey questionnaire after a pre-test. Pre-test responses were used to restructure the survey questionnaire. Data were collected between June and July 2007 in the selected communities. Secondary data were obtained from the National Population Commission (NPC) and ADPs on the physical features, agroecology, and maize production systems at the district level. Data were analyzed using descriptive statistics, principal components analysis (PCA), and the Tobit regression model. The descriptive statistics, involving the use of means and frequency counts to describe the study variables, were presented using tables and charts. Principal components analysis was used to analyze the household's wealth index (WI) ranking and their impact factors; the Tobit regression model was employed to analyze the determinants of adoption and the intensity of use of improved maize varieties. The test of differences between means and proportions was used to compare study variables between adopter & wealth groups.

3. Agroclimatic characterization of survey locations

The dry savanna covers an area of about 40.6 million ha in West and Central Africa. It is characterized by a growing period of between 151 and 180 days; and its major soils include luvisols (36%), vertisols (12.2%), lithosols (11.3%), regosols (8.7%), and ferralsols (8%) (Agboola 1987; Jagtap 1995). The temperature ranges are from a minimum of 8.6–21.6 °C to a maximum of 27.3–34 °C (Fig. 2.). The mean annual rainfall is between 1200 and 1700 mm and the monthly distribution pattern is similar throughout the region (Wall 1997; Smith et al. 1997).

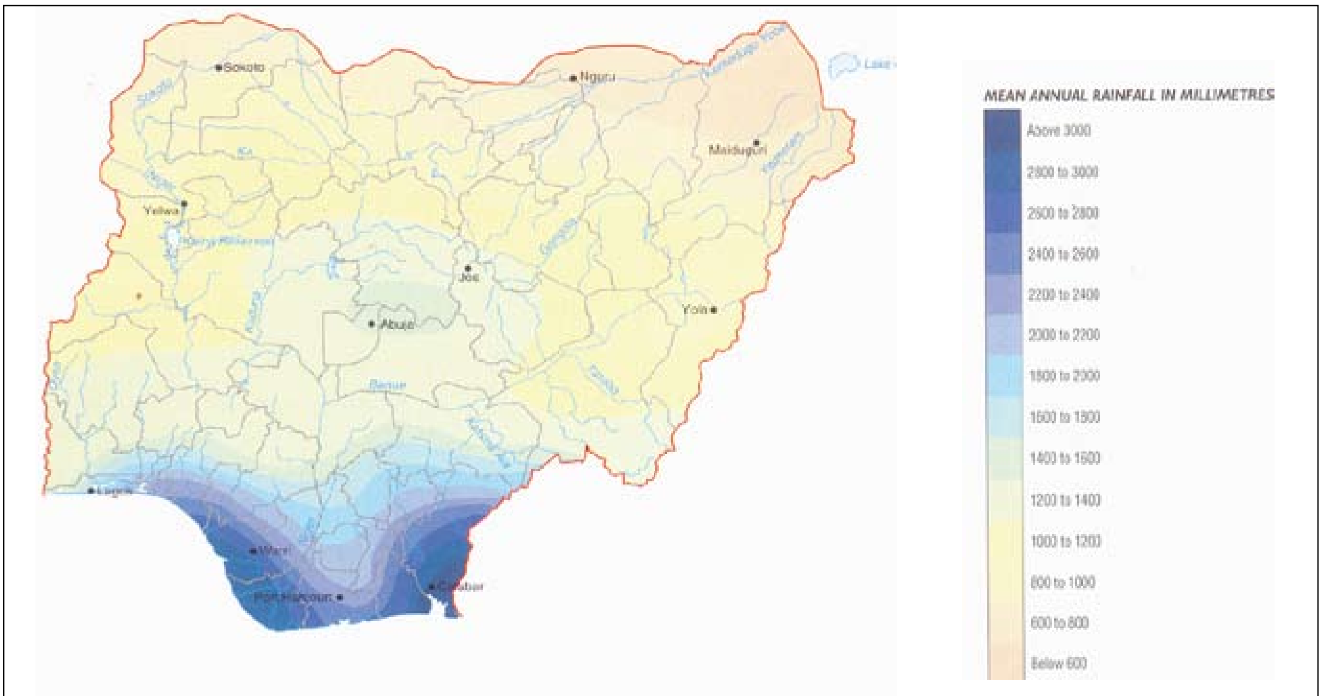

Figure 2. Agroclimatic distribution in selected countries.

Table 1. Selected survey districts and agroclimatic characteristics.

Features	District	
	Rano	Malumfashi
Lowest monthly rainfall (mm)	44.8	8.70
Highest monthly rainfall (mm)	303.0	307.6
Annual rainfall in 2006 (mm)	1127.5	952.95
Average altitude of district (m)*	534	595
- Latitude (°N)	11.55	11.79
- Longitude (°E)	008.52	007.61
Minimum monthly temperature level (°C)	13	27
Maximum monthly temperature level (°C)	40	38

Note: *Taken from GPS with community centers used as reference points.
Source: District Secretariats; Agboola (1987) and Balogun (2005).

Malumfashi district is located between latitude 11.78540° N and longitude 007.61306° E, with an altitude of 614 masl. Rano is situated on latitude 11.55935° N, longitude 008.57891° E and an altitude of 534 masl. There are variations in monthly rainfall distribution in the zone (Table 1). For example, the highest monthly rainfall in 2006 was recorded in September for Malumfashi, and in August for Rano; the lowest was recorded in October in both districts. There was no rain from November 2005 to April 2006 in the two districts. Thus, the zone is characterized by a mono-modal rainfall of 900–1200 mm that extends over a season of 150–180 days. Early season drought is common, although late season drought also occurs. Rainfall variability is higher at the beginning and towards the end of the wet season than in the middle (Kamara et al. 2006). The rainfall distribution, the duration, and the number of months with very low rainfall, have a greater impact on agricultural production activities than the total rainfall (Aina and Salau 1992).

Temperature plays an indirect role on plant growth through its effects on evaporation and photosynthesis, with high mean annual temperatures encouraging high evapo-transpiration and consequently low water balance levels (Agboola 1987; Aina and Salau 1992). Agboola (1987) and Jagtap (1995) have shown that the period December–February is particularly cold in the zone covering both districts due to the cold dry harmattan winds. High temperatures are usually recorded from March to June. The mean annual temperature was 34.6 °C.

Monthly variation in temperatures was also recorded in the zone in 2006. In Rano, a minimum temperature of 13 °C was observed in December and the highest temperature of 40 °C was reached in April. The minimum temperature in Malumfashi (27 °C) was higher than that of Rano, but Malumfashi had a lower maximum temperature of 38° C in May, compared with 40 °C in Rano.

4. Demographic characterization of households

The age of respondents ranged from 20 to 80 years with a mean of about 47 for the zone. The modal age was 50 years, and about 89% of the respondents were within the age range of 21 to 60 years. However, about 11% were over 60 years old which suggests an ageing farming population. Few younger people entered the farming business. The majority of the youths out-migrated to urban centers for better job opportunities or engaged in ferrying people on motor cycles (locally called *kabukabu* in Malumfashi and *yan achaba* in Rano). The business was believed to be lucrative (Table 2).

The majority (about 98.6%) of the household heads were married, about 1% were single, only 0.3% were divorced. This suggests that most households in the survey area had some responsibilities towards their families.

About 97% of the household heads indicated that crop production decisions in the household depended on them, and other members (e.g., spouses and children) contributed less. A larger percentage of households was educated in Malumfashi than in Rano district. About 48% were literate, having attained primary, post-primary,

Table 2. Descriptive statistics of sampled households.

Household feature	Whole sample (n = 350)	District Malumfashi (n = 175)	Rano (n = 175)
Gender (%): male	99.4	98.9	100.0
Age	47.4	46.7	48.0
Educational level	4.5	4.2	4.8
Membership of farmer association (%)	65.1	67.4	62.9
Household size (#)	12.9	12.5	13.4
Major decision-maker in household:			
- Household head	97.7	97.7	97.7
- Household head and spouse	1.7	1.7	1.7
- Children	0.3	0.6	-
- All members of household	0.3	-	0.6
Marital status (%): - Married	98.6	97.7	99.4
- Single	1.1	1.7	0.6
- Divorced	0.3	0.6	-
Credit (%)	95.0	97.1	92.0
Frequency of extension contact	1.7	1.7	1.8
Area cultivated to improved maize (ha)	2.5	1.4	3.6
Farm distance (km)	4.6	3.9	5.3
Adoption of improved maize (%)	68.3	63.4	73.1
Perception (%) of: - Yield potential	76.9	76.6	77.1
- Pest/disease resistance	3.7	2.3	5.1
- Seed availability	37.4	34.9	40.0
Wealth index	0.0	-0.58	0.57

Note: () figures in parentheses are standard errors, *, ** indicate significance at 1% and 5%.

and adult education; only about 1% had no formal education. Islamic education was, however, predominant in the two districts, particularly in Rano where more than half of the sampled households attended Koranic school. About 65% of the households belonged to different associations, such as farmers' groups, cooperative societies, and religious groups.

A larger proportion of households in Rano had adopted the cultivation of improved maize and allocated more land to its production than in Malumfashi. This might be associated with the positive average wealth index (0.57) recorded for Rano, which showed a better endowed farming population. Consideration of yield potential and seed availability was important for the cultivation of improved maize in both districts.

5. Household access to capital assets

*Note :** Multiple responses taken. Capital assets denote the physical assets which have been produced by human activity but which are not yet utilized. Some capital is needed for any kind of productive activity. According to Upton (1979), farm capital assets include machines, tools, buildings, roads, footpaths, drainage ditches, terraces, irrigation equipment, growing crops, livestock, and stocks of food, seeds, fertilizers and other materials. In general, household capital assets or livelihood resources could be classified into five: human assets (household labor capacity, family and non-family labor); natural assets (e.g., total and cultivated farm land); physical assets (ownership of cattle, bicycles, radios, television sets, etc.,); financial assets (access to cash, credit, and remittances); and institutional/social capital assets (access to social networks and membership of associations).

Table 3. Household labor force availability.*

Item	No. of persons	No. of persons available for farm work/household	No. in months available for farm work
Mean	12.9	4.4	4.9
Mode	15	1.0	6.0
Minimum	4	1	1
Maximum	26	23	10
Standard deviation	4.70	3.15	1.31

Note: *The figures are based on male respondents alone, as only two female respondents were sampled.

Table 4. Land use by households.

Plots	Percentage of households	*Proportion of farm land (ha.
Abandoned	11.4	49.3
Fallow	14.3	10.6
Pasture	2.0	3.3
Tree crop	0.3	3.8
Cultivated	100.0	33.1
Total (n)	350	100.00

Human assets

The relationship between the household head and household members varied, with the latter including spouses, parents, children/grandchildren, nephews/nieces, sons in law /daughters-in-law, and brothers/ sisters. Children predominated, and were 56% of the total household members. This showed a relatively high dependency ratio.

Labor availability on the farm is defined in terms of the work done by other people apart from the farmers themselves, and hence it is measured as a flow over a given period of time (Upton 1979). Although the total number of males/household was larger than that of females, on average, almost equal numbers of persons were available for farm work in each household (Table 3). This suggested that not all the persons in a household contributed to farm work in the study area. The results also showed that male family labor accounted for 42% of farm work and hired labor for the remaining 58%. This was attributed to the out-migration of rural youths to urban centers and the shift of those remaining to other businesses (particularly carrying passengers on motor cycles—*yan achaba*), leading to the scarcity and high cost of farm labor. However, male household labor was available for farm work over a longer period (5 months) than female labor due to the domestic chores which female household members have to attend to after farm work.

Natural assets

The average farm size in the study area was about 11 ha, but the area of farm land actually cultivated was 8.7 ha. Household farms were subdivided into different plots comprising abandoned, fallow, pasture, tree crop, and cultivated areas (Table 4).

An area of about 33% of the farm land was cultivated by all the sampled households; a larger proportion (49%) was abandoned due to lack of funds; an area of 11% was left to short fallow for the land to replenish its nutrient status. Most abandoned plots were located far away from the households' dwellings.

The majority (85.7%) of the respondents continuously cropped the farm land without leaving it to fallow. This negates the traditional practice of leaving the land to fallow for over 10 years to enable its fertility to be restored (Agboola 1987; Manyong and Houndekon 1997). Respondents attributed the change to the increasing pressure on land arising from population growth, which had drastically reduced the size of the farmers' average land holding over time. Only male respondents left their land to fallow, as females do not have the easy access to

land that would allow them to leave some portion to fallow. The time taken to walk to fallow plots averaged 1.14 h. About 66% of the respondents claimed that they owned the fallow plots; 28% acquired them through outright purchase; 4% of plots were acquired through inheritance. The crops grown after fallow included sorghum, maize, groundnut, cowpea, rice, finger millet, and beans.

A group of farmers being interviewed.

Only 2% of the households had pasture land. About 57% of the respondents claimed that they owned this land; 28.6% indicated it was acquired through outright purchase and 14.3% through inheritance. The number of farm plots owned by households ranged from one to ten. The major crops grown on these plots included sorghum, improved OPV maize, local maize, hybrid maize, rice, groundnut, pearl millet, finger millet, cowpea, beans, sweetpotato, soybean, cassava, and teff, with little variation in number and crop type across plots. Average trekking time to farm land was about 1.2 h from the respondent's dwelling. The two main sources of water supply to the maize plots were rainfall (96% of the respondents, including the females) and irrigation (4.4%). Land owned through inheritance, outright purchase, rented-in land, sharecropping, and rented-out land were the main tenure arrangements on these plots, in order of predominance.

The gender distribution of households' access to farm land is shown in Table 5. Only male household heads had access to abandoned, fallow, pasture, and tree farm land. Additionally, the area of land cultivated by men (about 7 ha) was significantly larger ($P \leq 0.01$) than that cultivated (about 2 ha) by the two women in the study sample. This further reflects the sociocultural factors constraining female access to farm land in the survey location.

When asked how the size of maize farms in the previous seasons compared with that of the season studied, about 41% of the respondents claimed to have larger maize farms than in previous years; about 30% indicated that there was no difference in the land area cultivated to maize; 19% reported having smaller maize farms. These estimates basically reflected the views of males who dominated the maize growing population. One of the two female respondents indicated no change in the size of her maize farm cultivated in the two seasons, while the other reported that she had no basis for comparing maize farms for the two periods since she had just started production. The major reasons for keeping the same size of maize plot included unchanged amount of cash available for inputs (for 29.8% of the respondents), unchanged land size (28.8%), unchanged labor force and seed prices (1%). The female respondent attributed the unchanged size of her maize farm to her inability to acquire more land. The respondents who claimed they had currently larger maize farms attributed this to their

Table 5. Access to farm land by gender.

Land type	Whole sample (n = 350)	Male (n = 348)	Female (n = 2)
Abandoned plot (ha)	13.1	13.1	-
Fallow (ha)	2.8	2.8	-
Pasture (ha)	0.9	0.9	-
Tree crops (ha)	1.0	1.0	-
Cultivated farm land (ha)	6.7	8.3*	1.6

Note: * Significant at 1% level.

having enough cash to buy inputs (47.9%), high interest in expanding their farms (14.6%), and access tosufficient labor (12.5%), and also to better rainfall (11.8%). Other reasons included enough seeds (6.9%) and the availability of land for expansion (4.2%). The management of smaller maize plots in the current season was attributed to the shortage of cash for inputs. Other reasons included the reduced availability of land (10.3%), reduced labor force (8.8%), farmers' interest in intensive farming (5.9%), poor rainfall (5.9%), pests and diseases (2.9%), and floods (1.5%).

The most important factors determining the size of the cultivated farm land are shown (Table 6). Five main factors determined the size of the cultivated land. These were cash availability to purchase other inputs, food needs, expected availability of family labor, expected postharvest grain price, and the availability of cash to hire labor. The percentages of households cultivating different farm sizes are shown in Figure 3. Most of the households (57%) cultivated small land areas of less than 2.5 ha; 27% cultivated a medium sized area of between 2.6 and 5.0 ha; only 16% cultivated larger plots that were greater than 5.0 ha. This showed that households in the survey area were mostly smallholders.

Table 6. Ranking the determinants of farm sizes.

Item	Percentage of households
Food needs	26.2
Cash availability to purchase other inputs	26.4
Expected family labor availability	13.9
Expected grain price after harvest	13.4
Cash availability to hire labor	13.4
Current grain prices	2.4
Draft power	0.1
Seed availability	3.0
Others	1.2
Total	100.0

(16.3%); and unchanged seed quantity (10.6%). Other reasons were the lack of interest in expanding the farm size (3.8%), pests and diseases (1.9%), unchanged rainfall pattern (1.9%), yield (1%), market prices (1%)

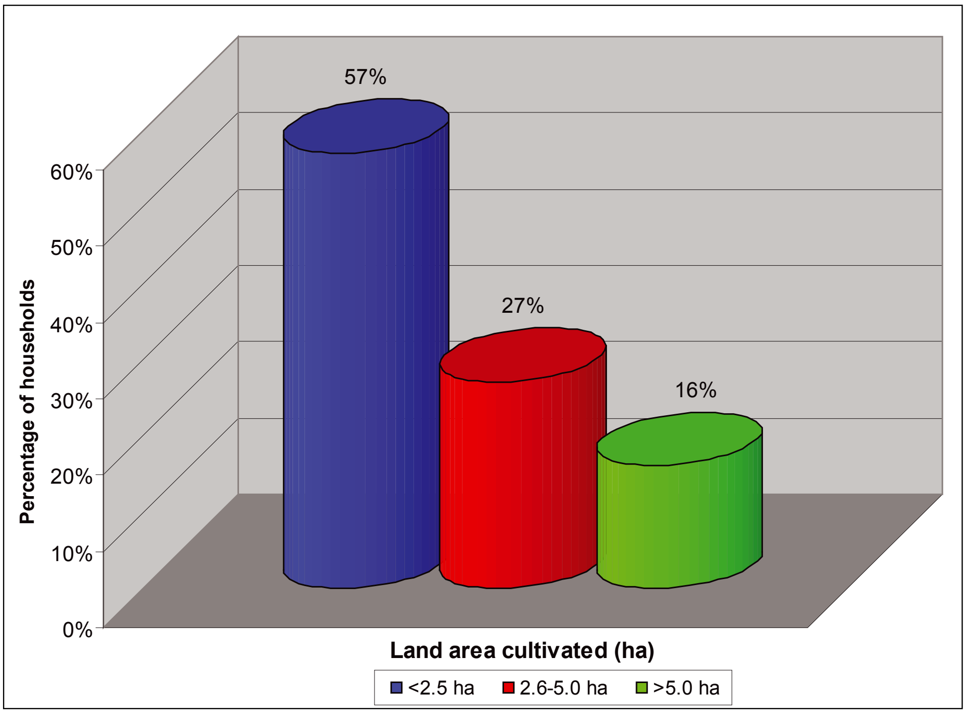

Figure 3. Land area cultivated by households.

Physical assets

There were 10 different types of dwelling typical of households in the study area, with eight in each of the districts. These included mud huts, brick and block houses with different roofing materials, as well as pole and *dagga* houses with grass thatched roofs (Table 7). *Dagga,* sometimes called *cannabis,* is a material added to clay to strength the bricks used for building. About 20% of the households in Rano identified the major dwelling types as mud huts with grass thatched roofs, brick houses with asbestos/corrugated iron roofs, and block houses with asbestos/corrugated iron roofs. In Malumfashi, the block houses with asbestos/corrugated iron roofs and brick houses with asbestos/corrugated iron roofs were predominant. In general, the brick houses with asbestos/corrugated iron roofs and mud huts with asbestos/corrugated iron roofs were the most common types among the rural farming households in Nigeria.

Households in the survey location owned and had access to different physical assets. About 92% of the respondents owned a radio, 81.7% a bicycle, 56.6% a motor cycle, and 54.6% a private well (Table 8). Other capital assets owned in order of accessibility were mobile phones (30.6%), draft animals (27.7%), animal-drawn plows (25.1%), wheelbarrows (24.9%), television sets (20.9%), electricity generators (14%), motor vehicles (12.6%), animal scotch carts (12%), animal-drawn harrows (10.6%), water pumps (6%), tractors (3.1%), diesel pumps (2.6%), fixed phones (2.6%), tractor-drawn harrows (2.3%), tractor-drawn plows (2%), water tanks (2%), and cultivators (0.6%). In general, over 50% of the respondents owned a radio, bicycle, motor cycle, and private well. However, the number of radios and bicycles owned by the households was larger than that for other assets. Respondents indicated that the radio is the most common

A maize farmer in Malumfashi, Nigeria.

Table 7. Types of dwelling used by households.

Type of house	Rano		Malumfashi		Whole sample	
	Frequency	%	Frequency	%	Frequency	%
Mud hut/grass thatch roof	17	9.7	2	1.1	19	5.4
Mud hut/asbestos/corrugated iron roof	44	25.1	1	0.6	45	12.8
Mud house/mud roof	-	-	23	13.1	23	6.6
Brick house/grass thatched roof	15	8.6	-	-	15	4.2
Brick house/asbestos/corrugated iron roof	41	23.4	62	35.4	103	29.4
Brick house/mud roof	-	-	1	0.6	1	0.3
Block house/asbestos/corrugated iron roof	38	21.7	70	40.0	21	6.0
Block house/ mud roof	1	0.6	13	7.4	14	4.0
Block house/grass thatched roof	18	10.3	3	1.8	21	6.0
Pole and *dagga*/grass thatched roof	1	0.6	-	-	1	0.3
Total	175	100.0	175	100.0	350	100.0

Table 8 .Proportional distribution of physical assets by households*.

Asset	Quantity owned (%)	Ownership (percentage of households)	No. bought within study period	No. sold within study period	Asset balance
Motor vehicle	22.9	12.6	10	12	-2
Motor cycle	83.7	56.6	86	27	59
Bicycle	164.3	81.7	97	29	68
Tractor	4.6	3.1	3	0	3
Tractor-drawn plow	2.0	2.0	1	0	1
Tractor-drawn harrow	2.6	2.3	1	0	1
Draft animal	79.4	27.7	35	18	17
Animal-drawn plow	39.1	25.1	12	4	8
Animal-drawn harrow	13.4	10.6	6	1	5
Animal scotch cart	14.0	12.0	3	1	2
Wheelbarrow	30.3	24.9	8	1	7
Television set	32.0	20.9	20	10	10
Radio	212.9	91.7	187	38	149
Private well	61.7	54.6	6	0	6
Water pump	9.1	6.0	5	0	5
Cultivator	0.6	0.6	0	0	0
Diesel pump	3.1	2.6	0	1	-1
Water tank	2.9	2.0	2	0	2
Generator	18.0	14.0	16	5	11
Mobile phone	50.3	30.6	80	6	74
Fixed phone	4.9	1.4	8	1	7

Note: *Multiple responses. A scotch cart is a heavy horse-drawn vehicle used for farm work,

medium through which information was received about their farm activities. About 29% of those who had a radio bought only one within the period under study; 7.1% bought two, while 10 was the maximum number bought. About 31% of household heads owned a radio compared with 5% for children under 18 years of age, and 82% owned bicycles. The majority of the respondents who owned between one and three motor cycles bought them during the study period. About 48% of the household heads had private wells, which are regarded as an investment by the wealthy within the community.

Based on the total number of other assets bought and sold within the period under study, it was found that respondents recorded no addition in the total number of cultivators owned; diesel pump sales reflected sales out of old stock; the higher sales over purchases for motor vehicles implied sales out of old stock; and motorcycles recorded a positive balance, implying some addition to asset stock. In all cases, the household head was the main buyer and seller of the assets.

Table 9. Access to credit by households in 2005–2006.

Credit type	Percentage of households	Timely receipt of credit (%)	Total amount of credit received (N)	Interest rate on credit (%)	Amount repaid (%)	Form of repayment
Cash credit:						
Production	19.7	16.0	52,758.0	8.7	56,691.3	-Cash -Grain
Consumption	2.6	2.6	15,333.0	2.2	15,422.2	-Cash
Input credit:						
Maize seeds	0.3	100.0	15,600.0	-	15,600.0	-Grain
Basal fertilizer	2.3	1.4	7,046.3	11.0	49,978.1	-Cash -Seeds -Grain
Top dressing fertilizer	1.7	83.3	1,141.7	11.1	30,870.8	-Cash -Seeds

Access to financial assets

About 27% of the respondents indicated having received cash/input credit during the 2005–2006 maize production season (Table 9). The major sources of these credits were neighbors, relatives, money lenders, Government programs, financial institutions, and NGOs. However, the majority (over 70%) of the household heads did not have access to credit. The reasons given for their inability to obtain credit, in order of importance, included lack of access to sources of credit in the vicinity, no attempt made to look for credit on the part of the respondents, no collateral to guarantee credit, high interest rates, and a combination of no collateral and no source of credit.

The average interest rate charged on input credits was found to be higher than that for cash credit, while the interest on production credit was greater than that charged on consumption. However, more than 100% of the cash credit received for production by households was repaid, compared with the repayment of input credit. This might be attributed to the tailoring of production credit to the purpose for which it was meant, but input credit might not have been used as appropriately as expected. Most farmers claimed to use inputs below the recommended dosages just because they wanted to ensure that the small amount of input they got was adequate for their farm size. In effect, the input becomes insufficient and hence ineffective where applied. This calls for effective extension services to enlighten farmers on the need to apply recommended rates of inputs.

The major forms of repayment were cash, grain, and seeds. Maize seed input was specifically repaid as grain. All the household heads indicated that they had received the maize seed input on time; over 80% of them indicated that they had received top dressing fertilizer on time. However, respondents indicated that there were delays in receiving production credit and basal fertilizer from credit providers, thus making it impossible for them to repay promptly, due to wrong timing and their inability to use the credit provided for the intended purpose. Thus, there is a need for adequate and timely provision of both cash and credit facilities to the households for their effective and efficient use by farmers.

Institutional and social capital

A total of 16 (4.6%) households benefited from either Government or NGO programs within the two years before the period under study. Only about 1% benefited from Sasakawa Global 2000; 2.6% benefited from the Government Starter Pack Program; 0.9% benefited from the ADPs (Table 10).

Table 10. Sources of institutional support to households.

Type of support	Average number of times household benefited	Package of relief benefits enjoyed
Sasakawa Global 2000	Once (Range: 1- 4 times)	-Fertilizer -Seeds and fertilizer
Government Starter Package	1.5	-Fertilizer -Seeds and fertilizer
ADPs	Once	-Fertilizer -Seeds and fertilizer
Government Safety Network	2.3	-Food -Fertilizer
Other support programs	4.3	-Food -Seeds -Fertilizer -Seeds and fertilizer -Livestock breeding stock

Table 11. Access to field demonstrations.

Host for activity	Percentage of households who attended field demonstrations	Percentage of households who attended field days	Percentage of households who discussed maize crop production in field demonstrations
Agricultural research institute	1.4	-	1.4
Agency of agricultural research institute	-	-	-
NGOs	1.1	0.6	1.4
Cotton company	0.3	-	-
Agricultural development agency	2.3	2.9	3.4

The benefits enjoyed by the households included seeds, fertilizer, and food relief, as well as livestock breeding stock from other developmental programs, with most households benefiting either once or twice within the period.

About 65% of household heads had been members of farmers' associations for an average of 3.5 years. The major sources of extension messages were radio, agricultural extension staff, bulletins, newspapers, and television. On average, households interacted twice with extension officers within the period 2005–2006.

Field demonstrations were mainly organized by agricultural research institutes, NGOs, cotton companies, and agricultural development agencies in the area. Field days were hosted by NGOs and agricultural development agencies (Table 11).

Only a few of the respondents attended either the field demonstrations or field days. Among the respondents who had attended field demonstrations, two persons took part once in that organized by agricultural research institutes, and only one person attended twice. One person participated once in field demonstrations hosted by NGOs; another participated twice. Only one person twice attended field demonstrations organized by cotton companies. The highest frequency recorded of participation in field demonstrations was in those hosted by agricultural development agencies. Maize production was discussed during field demonstrations organized by other organizations, apart from those hosted by the cotton companies and NGOs.

6. Household wealth computation

To a large extent, each of the capital assets discussed potentially contributed to the households' wealth status and determined the households' ability to take the risks associated with the adoption of innovations (Moser 1998; Freeman et al. 2004).

A composite measure of the cumulative living standard or wealth status of a household is the wealth index (WI). It is calculated using data on the households' ownership of selected assets, such as television sets and bicycles, materials used for housing construction, and types of water supply and sanitation facilities. Generated using a principal components analysis (PCA), the WI places individual households on a continuous scale of relative wealth. In computing this index, those household capital assets were used that are generally perceived to be important indicators in defining wealth status in the study area. These comprised ten differently categorized assets, namely: labor force (human capital), total farm size and area cultivated to improved maize (natural capital), motor cycles, draft animals, radios, bicycles, and television sets (physical capital), access to credit or cash (financial capital), and membership of an association (social capital).

Each household asset for which information is collected is assigned a weight or factor score generated through PCA, a multivariate statistical technique used to reduce the number of variables in a data set into a smaller number of "dimensions". PCA starts by specifying each variable normalized by its mean and standard deviation (Langyintuo 2008). 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*:

$$
\begin{aligned}
a_{1j} &= v_1 A_{1j} + v_2 A_{2j} + \ldots + v_{1K} A_K \\
&\ldots \qquad\qquad \forall j = 1, \ldots, j \qquad (1) \\
a_{K1j} &= v_{K1} A_{1j} + v_{K2} A_{2j} + \ldots + v_K A_K
\end{aligned}
$$

Maize field in Rano, Nigeria.

where the *A*s are the components and the *v*s the coefficients on each component for each variable (and do not vary across households). PCA finds the linear combination of the variables with maximum variance, usually the first principal component A_1j, and then a second linear combination of the variables, orthogonal to the first, with maximal remaining variance, and so on. This technique extracts the few orthogonal linear combinations from a set of variables that capture the common information most successfully (Grandin 1988; Filmer and Pritchett 1998, 2001; Ellis and Bahiigwa 2003; Freeman et al. 2004; Zeller et al. 2005; Langyintuo 2008). 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 of the variables. According to Filmer and Pritchett (2001) the critical assumption of PCA is that the undefined "common information" is determined by the underlying phenomenon that the index is trying to measure (in this case, wealth). This, 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. The first principal component is hence expressed in terms of the original (un-normalized) variables, and an index for each household is based on the expression:

$$A_{1j} = f_1\ (a^*_{1j} - a^*_1)(\ s^*_1) + ... + f_{1K}(a^*_K\ - a^*_K)(\ s^*_K) \qquad (2)$$

Suppose we have a set of *K* variables, *a**1*j* to *a***K j*, representing the ownership of *K* assets by each household *j*. Principal components starts by specifying each variable normalized by its mean and standard deviation. Technically, the procedure solves the equations (**R** –λ**I**)**v***n* = 0 for λ*n* and **v***n*, where **R** is the matrix of correlations between the scaled variables (the *a*s) and **v***n* is the vector of coefficients on the *n*th component for each variable. Solving the equation yields the eigenvalues (or characteristic roots) of **R**, λ*n,* and their associated eigenvectors, **v***n*. The final set of estimates is produced by scaling the **v***n*s so that the sum of their squares sums to the total variance. The resulting asset scores are standardized (using assigned weights) in relation to a standard normal distribution with a mean of zero and a standard deviation of 1.0.

The assigned weights are then used to construct an overall WI applying the following formula:

$$W_j = \sum_{i=1}^{k} [b_i(a_j\ - x_i]\ / s_i \qquad (3)$$

where: ***Wj*** is a standardized wealth index for each household; **b*i*** represents the weights (scores) assigned to the (*k*) variables on the first principal component; **a*ji*** is the value of each household on each of the *k* variables; **x*i*** is the mean of each of the *k* variables; and **s*i*** the standard deviations. These standardized scores are then used to create the break points that define wealth categories as **lowest, second, middle, fourth, and highest.** A negative index (-*Wj*) means that, relative to the communities' measure of wealth, the household is poorly endowed and hence worse-off. A positive figure (*Wj*) signifies that the household is well-off or well endowed. In this study, the sample mean index of zero is used. Households above the mean are categorized as well endowed while those below are poorly endowed. One of the advantages of PCA, apart from the objectivity of the weights, is that it estimates the contribution of each variable to the underlying common phenomenon, and thus enables the ranking of indicators according to their importance in determining a household's level of wealth. Also, multicollinearity is not a problem in PCA as matrix inversion is not required,**fixed assests,** multicollinearity **.** The impact factor, which indicates the relative adjustment of the WI by acquiring corresponding assets, is computed by dividing the score by the standard deviation (Langyintuo 2008).

Based on the overall standardized composite WI computed from the varying levels of different assets owned by the household, the probability distribution of households by wealth group in the study area is shown in Figure 4.

The average WI of maize producing households below the mean index (with Wi < 0) was -0.598: for those above the mean index (with Wi > 0) it was + 0.967. The distribution of households within the wealth categories showed that there was a decreasing trend in the number of households that belonged to each wealth category, as the WI increased. With a sample mean index of zero, about 62% of the households were categorized as poorly endowed and 38% were well endowed. This showed that the majority of the maize producers in the

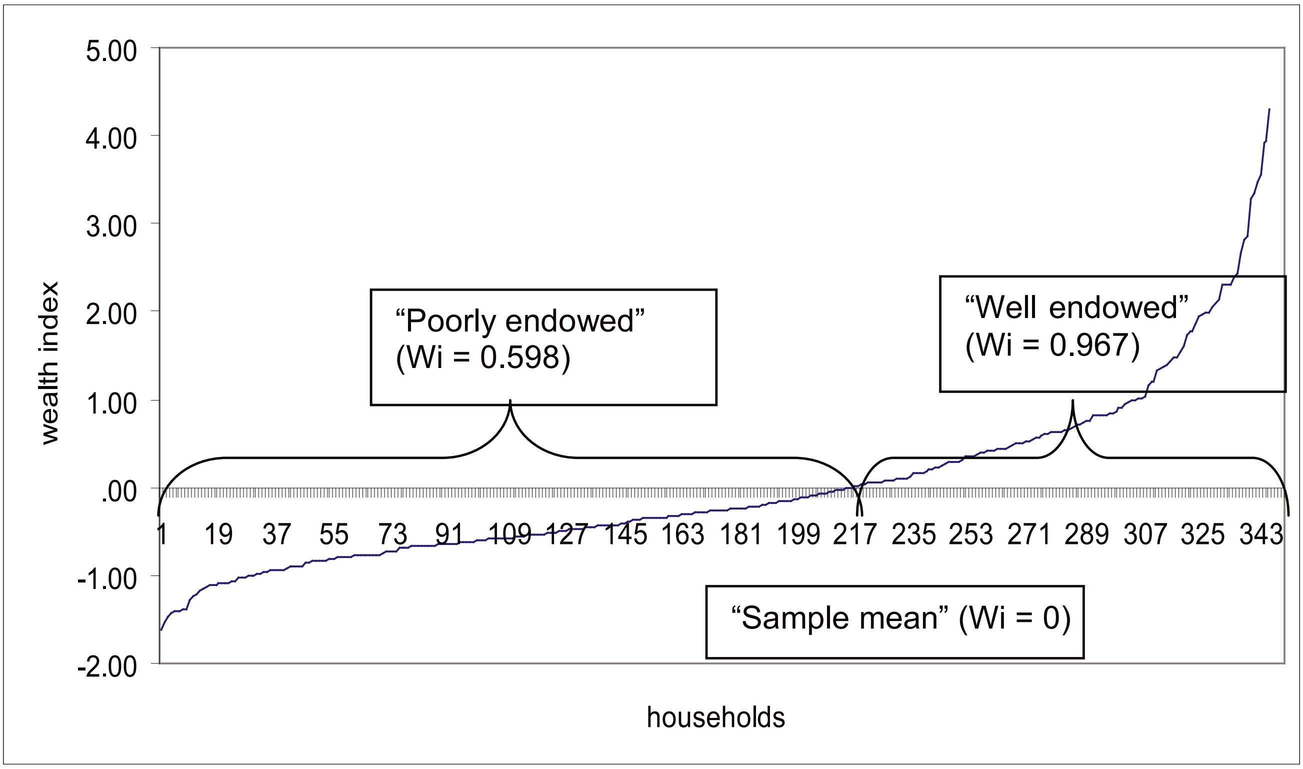

Figure 4. Probability distribution of households within wealth categories.

study area were poor. The estimation of the impact factor showed that the assets with the highest impact in the study area were the household's ownership of a cultivable farm, radio, remittances, total farm size, motor cycle, television set, mobile phone, draft animal, bicycle, wheelbarrow, private well, and the total household size, in descending order. Cash credit had the least impact. Respondents attributed this to the diversion of cash credit facilities to non-productive activities, such as marrying more wives, by most resource-poor rural households, as earlier reported by Upton (1979).

Household demographic characteristics by wealth groups

The distribution of some selected characteristics of the households according to wealth groups is shown in Table 12. There were significant differences between the characteristics of the well endowed and the poorly endowed households. For example, the ownership of a large plot of land was an important measure of wealth in the area. A larger percentage of the well endowed households (72%) belonged to associations and had larger farm sizes, averaging about 20 ha. These were located at longer distances of 5.4 km from the market center, than the farms of the poorly endowed. They also adopted more (79% households) and cultivated larger areas of about 4.4 ha to improved maize. On the other hand, more (97%) of the poorly endowed households had better access to credit. This was attributed to the targeting of credit facilities to poor households by Government and NGO programs (such as Sasakawa Global 2000 and the Government Starter Pack scheme) in some of the communities during the period under study. A larger percentage of the poorly endowed households actually cultivated their farm land compared with the well endowed. Respondents attributed this to households shifting away from agriculture to other economic activities as a means of livelihood as they become wealthier.

Table 12. Distribution of household demographic characteristics by wealth group.

Variable	Whole sample (n = 350)	Wealth group		Significance (/t/)
		Poorly endowed (n = 218)	Well endowed (n = 132)	
Demographic characteristics				
Age (years)	47.37 (0.62)	46.67 (0.75)	48.52 (1.06)	1.46
Education (years)	4.51 (0.09)	4.63 (0.12)	4.31 (0.14)	1.70
Credit	0.95 (0.01)	0.97 (0.01)	0.92 (0.02)	2.10**
Membership of associations	0.65 (0.03)	0.61 (0.03)	0.72 (0.04)	2.09**
Extension contact	1.74 (0.12)	1.62 (0.14)	1.93 (0.22)	1.23
Farm size (ha)	10.68 (1.06)	5.02 (0.22)	20.04 (2.60)	7.36*
Household size (No.)	12.91 (0.25)	12.70 (0.32)	13.27 (0.41)	1.58
Area cultivated to improved maize (ha)	2.49 (0.22)	1.34 (0.08)	4.39 (0.54)	2.93*
Farm distance (km)	4.59 (0.14)	4.11 (0.12)	5.38 (0.29)	4.64*
Yield potential	0.77 (0.02)	0.74 (0.03)	0.81 (0.03)	1.45
Pests and diseases	0.04 (0.01)	0.03 (0.01)	0.05 (0.03)	0.64
Seed availability	0.37 (0.03)	0.34 (0.03)	0.42 (0.04)	1.50
Family labor (#)	0.39 (0.02)	0.49 (0.03)	0.23 (0.02)	6.87
Adoption of improved maize (#)	0.68 (0.03)	0.62 (0.03)	0.79 (0.04)	3.33*
Physical assets				
Bicycles	1.66 (0.08)	1.37 (0.07)	2.13 (0.15)	5.12*
Motor cycles	0.84 (0.06)	0.46 (0.04)	1.47 (0.11)	10.21*
Television sets	0.32 (0.04)	0.07 (0.02)	0.72 (0.09)	8.59*
Radios	2.13 (0.09)	1.60 (0.07)	2.99 (0.17)	8.65*
Draft animals	0.79 (0.09)	0.24 (0.05)	1.71 (0.20)	8.66*
Cattle	1.55 (0.29)	0.66 (0.22)	3.00 (0.67)	3.94*
Bulls	1.21 (0.17)	0.55 (0.10)	2.29 (0.39)	5.32*
Goats	10.79 (0.57)	9.54 (0.50)	12.84 (1.24)	2.85*
Sheep	6.07 (0.40)	4.13 (0.34)	9.25 (0.84)	6.50*
Local chickens	13.29 (1.00)	12.08 (1.11)	15.26 (1.91)	1.55
Wealth index (wi)	0.001 (0.054)	0.598 (0.024)	0.97 (0.08)	21.555*

Note: () figures in parentheses are standard errors, *, ** indicate significance at 1% and 5%.

On average, there were no significant differences in the age, education, extension contact, household size, and family labor of the well endowed and poorly endowed households. This implies that these variables are almost the same for both categories of wealth group, as the notable differences are due to chance factors. Similarly, there was no significant difference in the perception of both wealth groups on the yield potential of the maize variety, resistance to pests and diseases, and seed availability.

Household physical assets by wealth groups

In general, households' asset distribution showed some variations between the two wealth groups (Table 12). Except for local chickens which were not significantly different for the two wealth groups, other physical assets owned by the well endowed households were significantly larger than those owned by the poorly endowed. This was further indicated by the significantly different WI of the poorly endowed and the well endowed households.

7. Household livelihood strategies

The livelihood of households in the study area was centered on the availability of land for food crop and livestock production and on marketing. This section is divided into four subsections. The first provides information on crop production, particularly with respect to the pattern of distribution of farm lands among crops, input use by the farm households, determinants of adoption of improved maize seeds, and crop marketing decisions. The second discusses livestock production and marketing decisions. The third reports the income and expenditure profiles of households, based on income earned from agriculture and off-farm activities and the households' expenditure profiles. The impact of shocks on household livelihood outcomes is described in the fourth section.

Crop production

Distribution of farm land among crops

The household allocation of farm land to different crops is shown (Fig. 5). Cereals dominated the land area, with improved maize, local maize, hybrid maize, and sorghum being cultivated by a larger number of the households. The highest number of crop plots owned by household heads was 10, with either improved OPV, local, or hybrid maize varieties constituting the first crops planted on the fields. Other crops planted in order of importance included sorghum, sweetpotato, rice, groundnut, and soybean. Pearl millet, finger millet, cowpea, and cassava were also grown by some households.

When considered along wealth groups, the distribution of farm land among crops showed that sorghum, local maize, improved OPV maize, and hybrid maize were major crops grown by both the poorly endowed and the well endowed households (Figs 6a and 6b). However, a larger proportion of the poorly endowed households cultivated sorghum and local maize and the well endowed cultivated more improved OPV and hybrid maize.

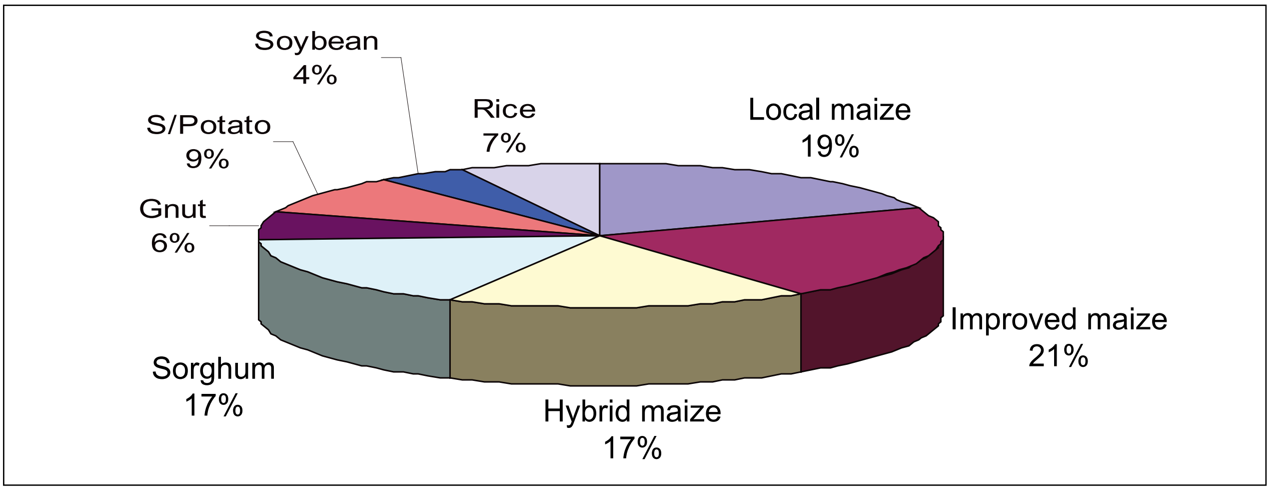

Figure 5. Distribution of land area among crops by households.

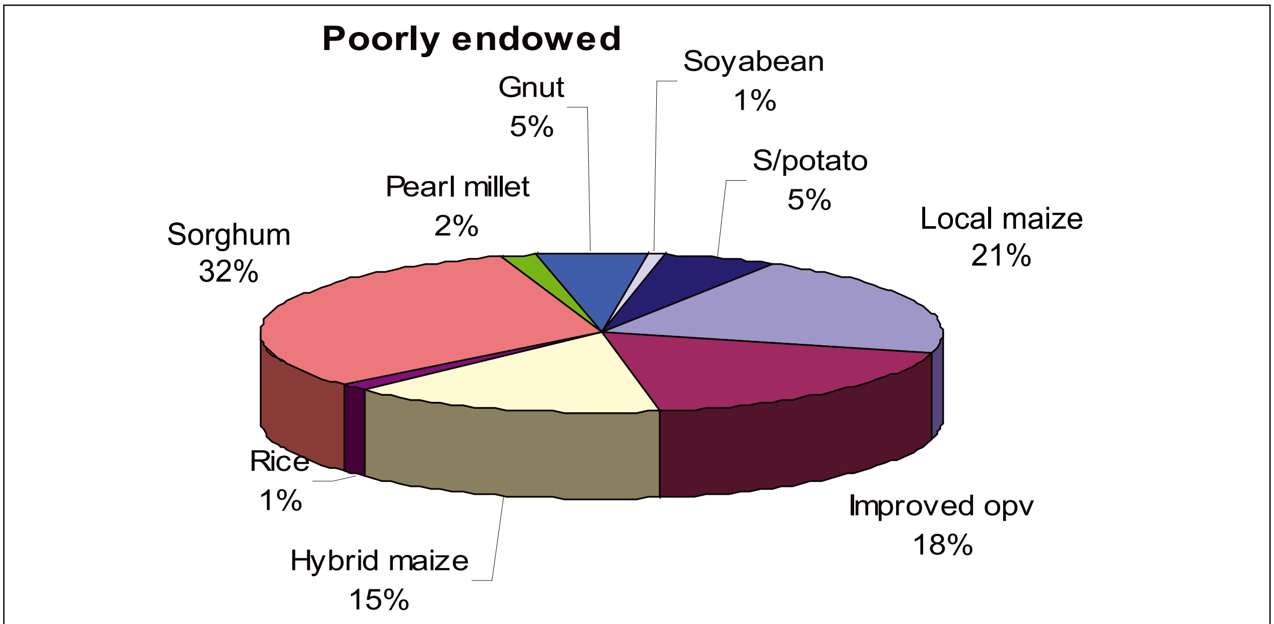

Figure 6a. Crops grown by poorly endowed households.

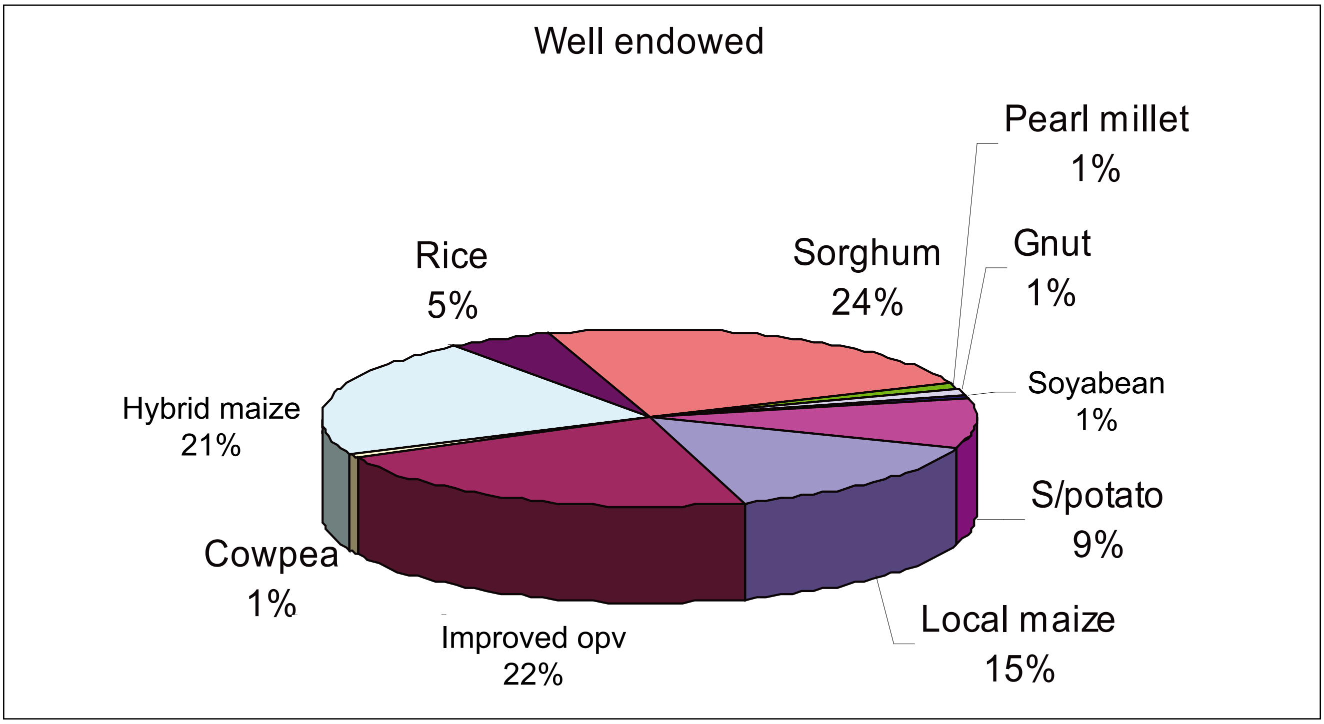

Figure 6b. Crops grown by well endowed households.

Input use by farm households

About 58.6% of the sampled households purchased maize seeds in the 2005–2006 production season. Among the varieties purchased were Oba Super 1 (16.9%), Yar kassa (15%), ACR97 (10%), white hybrid (6%), Oba Super 2 (4.6%), yellow hybrid (2.6%), Geo 1 (0.9%), Geo 2 (0.9%), Bilangara (0.6%), TZPB (0.6%), Ba hausa (0.3%), and TZE (0.3%). More of the households (45%) purchased an improved maize variety in the major season (between April and June). The quantity of seeds purchased varied between 0.20 and 300 kg, with a mean of 21.42 kg. The average cost of purchased seeds was about N2490 ($1 = N150 and with N61.7 transport charge, as determined by the farm distance. Maize seed varieties were mainly obtained from the market by 27.3% of the buyers. Other sources were the farmer's own stock (23.4%), Kano Agricultural and Rural Development Authority (KNARDA) (17.6%), agricultural extension unit (9.8%), Kano Agricultural Seed Company (KASCO) (4.9%), seed companies such as Premier and Alheri (3.4%), neighbors, agro-dealers, and NGOs. Twenty of the household heads purchased other cereals within the same period in the major season; the quantity purchased was about 27.8 kg at a cost of about N1803.3 on average, with N86.7 as transport charge. About 75% of the buyers indicated that these cereals were usually from the market, the farmer's own stock, KNARDA, and the Ministry of Agriculture. Legumes (about 53.33 kg) were also purchased at an average cost of N1709.9 from market centers, such as Malumfashi, Rano, Dayi, Gwarzo, Kankara, and Kibya. About 444.7 kg of tubers and 1917 root cuttings were also purchased in the month of May. The total cost of yam tubers purchased was N5600 including a transport charge of N233.3. Cassava root cuttings averaged N9000 with a transport charge of N833.3. Maize seed sales were mainly through the market centers within and outside the communities.

Only 17 households purchased maize seeds in the minor or late season. Varieties grown during this season included Oba Super 1, Oba Super 2, ACR 97, and white hybrid. An improved variety was purchased by 2.6% of the households who cultivated maize in the minor season. The average quantity of seeds purchased during this season was slightly more than in the major season (about 27.9 kg). This, according to the respondents,

was because the seeds were mostly available during this period and farmers tended to increase their stock by buying more. The seeds were purchased between March and June with most being bought in May. The average amount paid for seed purchase was N2450 and a transport charge of N20, and these costs were lower than those in the major season, as a result of the increased seed supply. About 47% of households purchased their seeds from the Ministry of Agriculture, 25% from other farmers, 15% from the markets, and 5% from seed companies, such as Premier Seeds and KASCO. Households' sources of seeds are shown in Figure 7.

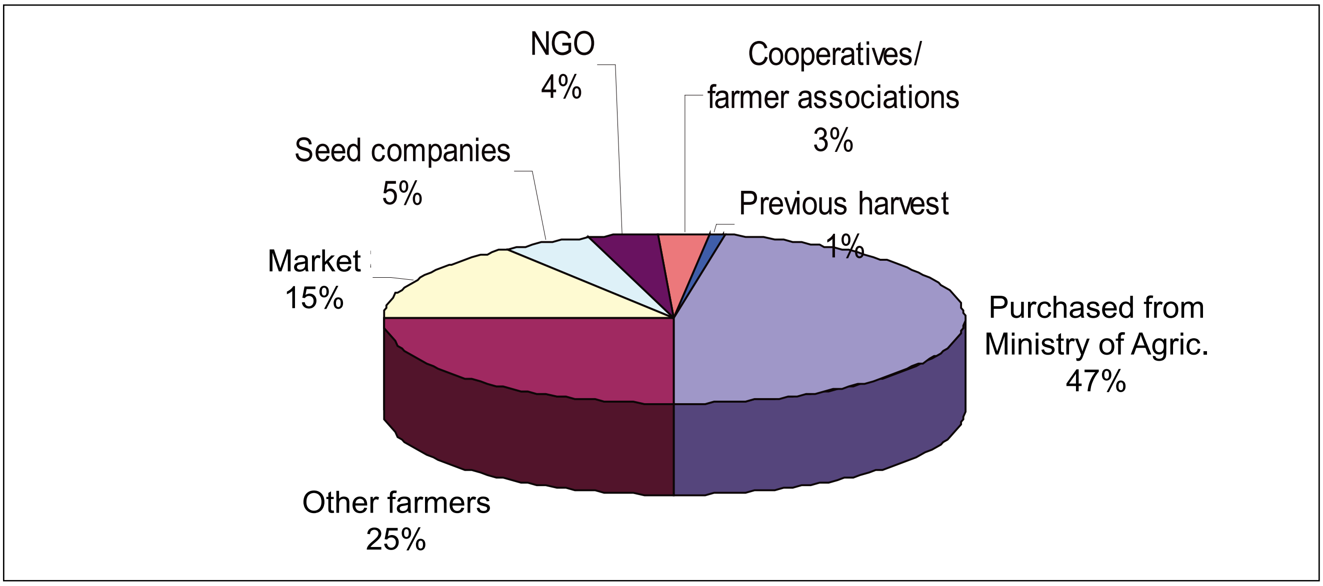

Figure 7. Households' sources of maize seeds.

A maize farmer and his crop in Malumfashi, Nigeria.

Table 13. Non-seed input use by households in selected districts.

Input	Districts	
	Malumfashi (n = 175)	Rano (n = 175)
Quantity of basal NPK purchased (kg)	75.0	357.1
Amount paid for basal NPK (N)	4,050.0	19,442.9
Transport charge of basal NPK purchased (N)	62.5	614.3
Quantity of top dressing urea purchased (kg)	50.0	216.7
Amount paid for top dressing urea (N)	2650.0	11,166.7
Transport charge of top dressing urea purchased (N)	62.5	433.3
Quantity of herbicides purchased (kg)	-	4.0
Amount paid for herbicides (N)	-	150.0
Transport charge for herbicides (N)	-	4,400.0
Quantity of insecticides purchased (kg)	-	3.7
Amount paid for insecticides (N)	-	2900.0
Transport charge of insecticides purchased (N)	-	190.0
Quantity of other inputs purchased (kg)	556.3	73.2
Amount paid for other inputs purchased (N)	22,975.0	3,257.1
Transport charge for other inputs purchased (N)	512.5	171.4
Major sales point for all inputs	market	market KNARDA

The non-seed inputs purchased in the major season included basal NPK, top dressing urea, herbicides, insecticides, manure, and other inputs (Table 13).

In Rano, five times more basal NPK and four times more top dressing urea were purchased than in Malumfashi. Herbicides and insecticides were not even used in Malumfashi. This showed that more households used non-seed inputs in the Rano district, suggesting the need to encourage farming households in Malumfashi to use these materials to enhance their production efforts. Thus, the total cost of purchase and the transport cost for the inputs were greater in Rano district. However, the unit cost of the material for the two districts was almost the same (N56 in Rano and N55 in Malumfashi), further supporting the fact that Rano recorded more households using the inputs. There were differences in the time of purchase of these inputs; households in Rano purchased basal NPK in December, those in Malumfashi bought it in January. Other inputs, such as manure, were obtained from cattle rearers, the farmer's own stock of cattle, and the market between the months of April and June.

The total quantity of about 294 kg of basal NPK was purchased mainly from the market in the minor season at an average cost of N16, 022 and a transport cost of about N492. About 175 kg of top dressing urea were purchased at the cost of N9378 (including a transport cost of N340.6) in December. Four liters of herbicides (N4400 with transport cost of N340.6) and insecticides (N2900, transport cost N150) were also purchased in October. Major sources of purchased non-seed inputs were the markets, farmers' own stock, and KNARDA.

Maize varieties cultivated

The different maize varieties that have been planted over the years by households in each district are shown in Table 14. These are the landrace or local varieties, improved OPVs, and hybrid maize. Except for hybrid maize, more maize varieties were grown in Malumfashi than in Rano. Respondents however indicated that most of the improved maize varieties had been given local names for easy identification.

Table 14. Maize varieties planted by households in selected districts.

Maize variety	Districts	
	Malumfashi	Rano
Landrace (local)	Yar kassa Yar acre Yar hausa	Yar kassa Yar acre
Improved	ACR97 TZPB TZE Geo 1 & 2 Bilangara MRI 594 Jan Bahaushya Bazawara Red OPV Fara mai ture Yar Proja Tarami Mirti_Zer Hakori haji	ACR97 Hararghe Bakanuwa TZE Bahausa Fara mai ture
Hybrid	Oba Super I and 2 White and yellow hybrid	Oba Super I and 2 White and yellow hybrid

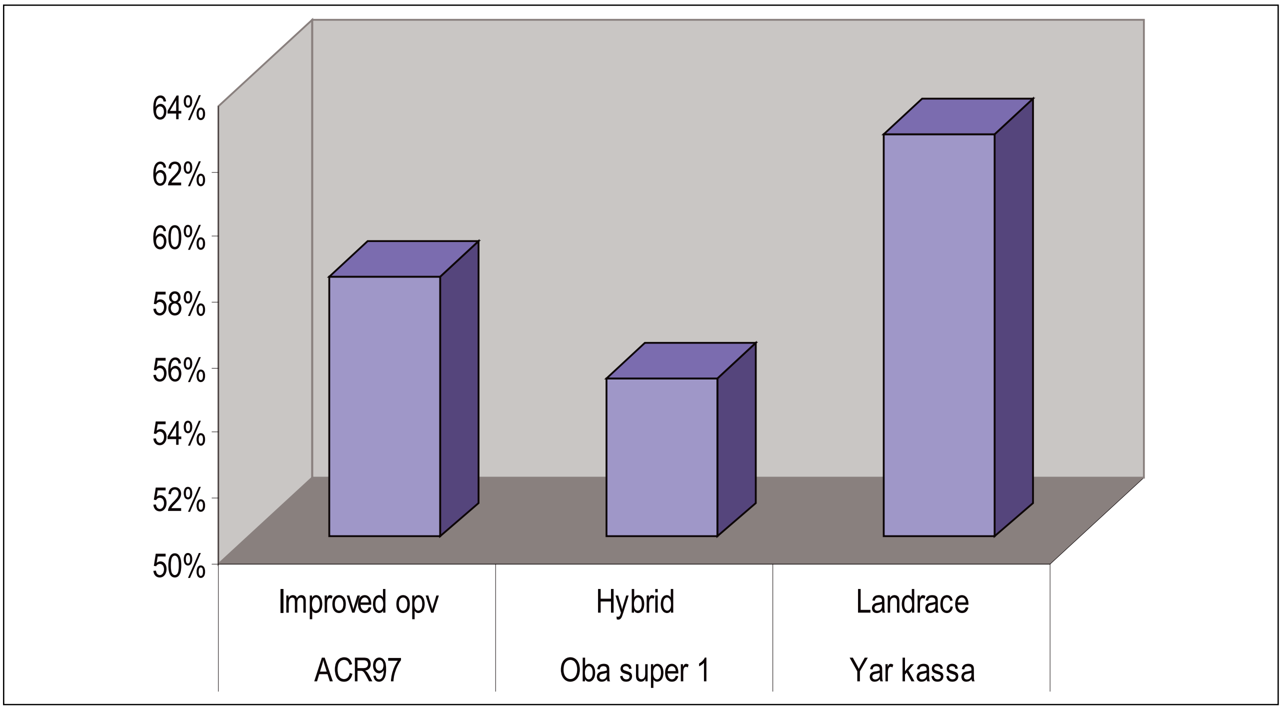

Figure 8. Best ranked maize varieties.

Ranking of maize varieties by households

The ranking of maize varieties grown by households is shown in Figure 8. Among the landrace varieties, Yar kassa was ranked best. ACR97 was the best ranked improved OPV, and Oba Super 1 the best ranked hybrid maize variety.

Table 15. Best ranked maize varieties by wealth groups.

Rank	Poorly endowed (n = 218)	Well endowed (n = 132)
1	Yar kassa	Oba Super 1
2	Oba Super 1	Yar kassa
3	Yar acre	ACR97
4	ACR97	Yar acre
5	Oba Super 2	Bilangara
6	White hybrid	White hybrid

Table 16. Ranking of desirable attributes of ideal maize varieties by households.

Attributes	Percentage of households
Yield potential	80.6
Cob size	36.7
Grain size	22.1
Performance in poor soils	21.8
Early maturity	21.8
No. of cobs/plant	18.8
Yield stability	15.6
Pest/disease resistance	14.1

The ranking of these varieties according to wealth groups is shown in Table 15. The landrace Yar kassa ranked best among the poorly endowed households; Oba Super 1 ranked best among the well endowed households.

The most desirable characteristics of an ideal maize variety as given households by are shown in Table 16. High yield potential, cob size, and grain size were the three most important features that households considered in selecting maize varieties to plant.

Determinants of adoption of improved maize seeds

The Tobit regression model was used to describe the adoption of improved maize technology. This method estimates the likelihood of adoption and the extent (i.e., intensity) of adoption. The Tobit model is preferable in binary adoption models when the decision to adopt simultaneously involves the decision regarding the intensity of adoption (Feder and Umali 1993), as it does with improved maize varieties. The Tobit regression technique was employed to analyze the effect of wealth and other household factors on the adoption of improved maize varieties for an improved food security situation of farming households. Based on adoption literature, farm and farmer specific characteristics (such as the age of the household head, educational level, household size, gender, and total farm size), institutional factors (e.g., extension services, credit, distance to output markets) and technology specific characteristics (e.g., seed availability, perception of yield, and resistance to diseases and pests) are used as variables in the adoption model. The Tobit approach has been applied in studies of the adoption of conservation tillage (Norris and Batie 1987; Gould et al.1989) and the adoption of alternative crop varieties (Adesina and Zinnah 1993). A two-limit Tobit model (Rosett and Nelson 1975; Maddala, 1983) is used in this study because the dependent variable is the proportion of the land (between 0 and 1) cultivated to improved maize technology.

According to Tobin (1958), Rahm and Huffman (1984), and Adesina and Zinnah (1993), the Tobit model assumes that a farm household's decision to adopt a given technology, y_i, in a given period derived from the maximization of expected utility (income/food security) satisfies

$$yi = \max (y_i^*,0) \quad (1)$$

Where, yi is the observed dependent variable (e.g., proportion of land cultivated to improved maize by the ith household), and y* is the non-observable latent variable (the expected utility). However, the utility derivable from the technology depends on a vector of explanatory variables, Xi, which represents the household's wealth and demographic factors. Thus, the probability that a household will adopt improved maize with a profit or food security objective is a function of the vector of explanatory variables, Xi, the unknown parameters, βi, and the error term, μ_i, assumed to be independently *N* (0, σ^2) distributed, conditional on the X_i's as:

$$y_i^* = \beta X_i + \mu_i \qquad (2)$$

This is explicitly expressed as: $Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_N X_N \ldots$; i = 1,2,..N.

Since the disturbance term, μ_i, is a function of the independent variables, an attempt to estimate equation (2) using Ordinary Least Squares will result in biased and inconsistent estimates (McDonald and Moffitt 1980; Maddala 1983). The use of maximum likelihood estimation guarantees that the parameter estimates will be asymptotically efficient for the appropriate statistical tests to be performed (Pindyck and Rubinfeld 1997; Gujarati 2006). Unlike traditional regression coefficients, the Tobit coefficients cannot be interpreted directly as estimates of the magnitude of the marginal effects of changes in the explanatory variables on the expected value of the dependent variable. In a Tobit equation, each marginal effect includes both the influence of the explanatory variable on the probability of adoption as well as on the intensity of adoption. As Gould et al. (1989) observed, the total (marginal) effect takes into consideration the fact that a change in an explanatory variable will affect simultaneously the number of adopters and the extent of adoption by the both current and new adopters.

Description and measurement of variables for the Tobit regression model

Dependent variable (Y_i): This is a continuous and discrete variable for the ith farmer. The continuous part is measured by the proportion of land cultivated to improved maize; the discrete part takes on a value of either zero or 1. A farmer is scored 1 if he adopts the technology, and zero if otherwise. It is hypothesized that this decision is influenced by the independent variables.

Independent variables: Based on adoption literature, variables that are associated with the adoption of improved maize varieties were used along with those for whom evidence from previous studies had been inconsistent. These included farm and farmer specific characteristics (such as age of household head, educational level, household size, and total farm size), institutional factors (e.g., extension services, credit/ membership of associations, off-farm income, wealth index, and distance to output markets) and technology specific characteristics (e.g., seed availability, perception of yield, and resistance to diseases and pests). The expected signs of their coefficients were predicted *a priori*, based on past studies, economic theory, and/or logical reasons.

Characteristics of adopters and non-adopters of improved maize varieties

Maize production was male-dominated in the study area, with less than 1% of female involvement. In fact, all the maize producing households in Rano district were men. Respondents attributed this to the sociocultural background of the people which ascribed farming to be an exclusive preserve of men. The categorization of sampled households into improved maize adopter and non-adopter groups and their characteristics are shown in Table 17.

About 68.3% of the sampled households were adopters of improved maize while 31.7% were non-adopters. Significant differences were found between the two categories for age, membership of farmers' associations, extension contact, farm distance, yield potential, and seed availability. A larger proportion of adopters belonged to associations, such as farmers' unions and cooperative societies, and had more frequent interactions with

Table 17. Demographic characteristics of households by adopters and non-adopters of improved maize varieties.

Variable	Whole sample (n = 350)	Adopters (n = 239)	Non-adopters (n = 111)	t-test
Age (years)	47.37 (0.62)	46.51 (0.72)	49.22 (1.17)	2.05**
Education (years)	4.51 (0.09)	4.43 (0.11)	4.68 (0.16)	1.25
Credit	0.95 (0.01)	0.93 (0.02)	0.98 (0.01)	1.94
Membership of associations	0.65 (0.03)	0.75 (0.03)	0.45 (0.05)	5.60*
Extension contact	1.74 (0.12)	2.08 (0.16)	1.01 (0.15)	4.20*
Farm size (ha)	10.68 (1.06)	11.57 (1.36)	8.78 (1.61)	1.23
Household size (no.)	12.91 (0.25)	13.06 (0.30)	12.60 (0.46)	0.84
Area cultivated to improved maize (ha)	2.49 (0.22)	2.75 (0.29)	1.94 (0.32)	1.69
Distance from market (km)	4.59 (0.14)	4.84 (0.18)	4.05 (0.16)	2.71*
Yield potential	0.77 (0.02)	0.86 (0.02)	0.57 (0.05)	6.41*
Diseases/pests resistance	0.04 (0.01)	0.05 (0.01)	0.01 (0.01)	1.90
Availability of seeds	0.37 (0.03)	0.54 (0.03)	0.02 (0.01)	10.82*
Family labor	0.39 (0.02)	0.38 (0.02)	0.41 (0.04)	0.90

Note: () figures in parentheses indicate standard error, *,** Significant at 1% and 5%.

extension agents. This suggested better extension advice on appropriate agronomic practices and linkages with input sources and output markets, in spite of the more distant location of their farms. The adopters also considered high yield potential and seed availability to be more important when selecting maize varieties to grow, implying that these characteristics are necessary for consideration in any breeding program of improved maize to ensure wider acceptability by farmers.

On the other hand, non-adopters were significantly older than the adopters, a detail that tends to support the findings of Polson and Spencer (1991) that older farmers were less likely to adopt new ideas as they had more confidence in their traditional ways and methods of farming. It is, however, interesting to note that though the farm size and area cultivated to improved maize by adopters were larger than those of non-adopters, there was no significant difference between them. This suggested that, rather than expanding the area farmed, adopters focused more on the technology characteristics (such as yield potential and seed availability) and social networks that could enhance their knowledge of good agronomic practices for increased production.

The classification of household wealth groups into adopters and non-adopters showed that the membership of associations, frequency of extension contact, distance to market, perception of yield potential, disease/pest resistance, and the WI were significantly different between adopters and non-adopters within the poorly endowed wealth group, with adopters having a larger proportion (Table 18). For instance, a higher percentage of the

adopters within the poorly endowed group belonged to associations, had extension contact, and were wealthier than the non-adopters. On the other hand, age, membership of associations, yield potential, and seed availability were significantly different between adopters and non-adopters within the well endowed wealth group. However, while the non-adopters were older on average than adopters, a larger proportion of adopters belonged to associations, and indicated that a high yield potential and seed availability were important for maize adoption. These findings imply that these three factors are relevant for consideration in the adoption of maize varieties among wealth groups in the study area.

Table 18. Demographic characteristics of household wealth groups by adopters and non-adopters of improved maize varieties.

Variable	Poorly endowed			Well endowed		
	Adopters (n = 135)	Non-adopters (n = 83)	t-test	Adopters (n = 104)	Non-adopters (n = 28)	t-test
Age	45.86	47.98	1.37	47.35	52.89	2.17**
	(0.89)	(1.35)		(1.19)	(2.22)	
Education	4.57	4.72	0.63	4.25	4.54	0.82
	(0.15)	(0.19)		(0.16)	(0.32)	
Credit	0.96	0.98	0.53	0.89	1.00	1.81
	(0.02)	(0.02)		(0.03)	(0.00)	
Membership of associations	0.73	0.42	4.67*	0.77	0.54	2.48**
	(0.04)	(0.06)		(0.04)	(0.10)	
Extension contact	2.08	0.88	4.22*	2.08	1.39	1.29
	(0.20)	(0.17)		(0.26)	(0.35)	
Farm size	5.32	4.53	1.79	19.68	21.37	0.27
	(0.28)	(0.35)		(2.93)	(5.74)	
Household size	12.84	12.48	0.54	13.35	12.96	0.38
	(0.39)	(0.54)		(0.47)	(0.83)	
Proportion of land cultivated to	0.35	0.33	0.29	0.33	0.24	1.62
improved maize	(0.03)	(0.04)		(0.03)	(0.04)	
Distance from market	4.32	3.78	2.19**	5.51	4.86	0.93
	(0.16)	(0.16)		(0.35)	(0.39)	
Wealth index	-0.52	-0.72	4.23*	1.02	0.77	1.25
	(0.03)	(0.04)		(0.09)	(0.20)	
Yield potential	0.85	0.57	4.92*	0.88	0.57	3.81*
	(0.03)	(0.06)		(0.03)	(0.10)	
Disease/pest resistance	0.04	0.01	1.32	0.06	0.00	1.30
	(0.02)	(0.01)		(0.02)	(0.00)	
Seed availability	0.54	0.02	9.14*	0.54	0.00	5.67*
	(0.04)	(0.02)		(0.05)	(0.00)	
Family labor	0.50	0.46	0.84	0.21	0.28	1.13
	(0.03)	(0.05)		(0.03)	(0.06)	

Note: ( ) Figures in parentheses indicate standard error, * and ** significant at 1% and 5%.

Determinants of the probability of adoption of improved maize varieties by wealth groups

The Tobit regression estimates of the adoption of improved maize varieties are shown in Table 19. The log likelihood ratio and sigma estimates show that the amount of variation explained by the model is significantly different from zero.

The frequency of extension contact, yield potential, seed availability, and WI significantly and positively influenced the probability of adoption of improved maize among the poorly endowed wealth group. Hence, for every additional visit made to farmers by extension agents, the probability of adoption of improved maize increased by 0.08 units. Similarly, as the potential for high yield increases by 1 unit, the probability of adoption. increases by about 0.39 units, while seed availability increases the probability of adoption by 1.57 units. In addition, as the wealth status of the poorly endowed increases by one unit, the probability of adoption increases by 0.59 units, implying that these factors are important for consideration by developmental programs or policy strategies targeted at the adoption of improved maize by poor households in the study area. On the other hand,

Table 19. Determinants of households' probability of adoption of improved maize varieties by wealth groups.

Variable	Whole sample (n = 350)	Wealth group	
		Poorly endowed (n = 218)	Well endowed (n = 132)
Age (years)	-0.01 (0.01)	-0.00 (0.01)	-0.01 ***(0.00)
Education (years)	0.00 (0.04)	0.01 (0.05)	-0.00 (0.02)
Credit	-0.16 (0.37)	0.36 (0.42)	-0.09 (0.12)
Membership of associations	0.21 (0.13)	0.17 (0.14)	0.15** (0.07)
Extension contact	0.07** (0.03)	0.08** (0.04)	0.00 (0.01)
Farm size	-0.01** (0.00)	-0.03 (0.03)	-0.00 (0.00)
Household size	0.01 (0.01)	0.01 (0.01)	0.00 (0.01)
Distance from market (km)	0.06** (0.03)	0.04 (0.04)	0.02 (0.01)
Wealth index	0.25* (0.09)	0.59* (0.22)	0.01 (0.04)
Yield potential	0.54* (0.14)	0.39* (0.15)	0.40* (0.09)
Diseases/pests resistance	0.59 (0.42)	0.30 (0.44)	0.48* (0.16)
Seed availability	1.73* (0.26)	1.57* (0.26)	0.29* (0.06)
Family labor	-0.14 (0.17)	-0.20 (0.18)	0.00 (0.11)
Constant	0.35 (0.05)	0.12 (0.07)	0.43 (0.20)
Sigma	0.80 (0.06)	0.74 (0.07)	0.32 (0.02)
Log likelihood	-210.50	-146.00	-36.40

Note: ( ) Figures in parentheses indicate standard error, *,*,and *** = Significant at 1%, 5%, and 10%

the farmers' age, membership of associations, perception of yield potential, seed availability, and resistance to disease/pests are major factors determining the adoption of improved maize among the well endowed households. Apart from the farmers' age which had a significant but negative relationship with the adoption of improved maize by the well endowed households, the other variables had significant and positive relationships. The negative coefficient of age suggests that as the well endowed farmer grows old, the probability of adoption of improved maize decreases by 0.01 units, implying that younger well endowed farmers adopt improved maize more readily. This supports the findings of Feder et al. (1985) that younger farmers are more willing to bear risk and adopt a new technology because of their long planning horizons. However, for every unit increase in the membership of associations by the well endowed, the probability of adoption increases by 0.15 units. Similarly, the probability of adoption of improved maize increases by 0.4, 0.3, and 0.5 units, as households perceive high maize yield, seed availability, and resistance to pests/diseases. This corroborates the findings of the adopter-perception model employed by Gould et al. (1989) that the perceived attributes of innovations condition adoption behavior. The negative sign of education of the well endowed is not consistent with the traditionally expected mode of behavior. This may suggest that a low level of education was not a hindrance to the adoption of improved maize varieties, thereby corroborating the findings of Caffey and Kazmierczak (1994). For the whole sample, however, farm size, extension contact, distance to market, perception of high yield potential, seed availability, and WI were the major factors that influenced the probability of adoption of improved maize varieties. These findings have economic implications for development programs aimed at promoting and targeting new technologies to specific wealth categories for the improved livelihood of the farming households.

Based on the second stage Tobit regression estimates, extension contact no longer plays a significant role in determining the land area cultivated to improved maize by the poorly endowed households after its adoption. However, membership of associations and farm size significantly influenced the intensity of their use of

Table 20. Determinants of households' intensity of adoption of improved maize varieties by wealth group.

Variable	Whole sample (n = 350)	Wealth group	
		Poorly endowed (n = 218)	Well endowed (n = 132)
Age	-0.005 (0.004)	-0.004 (0.004)	-0.001 (0.002)
Education	0.018 (0.024)	0.044 (0.029)	0.015 (0.013)
Credit	0.008 (0.231)	0.189 (0.274)	0.051 (0.075)
Membership of associations	0.214* (0.075)	0.198** (0.085)	0.058 (0.047)
Extension contact	0.011 (0.019)	0.025 (0.025)	-0.018** (0.009)
Farm size	-0.007* (0.002)	-0.063* (0.015)	-0.002** (0.001)
Household size	-0.005 (0.007)	-0.008 (0.008)	0.005 (0.004)
Distance from market	-0.017 (0.017)	-0.033 (0.027)	-0.012 (0.007)
Wealth index	0.186* (0.053)	0.597* (0.133)	0.028 (0.025)
Yield potential	0.259* (0.078)	0.193** (0.088)	0.032 (0.059)
Pests/diseases resistance	0.168 (0.255)	-0.145 (0.276)	0.166 (0.110)
Seed availability	0.923* (0.178)	0.862* (0.188)	0.002 (0.042)
Family labor	0.035 (0.097)	-0.029 (0.109)	-0.212* (0.077)
Constant	0.642** (0.286)	0.999* (0.380)	0.381* (0.139)
Sigma	0.439 (0.029)	0.420 (0.032)	0.220 (0.014)
Log likelihood	-113.936	-74.767	12.811

Note: ( ) Figures in parentheses indicate standard error, *,and ** significant at 1% and 5%.

the technology after the farmer's decision to adopt the technology (Table 20). Membership of associations positively influenced the intensity of use of the technology but farm size had a negative relationship. Hence, for any additional increase in the membership of associations, the poorly endowed households increased their intensity of use of the technology by about 0.20 units, suggesting that this category of farmers should be encouraged to join cooperatives and farmers' associations in the locality. Increasing the farm size by one unit will lead to a reduction in the intensity of use of the technology by 0.06 units, implying that poorly endowed households cannot cope with large farms after the adoption of improved maize varieties. This may be attributed to their need for money to purchase other associated inputs, such as fertilizers and agrochemicals, required to enhance the production of the high yielding maize varieties. Thus, for every unit increase in farmers' wealth status, their use intensity of improved maize increases by a factor of about 0.60. Similarly, when poorly endowed households perceive that the maize technology is readily available, the intensity of use increases by a unit of 0.86, and by 0.19 when they perceive that it has a high yield potential. On the other hand, extension contact, farm size, and family labor significantly and negatively influenced the intensity of use of improved maize by the well endowed households after adoption. Every additional contact with extension agents reduced the intensity of use of the technology by about 0.02 units after adoption, suggesting that extension advice was not effective beyond the adoption of improved maize technology in the study area.

Table 21. Disposal of harvested produce.

Crop	Percentage of households that dispose of produce				
	Home consumption	Sale	Given away as gifts	Preservation as seeds for subsequent season	Post-harvest loss
Local land race maize	37.3	47.6	12.9	1.6	0.6
Improved OPV	19.2	71.0	6.3	3.2	0.3
Hybrid maize	27.1	62.4	8.9	0.9	0.7
Millet	48.0	33.2	6.1	12.4	0.3
Sorghum	47.4	36.8	12.6	2.7	0.5
Paddy rice	39.0	50.2	7.9	1.1	1.8
Cowpea	26.2	60.3	10.3	3.0	0.2
Groundnut	15.9	72.8	8.2	2.7	0.4
Cassava	16.2	79.6	2.1	2.1	0.0
Cotton	0.0	99.8	0.0	0.0	0.2
Sweetpotato	56.2	34.2	7.8	0.9	0.9
Sesame	95.0	5.0	0.0	0.0	0.0
Rice	39.0	50.2	7.9	1.1	1.8
Onion	7.0	92.2	0.5	0.0	0.3
Pepper	18.8	77.3	2.6	1.3	0.0
Soybean	17.5	71.6	7.2	3.7	0.0

The intensity of use of improved maize by the well endowed households decreased marginally by 0.002 units with every unit increase in farm size. This may be attributed to the respondents' claim that as most households became wealthier, they tended to move away from farming to other economic activities as a means of livelihood. After the adoption of improved maize, family labor becomes ineffective for use by the well endowed households with the result that, for every unit increase in the amount of family labor employed for farm work,

the use intensity of the technology decreased by 0.21 units. This supported the claim of respondents that the well endowed households engaged hired labor in their farming operations. For the whole sample, extension contact and distance to market did not influence the intensity of use of the maize technology after adoption. Membership of associations was the only additional variable that significantly influenced the use intensity of improved maize. The consistency in the results obtained confirms the effectiveness and accuracy of the wealth ranking approach employed in this study in determining the wealth groups of households.

Crop marketing decisions

Households dispose of the crops harvested from their farm plots through home consumption, sales, gifts, and preservation as seeds for the next production season. There are also postharvest losses. The different ways in which harvested crops were disposed of in the 2005–2006 production season are shown in Table 21.

Households generally disposed of more of their harvests through sales than by other means. Up to 50% of the produce of the following crops were sold: cotton, onion, cassava, pepper, groundnut, soybean, improved OPV, hybrid maize, cowpea, and rice. Sesame, since the seeds and oil are used in cooking, was mostly consumed by the households with only 5% being sold. Crops whose produce was mostly consumed included sweetpotato, millet, sorghum, and local maize.

Livestock production and marketing

The types of livestock owned by households, both at home and on the farm, varied in number. These included local cows, bulls, young bulls, heifers, calves, goats, pigs, sheep, chickens, and animals for transport. The average number of cows owned by the households was 1.5, and varied from zero to 60. Respondents claimed that the number of animals owned indicated the wealth status of the household; the larger the number, the wealthier the household, and vice versa. The total value of cows of various sizes owned by households was about N235, 840. Not more than one cow was consumed, sold, or purchased in a year by the households. The same trend was noted for bulls and heifers, even though there were variations in their total value. The total value of bulls was N195, 833, with young bulls valued at N126, 286. The heifers were valued at N153,100. The calves were valued at N212, 000. However, the total value of goats owned by the households was N46, 762. Households consumed an average of two goats within a year and sold about three in the same period. Few households owned pigs which were valued at N35, 000. The average number of sheep owned was six, with the total value of sheep owned by households being N45, 554. The number of local chickens owned per household was the highest, about 13, the value for all households being N8493.5. Transport animals with a gross value of N50, 618 were owned. These animals are considered household assets, providing food, farm power, and cash income to meet other household needs, such as health care and children's education. The distribution of mean livestock ownership by wealth groups is shown in Figure 9. The number of livestock owned increased as households moved to higher wealth levels. It was noted that poorly endowed households did not own livestock. As reported by the respondents, the number of livestock owned was an indication of wealth status.

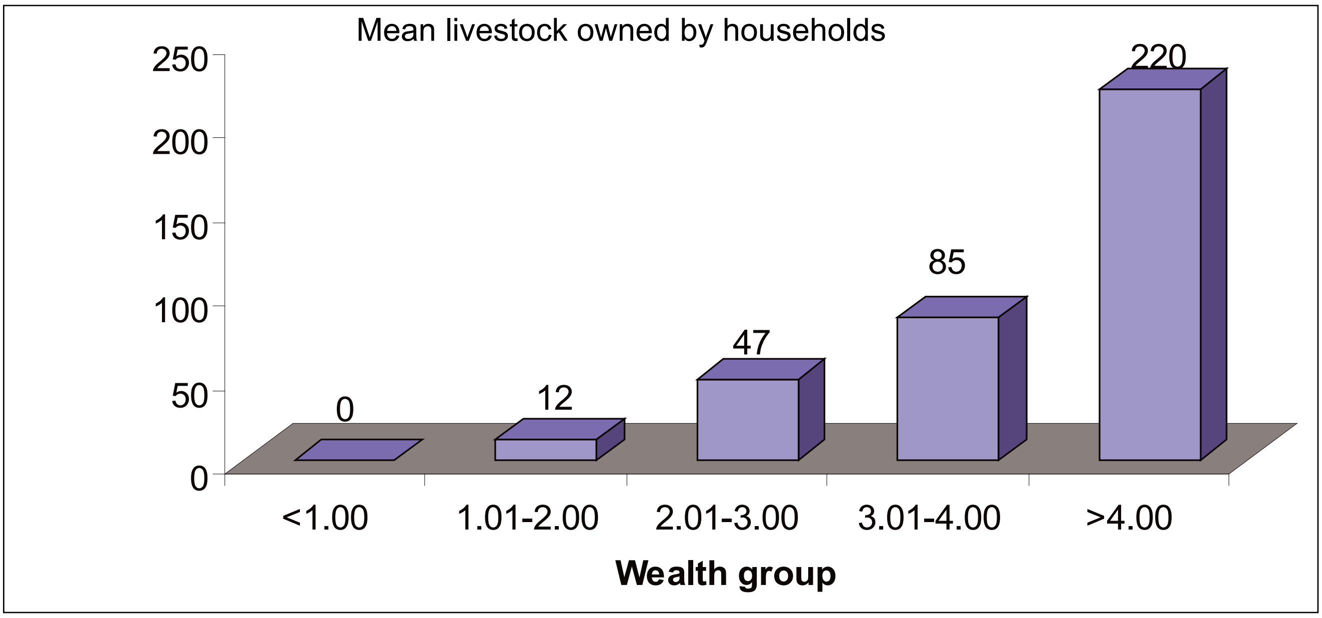

Figure 9. Distribution of mean livestock ownership by wealth group.

Table 22. Sources of household income.

Income sources	Malumfashi (n = 175)		Rano (n = 175)	
	Total income (N)	Percentage	Total income (N)	Percentage
Crops	19,056,603.8	90.9	58,996.7	12.1
Fruits and vegetables	62,561.1	0.3	46,068.7	9.5
Livestock/fish	198,665.4	0.9	40,209.9	8.3
Petty trading	41,683.0	0.2	39,531.3	8.1
Paid employment	650,174.5	3.1	151,637.5	31.1
Self-employment	139,626.9	0.7	42,565.2	8.7
Remittances	628,528.1	3.0	30,048.6	6.2
Other sources	176,086.2	0.8	77,864.3	16.0
Total	20,953,929.0	100.0	486,922.2	100.0

Note: 1US$ = N130.

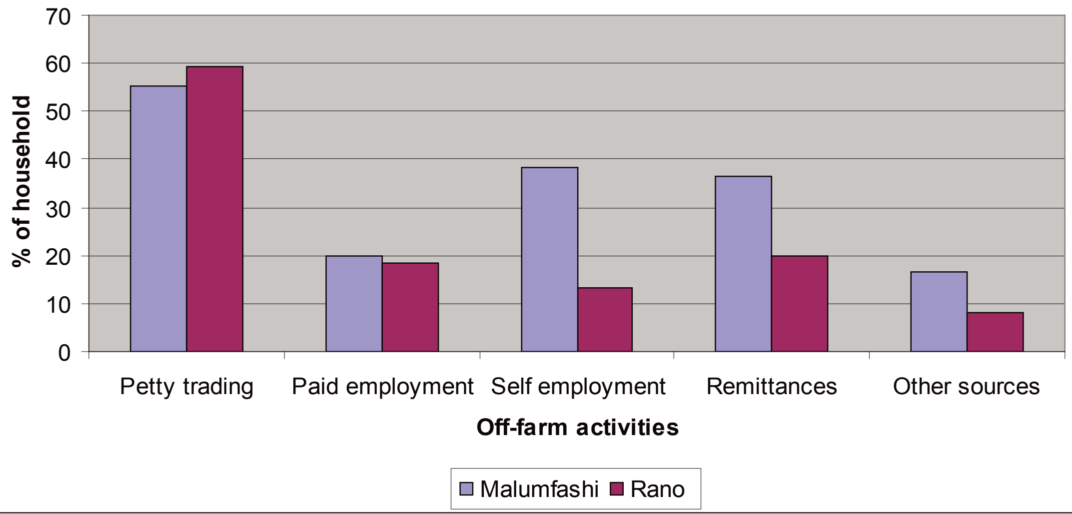

Figure 10. Proportion of households engaged in off-farm activities by district.

Income and expenditure profiles of households

Household incomes were sourced from farming and non-farm activities. The main farming activities were crop and livestock production and marketing; non-farm activities included trading, paid and self-employment, as well as remittances from relations.

Income from agriculture and off-farm activities

The sources and values of household income in the two districts (Malumfashi and Rano) are shown in Table 22. The household income in Malumfashi district was higher than in Rano, with crop production accounting for the largest component (about 91%), while paid employment, remittances, livestock/fish production, and trading followed, in order of decreasing importance. In Rano district, however, paid employment constituted the largest component of household income, followed by crop production, self-employment, livestock, and petty trading. Thus, households in Malumfashi depended more on crop production activities than those in Rano.

Among the off-farm activities engaged in by households, petty trading was the most important in the two districts. Other sources of off-farm income in Malumfashi,, in descending order, were self-employment, remittances, and paid employment. In Rano, the order was remittances, paid employment, and self-employment. The proportion of households engaged in off-farm activities is shown in Figure 10.

Household income sources by wealth groups

When considered along wealth groups, a larger proportion of the well endowed households sourced their income by selling crop produce, livestock, and fish, and through self-employment than the poorly endowed households (Figs 11 and 12).

Household expenditure profiles

The expenditure profile of households showed that food was the highest component of expenditure in both Malumfashi and Rano districts (Table 23). However, the major item of expenditure in Malumfashi was staple food, accounting for about 98% of total household expenditure. In Rano, staple food was about 32% of the total expenditure. Expenditure on clothing, education, health, remittances, fuelwood, social activities, and miscellaneous items, such as bicycle repairs and gifts, accounted for more than 6% of household expenditure in Rano. This pattern of expenditure was attributed to the closeness of Rano district to Kano, a major city in the study area.

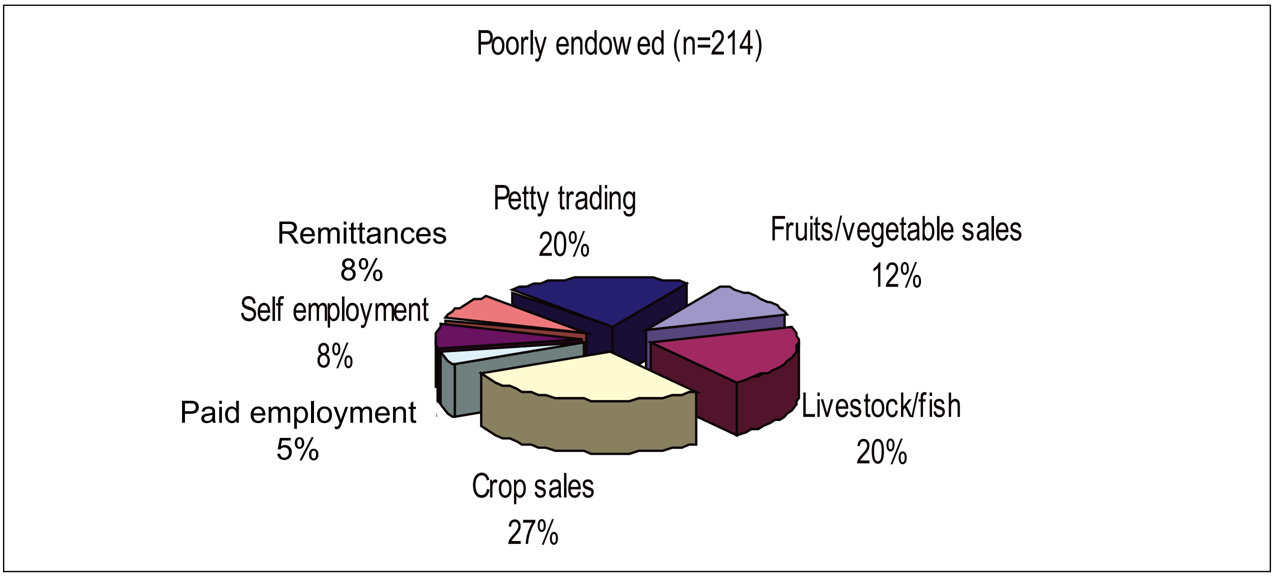

Figure 11. Income sources of poorly endowed households.

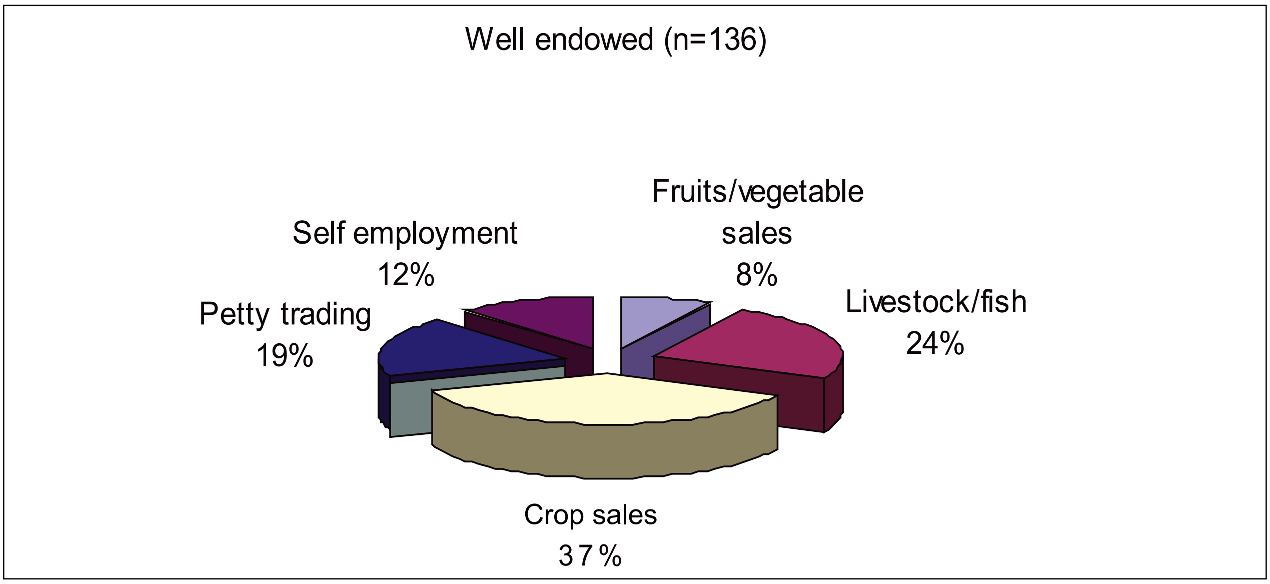

Figure 12. Income sources of well endowed households.

Table 23. Expenditure patterns of households.

Item of expenditure	Malumfashi (n = 75)		Rano (n = 175)	
	Value of expenditure (N)	Percentage	Value of expenditure (N)	Percentage
Staple food	11,563,000.0	98.4	36,666.3	31.7
Education	37,151.6	0.3	11,355.9	9.8
Medical	20,424.4	0.2	10,111.8	8.7
Clothing	39,268.2	0.3	18,845.2	16.3
Fuelwood, paraffin (kerosene)	20,582.4	0.2	8,824.9	7.6
Remittances	23,800.6	0.2	10,114.3	8.7
Social contribution	19,574.2	0.2	7,513.6	6.5
Miscellaneous (bicycle repairs, gifts)	32,643.6	0.2	12,396.2	10.7
Total	11,756,445.0	100.0	115,828.20	100.0

Note: 1US$ = N130 .

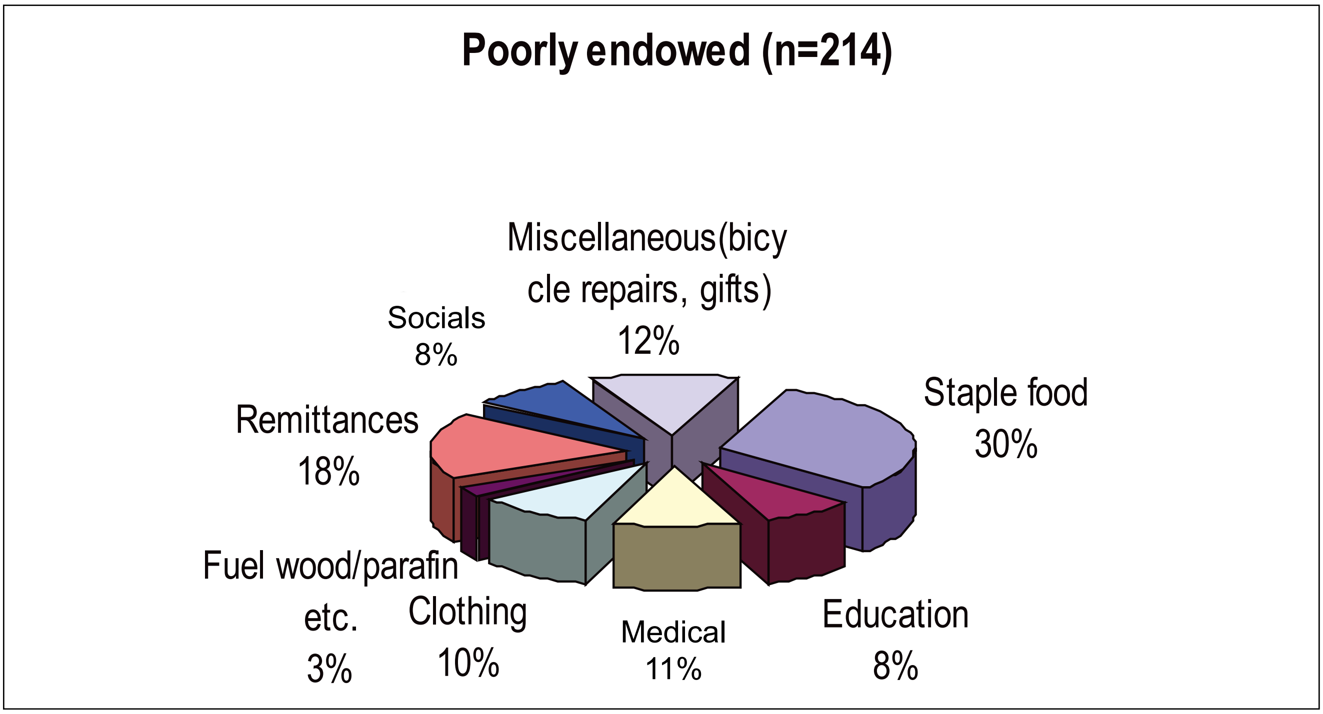

Figure 13. Expenditure profile of poorly endowed households.

Household expenditure profile by wealth groups

The distribution is shown of expenditure by the poorly endowed (Fig. 13) and by the well endowed households (Fig. 14). Although a larger proportion of households in both wealth groups spent more on food, this was slightly higher for the poorly endowed. While education and remittances accounted for the largest items of expenditure by the well endowed, the poorly endowed spent more on medical expenses and social activities. This may be attributed to their greater exposure to health hazards as a result of a poor diet while the social system allowed for their greater participation in sociocultural functions.

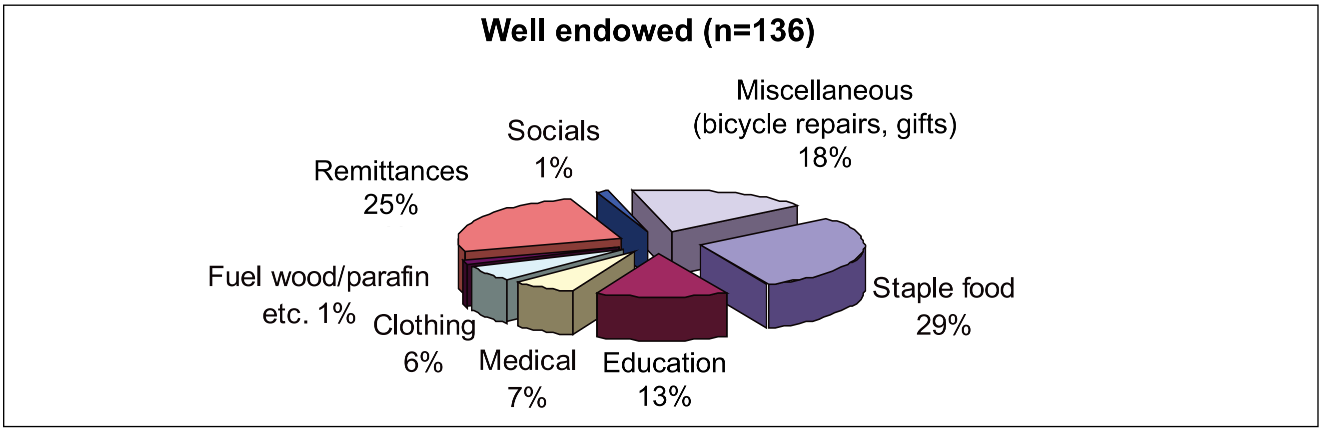

Figure 14. Expenditure profile of well endowed households.

Table 24. Important household livelihood strategies.

Livelihood strategy	Frequency*	Percentage	Rank
Increase agricultural production	233	66.6	1st
Reduce agricultural production risk	97	27.7	5th
Reduce marketing risk	70	20.0	8th
Reduce food security risk	144	41.1	4th
Reduce health status risk	156	44.6	3rd
Reduce household assets risk	57	16.3	9th
Reduce educational level risk	96	27.4	6th
Reduce land ownership risk	46	13.1	10th
Reduce social status risk	22	6.3	12th
Reduce income risk	162	46.3	2nd
Earn more wages	76	21.7	7th
Get out of agriculture	35	10.0	11th

Note: * Multiple responses taken.

Impact of shocks on household livelihood outcomes

Household livelihood outcomes

The typical livelihood outcomes employed by households when confronted with shocks included increasing agricultural production, reducing agricultural production risk, reducing market risk, increasing food security, improving the health status of household members, increasing the volume of household assets, increasing the educational level of household members, increasing land ownership, improving the social status of their households, increasing household income or reducing income risks, increasing job opportunities/earning power, and getting out of agriculture. However, the three most important livelihood outcomes to households were increasing agricultural production, reducing income risks, and reducing health risks, in descending order of importance. Other livelihood outcomes are shown in Table 24. When respondents were asked what specific actions would be sought by households to address the livelihood outcomes, the possible options to reduce income risk were the acquisition of more land and production assets, the use of agricultural inputs (e.g., fertilizers, pesticides, and improved seeds), diversification and efficient use of capital and labor employed by households to increase agricultural production, engaging in off-farm activities, growing cash crops, renting-out farm land, and working as wage labor. Similarly, closer medical attention, proper sanitation of the environment, and use of quality food and water were strategies employed to reduce households' health risks. To reduce food security risks, households stored food grains for longer periods, grew crops with differing maturing dates, replaced cash crops with food crops, increased the use of inputs for higher yield, and engaged in dry season

Table 25. Summary of livelihood outcomes and actions taken.

Livelihood strategy	Major action taken
Increase agricultural production	Use of agricultural inputs
Reduce agricultural production risk	Crop diversification
Reduce marketing risk	Storage of produce to sell when prices are high
Reduce food security risk	Storage of food grains for longer period
Reduce health status risk	Ensure closer medical attention
Reduce household assets risk	Buy more assets (e.g., bicycle,, buses)
Reduce educational level risk	Enroll children in school
Reduce land ownership risk	Buy more farm land
Reduce social status risk	Provide social amenities
Reduce income risk	Engage in off-farm activities
Earn more wages	Undertake some off-farm activities
Get out of agriculture	Engage in some businesses

farming. The approach used to reduce agricultural production risks included crop diversification, early planting, labor intensification, increased farm size and greater input use, accumulation of production assets, use of hybrid seeds, undertaking income generating off-farm activities, learning better practices of input use, and selling livestock. Risks associated with a low level of education were reduced when households enrolled more of their children in formal and Koranic schools, and attended adult literacy classes. To increase job opportunities, households embarked on off-farm activities, engaged in politics, and worked as wage labor in farms. Marketing risks were reduced through the storage of farm produce for sale at high prices, producing crops with lower market risks, and transporting produce to distant and more lucrative markets. To reduce household asset risks, households bought more assets (such as bicycles, tractors, buses, etc.), bought livestock and additional farm land, as well as building houses for rent. Land ownership risks were reduced by buying more farm land, renting farm land, and by avoiding the sale of farm land. To reduce dependence on agriculture, household heads engaged in some other businesses, such as being involved in politics or becoming commercial vehicle drivers. To minimize risk, households sought to provide social amenities, socialized themselves through politics, bought electricity generating plants, and also promoted the fair distribution of farm revenue among household members. The summary of the most important actions sought by households for the various livelihood outcomes is shown in Table 25.

Perceived shocks to household livelihoods

The three most important threats to households' livelihoods were drought, insufficient funds, and the poor health of household members. The three major constraints affecting the inability to improve on household livelihoods were inadequate input and output markets and poor health. About 83% of the households claimed to have had adequate food in the last one year, particularly in the first three months of the year. The months of June to September were noted for food shortages during the year, with shortages being most severe in August. The coping mechanisms employed by households against food insecurity are shown in Figure 15.

Selling small animals, increasing off-farm work, reducing other expenditure, and selling other assets were the major coping strategies employed by households against food shortages.

Households indicated that within the last ten years (1997−2006), they had been affected by serious shocks that had led to significant reductions in either the households' assets holding or resulted in a substantial drop in income which had consequently led to a significant reduction in consumption. The perceived shocks to households' livelihoods are shown in Table 26. These shocks included drought, frost or hailstorms, plant pests and diseases, livestock diseases, destruction of crops by livestock, dangerous weeds, large increases in input prices, large drops in the prices of maize, wheat, yam, and cassava, loss of farm land, death or loss of livestock, death of the breadwinner or spouse, illness/disability of breadwinner or spouse, theft of property or other assets, burning of property or arson, marriage breakdown, erratic rainfall, birds, conflict, and loss of off-farm income. These shocks affected maize farmers directly.

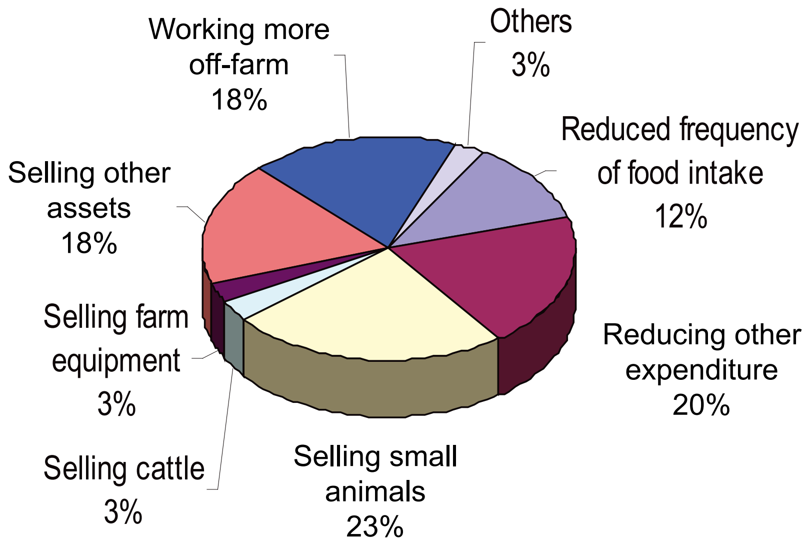

Figure 15. Coping mechanisms against food shortages

Table 26. Perceived shocks to household livelihoods.

Perceived shock	Frequency*	Percentage	Rank
Drought	248	70.9	1
Illness/disability of breadwinner or spouse	231	66.0	2
Large increases in input prices	141	40.3	3
Household breakdown	128	36.6	4
Livestock diseases	95	27.1	5
Large drop in maize prices	91	26.0	6
Death of breadwinner or spouse	89	25.4	7
Death or loss of livestock	81	23.1	8
Plant pests and diseases	75	21.4	9
Flood	64	18.3	10
Risk/shock on off-farm income	62	17.7	11
Large drop in other prices	51	14.6	12
Destruction of crops by animals	50	14.3	13
Other shocks	48	13.7	14t
Conflict	44	12.6	15
Erratic rainfall	36	10.3	16
Theft of property or other assets	35	10.0	17
Burning of property (arson)	23	6.6	18
Loss of farm land	21	6.0	19
Dangerous weeds	14	4.0	20
Frost or hailstorms	13	3.7	21
Birds	10	2.9	22
Risk/shock on livestock	8	2.3	23
Large drop in cassava prices	4	1.1	24
Large drop in yam prices	1	0.3	25
Large drop in wheat prices	1	0.3	26

Note: * Multiple responses taken.

About 71% of the respondents indicated the occurrence of drought in each of the last 10 years (1997−2006). Most of the respondents claimed that the drought occurred in 2002 and 2004, with about 95% indicating that it affected maize directly in each of the years. About 18% of the respondents reported that flooding of farm land occurred, in all the years, from 1997 to 2006 with severe floods occurring in 2000, 2003, and 2006. Adverse effects of frost/hailstorms were reported by about 4% of the households; the effects were greatest in 1998, 2001, 2004,.and 2005. Incidences of plant pests and diseases were reported from 1999 to 2006, with the highest incidences occurring in 2004, 2005, and 2006. About 61% of these respondents claimed that the pests and diseases directly affected their maize plots. Livestock diseases occurred from 1997 to 2006, with the highest impact in 2006. Crop destruction by farm animals occurred in 2005. The effects of dangerous weeds were felt yearly from 1999 through 2006. The large increases in input prices throughout the study period also constituted major shocks to household livelihoods, with those in 2006 identified as having the greatest impact. These increases were accompanied by a large drop in maize prices. Only one of the households indicated that the large drop in wheat and yam prices was a serious shock that affected its livelihoods, and this was noticeable only in 1999 for wheat and in 2000 for yam. Erratic rainfall, as claimed by about 10% of the households, caused serious shocks to people's livelihoods each year, particularly in 2004. In general, eight (2.3%) of the households indicated that livestock disease affected their livelihoods during the 10-year period, with the greatest effect experienced in 2006. Similarly, households indicated that risks/shocks to their off-farm income affected their livelihoods, particularly in 2000, 2004, and 2005. The shocks affected maize production directly. This suggests that off-farm income constitutes a major component of households' livelihood.

In general, serious shocks identified as affecting maize production were drought, illness/disability of breadwinner or spouse, large increases in input prices, family (marriage) breakdown, livestock diseases, large drop in maize prices, death of breadwinner or spouse, death or loss of livestock, plant pests and diseases, flood, loss of off-farm income, large drop in prices of other farm produce, destruction of crops by animals and other related incidents, conflict, erratic rainfall, theft of assets, arson, loss of farmland, dangerous weeds, frost

Maize farmer in Katsina state, Nigeria.

or hailstorms, and large drops in cassava, yam, and wheat prices. However, drought was the most important shock perceived by the sampled households as affecting their livelihood. The drop in prices of farm produce, such as cassava, yam, and wheat, was the least important. Responses from respondents and evidence from Olarinde et al. (2007) suggest that these risks are usually households' major reasons for seeking alternative means of livelihood.

8. Production and price risk analysis

The perception of households on the risks associated with production and price variations is next discussed. Households ranked sorghum, cotton, improved OPV, hybrid maize, and rice as the most profitable crops in the study area; sesame and sweetpotato were the least profitable. There was an increasing trend in the profitability of all the crops, with the household's profitability improvement plans aimed at increasing production and reducing costs. Local landrace maize, improved OPV, hybrid maize, sorghum, and rice were ranked as important crops that suffer most from drought stress.

More than 50**%** of the sampled households indicated that they sold some assets in the event of crop failure, as follows (percentages of growers and crop grown). included about 74% local landrace maize, 78% improved OPV, 76% millet, 52% sorghum, 90% beans, 67% groundnut, 62% cowpea, 86% cassava, 76% cotton, 80% sweetpotato, 50% sesame, 77% rice, 66% onion, 63% pepper, and 68% soybean. However, households conserved more assets in the years of good yields for all crops except for sweetpotato and cassava. On average, households experienced crop failure in three out of every ten years. About 77% of the households indicated that such difficulties led them into selling their assets to take care of domestic requirements, buy food, repay debts, and pay taxes, among others.

Households' perception of production risks and their coping mechanisms

The climatic conditions in the study area supported the production of relevant agricultural crops. Major food crops grown include sorghum, maize, millet, rice, and cowpea; major livestock were cows, goats, sheep, and poultry. However, households faced different risks in their production effort. The most risky crops in terms of yield fluctuations were sorghum, hybrid maize, local landrace maize, cotton, improved OPV maize, groundnut, rice, onion, millet, pepper, cowpea, soybean, and beans in that order, while cassava, sweetpotato and teff were the least risky crops (Table 27).

Table 27. Major crop and livestock production risks farmers face.

Crop	Ranking for risk in yield fluctuations
Local landrace maize	3
Improved OPV	5
Hybrid	2
Millet	9
Sorghum	Most risky – 1
Beans	13
Groundnut	6
Cowpea	11
Cassava	Least risky
Soybean	12
Rice	7
Cotton	4
Sweetpotato	Least risky
Sesame	Least risky
Onion	8
Pepper	10

Table 28. Households' perception of production and price risks.

Production (yield) risk	Coping strategy	Price risk	Coping strategy
Fluctuations in crop yields	Ex-ante	Fluctuations in selling price of crops	Ex-ante
	Agricultural diversification		Asset accumulation
	Asset accumulation		
	Ex-post		Ex-post
	Non-agricultural diversification		Participation in NGO and Government programs
	Participation in Government and NGO programs		Forward contracting, and informal insurance

The major production risk was fluctuation in crop yields. Fluctuation in the selling prices of crop produce was the major price risk (Table 28).

Household production risk coping strategies

Households used strategies, both ex-ante (before the shock) and ex-post (after the shock), to reduce production or yield risks to crops. The ex-ante approaches, which anticipate the occurrence of a shock, included agricultural diversification and asset accumulation. Diversification was a precaution commonly taken to meet risk, as the farmer avoided putting "all his eggs into one basket". It involved producing several different crops or livestock, in the hope that they would not all fail at the same time. The most common methods of diversification included intercropping in which crops that were more resistant to drought, for example, were planted together with preferred staple crops (such as sorghum—a drought resistant crop but susceptible to bird damage; and maize—more resistant to bird damage but drought susceptible) to ensure that some return is realized. Diversification also came in the form of staggered planting by which the same crop was planted at different times or on different soil types (through the use of fragmented plots) to ensure an even supply of food over as long a period as possible. The farmer also avoided risk by maintaining flexibility through making new decisions from day to day in view of changing conditions. For instance, if an early planted staple crop failed, he might replant with a more drought resistant variety. In general, diversification had the effect of reducing risk only if the yields of the various enterprises were not positively related. If they were positively related in such a way that, when one failed they all failed, then diversification did not reduce risk. The purchase and rearing of small animals, such as goats, chickens, and sheep, were some of the asset accumulation strategies engaged by the farming households to reduce risk. On the other hand, the ex-post approaches employed by households included petty trading, carpentry, tailoring, bricklaying and blacksmithing activities, and participating in Government and NGO programs such as Sasakawa Global 2000 and Government Starter Pack Programs.

Information on the production risks of each crop was usually obtained through extension officers, other farmers, radio/newspapers, NGOs, and on field days mostly organized by extension service units. To mitigate risks in the production of each crop, households cultivated additional crops on the fields. For instance, to reduce the risk on millet fields, maize and sorghum were planted along with the millet so that in case of failure, the household would fall back on the other crops. Except for sesame plots, where cotton is cultivated in case of identified production risks, all other crops were usually cultivated alongside the additional crops, whenever production risks were envisaged. The adjustment in crop portfolio to lessen production risks for crops grown is shown in Table 29.

Table 29. Adjustment in crop portfolio to reduce selected production risks.

Crop	Crops used to reduce production risks
Millet	millet, maize, sorghum
Sorghum	sorghum, maize, millet, beans, cotton, vegetable
Beans	beans, sorghum, cowpea
Groundnut	groundnut, sorghum, maize, cowpea, millet, cotton
Cowpea	cowpea, maize, sorghum, vegetable
Cassava	cassava, maize
Soybean	cotton, soybean, sorghum, maize, rice, millet, onion
Rice	rice, cotton, maize, sorghum, onion
Cotton	cotton, sorghum, rice, maize, groundnut, onion
Sweetpotato	sweetpotato, maize
Sesame	cotton
Onion	onion, cotton
Pepper	pepper, maize, cotton, sorghum, millet, rice

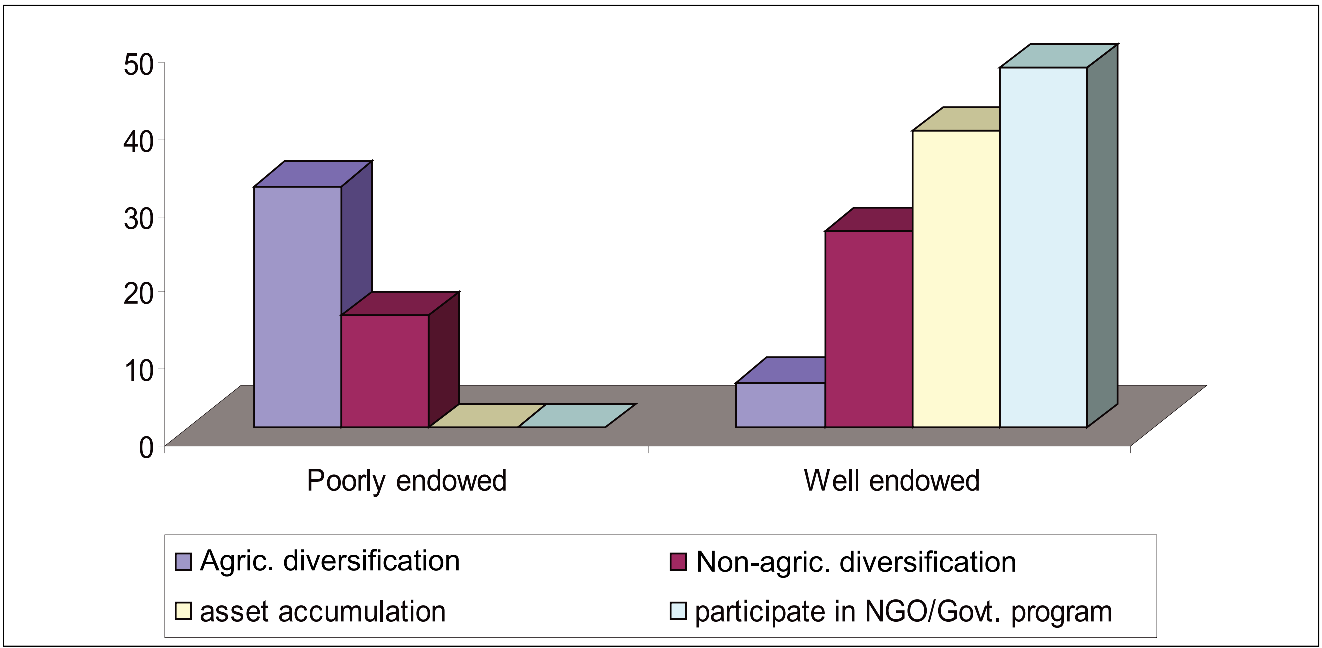

Figure 16. Production risk coping strategies employed by poor and well endowed households.

Production risk coping strategies adopted by wealth groups

Agricultural diversification was the predominant production coping strategy adopted by poorly endowed households (Fig. 16). Well endowed households predominantly participated in NGO and Government programs, and engaged in both asset accumulation and non-agricultural diversification as their production risk coping strategies. This corroborated the earlier finding that households shifted away from agriculture to other economic activities as their wealth status improved.

Households' perception of price risks and their coping mechanisms

Households also faced risks associated with unpredictable price variations and uncertainties about the behavior of others with whom they dealt. Households indicated that the selling price for all crops was an important factor in determining how much of the crop could be sold. About 61% of the households who grew local landrace maize and 82% of those who produced improved OPV maize concurred. Asset accumulation was the major

Table 30a. Major crop and livestock price risks faced by farmers..

Crop	Influence of sales price on quantity of crop sold (%)	Response on quantity of maize sales to higher crop prices	Crops sold when crop prices increase	Changes in input use when sale price increases	Credit acquisition with high sales price (%)	Effect of price decrease on assets (e.g. ,livestock)	Effect ofprice increase onassets (e.g.livestock)
Local land-race maize	61.4	-	-	Increase (85.5%)	80.2	Sell some (65.3%)	Keep more (57.1%)
Improved OPV	81.7	-	-	Increase (94.2%)	73.9	Sell some (77.9%)	Keep more (68.8%)
Hybrid	84.6	-	-	Increase (89.3%)	80.0	Sell some (74.4%)	Keep more (69.5%)
Millet	60.7	Less (48.8 %)	millet, maize, sorghum	Increase (88.5%)	67.0	Sell some (51.1%)	Keep more (54.5%)
Sorghum	63.0	Less (55.6%)	sorghum, maize, millet, beans, cotton, vegetable	Increase (86.2%)	71.0	Sell some (67.3%)	Keep more (61.1%)
Beans	100.0	More (62.5 %)	beans, sorghum, cowpea	Increase (100.0%)	87.5	Sell some (62.5%)	Keep more (50.0%)
Groundnut	89.0	Less (63.0%)	groundnut, sorghum, maize, cowpea, millet, cotton	Increase (76.6%)	72.0	Sell some (62.7%)	Keep more (69.3%)
Cowpea	85.7	Less (51.5%)	cowpea, maize, sorghum, vegetable	Increase (88.4%)	78.3	Sell some (64.7%)	Keep more (72.1%)

ex-ante strategy used to mitigate the effects of price risks. For instance, households responded to the effect of price increases on assets by acquiring more of the assets. In contrast, when asset prices fell, they responded by selling those assets, apart from rice, more of which was kept (Tables 30a and 30b). This suggested that rice was not a major staple in the study area.

When the selling price of any of the crops was profitable, the use of inputs such as fertilizer increased although households generally agreed to acquire more credit in all situations. However, with a decrease in crop produce

Table 30b. Major crop and livestock price risks faced by farmers.

Crop	Influence of sales price on quantity of crop sold (%)	Response on quantity of maize sales to higher crop prices	Crops sold when crop prices increase	Changes in input use when sale price increases	Credit acquisition with high sale price (%)	Effect of price decrease on assets (e.g. livestock)	Effect of price increase on assets (e.g.livestock)
Cassava	87.5	Less (83.3%)	cassava, maize	Increase (87.5%)	75.0	Sell some (50.0%)	Keep more (50.0%)
Soybean	87.5	Less (58.8%)	cotton, soybean, sorghum, maize, rice, millet, onion	Increase (92.0%)	83.0	Sell some (73.9%)	Keep more (76.1%)
Rice	91.9	Less (70.4%)	rice, cotton, maize, sorghum, onion	Increase (88.4%)	76.0	Keep more (50.0%)	Keep more (50.3%)
Cotton	83.0	Less (73.3%)	cotton, sorghum, rice, maize, groundnut, onion	Increase (93.0%)	83.0	Sell some (77.9%)	Keep more (76.7%)
Sweetpotato	40.0	Less (80.0%)	sweet potato, maize	Increase (60.0%)	80.0	Sell some (60.0%)	Keep more (80.0%)
Sesame	100.0	Less (100.0%)	cotton	Increase (100.0%)	100.0	Sell some (50.0%)	Keep more (100.0%)
Onion	89.0	Less (63.4%)	onions, cotton	Increase (95.6%)	78.0	Sell some (75.0%)	Keep more (81.8%)
Pepper	89.0	Less (66.2%)	pepper, maize, cotton, sorghum, millet, rice	Increase (91.4%)	86.0	Sell some (72.5%)	Keep more (81.2%)

prices, some household assets, such as livestock, were sold, except for rice. More assets were kept when its price decreased. On the other hand, more assets were generally kept when crop prices increased. For example, about 69% of assets were kept when there was an increase in the price of improved OPV and 70% after an increase in the price of hybrid maize. The response to higher crop prices on the quantity of maize sales showed that (except for beans when more maize sales were made), when changes in the selling prices of other crops (millet, sorghum, groundnut, and cowpea) were higher than normal, the quantity of maize sales was less compared with the other crops. Given these changes, most households planted some maize with other crops (except for beans, sesame, and onion) as a way of reducing price risks (Table 31).

Table 31. Adjustment in crop portfolio to reduce selected price risks.

Crop	Crops sold, given higher crop prices
Local landrace maize	-
Improved OPV	-
Hybrid	-
Millet	millet, maize, sorghum
Sorghum	sorghum, maize, millet, beans, cotton, vegetable
Beans	beans, sorghum, cowpea
Groundnut	groundnut, sorghum, maize, cowpea, millet, cotton
Cowpea	cowpea, maize, sorghum, vegetable
Cassava	cassava, maize
Soybean	cotton, soybean, sorghum, maize, rice, millet, onion
Rice	rice, cotton, maize, sorghum, onion
Cotton	cotton, sorghum, rice, maize, groundnut, onion
Sweetpotato	sweetpotato, maize
Sesame	cotton
Onion	onion, cotton
Pepper	pepper, maize, cotton, sorghum, millet, rice

Household price risk coping strategies

Ex-post coping strategies employed by households against price risks included forward contracting, informal insurance, and their participation in NGO and Government programs. Farmers reduced price risk and uncertainty through informal insurance by collecting information about market prices to predict future price trends. Wealthy households in the study area also paid for agreed quantities of farmers' produce in advance. Price risk was also reduced through forward contracting by which the farmer made advance contracts with the buyer of his products and the sellers of his inputs. For instance, in the study area, some seed companies contracted farmers to produce some quantity of seeds which they bought at a price agreed in advance. This used to be the type of service provided by the Commodity Marketing Board in Nigeria when the prices at which farmers' produce were bought were announced in advance (Okuneye 1985).

Price risk coping strategies adopted by wealth groups

Four main price risk coping strategies were adopted by households according to wealth groups. These were asset accumulation, participation in NGO and Government programs, forward contracting, and informal insurance (Fig. 17). Households who were worse-off or just emerging from the worse-off wealth category predominantly adopted asset accumulation and participation in NGO and Government programs as their price risk coping strategies. On the other hand, as wealth status increased, households tended to adopt forward contracting and informal insurance as price risk coping strategies. Key informants claimed that this is how standards were maintained between households that were well-off and those worse-off.

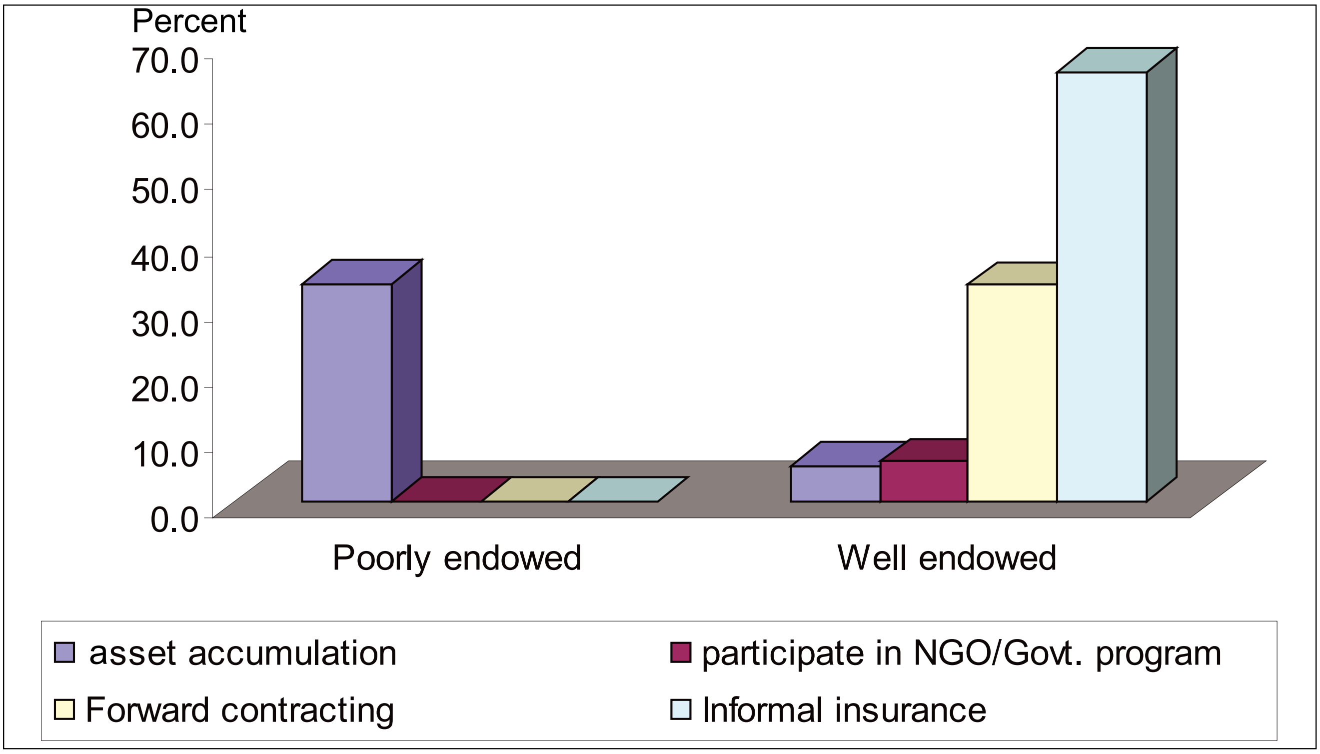

Figure 17. Price risk coping strategies employed by poorly and well endowed households.

9. Summary of household impact indicators

The maize production system was male dominated and households cultivated different maize varieties including the landraces, improved OPV, and hybrids. Among the landrace varieties, Yar kassa was ranked best; ACR97 was the best ranked OPV, and Oba Super 1 the best ranked hybrid maize variety. The ranking of these varieties according to wealth groups showed that the landrace (Yar kassa) ranked highest among the poorly endowed households and Oba Super 1, ranked highest among the well endowed. Households' major desirable characteristics of an ideal maize variety were high yield potential, large cob size, and large grain size. The major sources of improved maize seeds were the Ministry of Agriculture, other farmers, and the market centers.

The assets owned by households to a large extent determined their wealth status and ability to take the risks associated with the adoption of innovations. Assets owned were categorized into human, natural, physical, financial, as well as institutional and social resources. Arranged in descending order, the assets with the highest impact in the study area were the ownership of a cultivable farm, radio, remittances, total farm size, motor cycle, television, mobile phone, draft animal, bicycle, wheelbarrow, private well, and total household size. Households also owned local cows, bulls, young bulls, heifers, calves, goats, pigs, sheep, chickens, and transport animals. The number of assets owned was an important measure of household wealth. The distribution of the wealth index ranking of the households showed that majority of the maize producing households were poorly endowed, with about 62% of them being categorized as worse-off. Therefore, a larger percentage of the farming households were poor. There were significant differences in the characteristics of the well endowed and the poorly endowed. For instance, the ownership of a large plot of land was an important measure of wealth in the area. A larger percentage of the well endowed households (72%) belonged to associations and had larger sized farms, averaging about 20 ha, located up to 5.4 km from the market center. They also adopted more (79% of households) and cultivated larger areas of about 4.4 ha to improved

maize. On the other hand, more (97%) of the poorly endowed households had access to credit as a result of credit facilities targeted to poor households by Government and NGOs during the period under study. The major sources of credit used were neighbors, relatives, money lenders, Government programs, financial institutions, and NGOs. However, delays in receiving production credit and basal fertilizer from credit providers (Government programs, financial institutions, and NGOs) made it difficult for borrowers to effect prompt repayment when necessary. Thus, there was a need for adequate and timely provision of both cash and credit facilities to the households for their effective and efficient use.

The livelihood of households in the study area was centered on the availability of land for food crop production, as well as on livestock production and marketing. Farm sizes were generally small. However, the gender distribution of households' access to farm land revealed some sociocultural factors constraining female access to farmland among the farming households. This was reflected in the fact that only male household heads had access to abandoned, fallow, pasture, and tree farm land. In addition, the farm sizes cultivated by men were larger than those cultivated by women. Cereals were the major crops grown and included local maize, improved maize, hybrid maize, sorghum, and millet. Rice, sweetpotato, cowpea, groundnut, and cassava were also grown. Households ranked sorghum, cotton, improved OPV, hybrid maize, and rice as the most profitable crops. However, as households became wealthier, they tend to move away from farming to other economic activities as a means of livelihood.

The major production risk was fluctuation in crop yields. Fluctuation in the selling prices of crops ranked as the major price risk (Table 21). Households employed both ex-ante (before the shock) and ex-post (after the shock) strategies to reduce the production or yield risks of crops. The ex-ante approaches, which anticipated the occurrence of a shock, included asset accumulation and agricultural diversification (early planting, labor intensification, increased farm land and input use, accumulation of production assets, use of hybrid seeds, undertaking income generating off-farm activities, learning better practices of input use, and selling livestock). Risks associated with a low level of education were reduced when households enrolled more of their children in formal and informal (e.g., Koranic) schools, and attended adult literacy classes. On the other hand, the ex-post risk reduction approaches employed by households included involvement in politics, petty trading, carpentry, tailoring, commercial vehicle driving, bricklaying, and blacksmithing. Others comprised participation in Government and NGO programs, such as Sasakawa Global 2000 and Government Starter Pack Programs. Information on production risks of each crop was usually obtained from extension officers, other farmers, radio/ newspaper, NGOs, and on field days (mostly organized by extension service units). To reduce risks in the production of each crop, households cultivated additional crops on the fields. The ex-ante price risks coping strategy used was mainly asset accumulation, while ex-post strategies included forward contracting, informal insurance, and participation in NGO and Government programs. Four main strategies to cope with price risk were adopted by households according to wealth groups. These were asset accumulation, participation in NGO and Government programs, forward contracting, and informal insurance. Poorly endowed households predominantly adopted asset accumulation and participation in NGO and Government programs as their price risk coping strategies. Forward contracting and informal insurance were the price risk coping strategies preferred by wealthier households, as a way of maintaining class differences between the two wealth groups.

Drought was the most important shock perceived by the sampled households as largely affecting their livelihood. Local landrace maize, improved OPV, hybrid maize, sorghum, and rice were ranked as important crops that suffered most from drought stress. These risks were usually the households' major reasons for seeking alternative means of livelihood. The three most important household livelihood outcomes when confronted with shocks were increasing agricultural production, reducing income risks, and reducing health risks. To reduce food security risks, households stored food grains for longer periods, grew crops with differing maturing dates, replaced cash crops with food crops, increased the use of inputs for higher yields, and engaged in dry season farming. More than 50% of the sampled households indicated that they had had to sell some assets in the event of crop failure to take care of domestic needs, buy food, settle debts, and pay taxes,

among others. The most risky crops in terms of yield fluctuations were sorghum, hybrid maize, local landrace maize, cotton, improved OPV, groundnut, rice, onion, millet, pepper, cowpea, soybean, and beans. Cassava, sweetpotato, and teff were least risky. The period from June to August was noted for food shortages during the year. Selling small animals, increasing off-farm work, and reducing other expenditure were major coping strategies used to reduce the effects of food shortages.

About 68% of the sampled households were adopters of improved maize while 32% were non-adopters. A larger proportion of adopters belonged to associations, such as farmers' unions and cooperative societies, and had more frequent interactions with extension agents. This suggested better extension advice on appropriate agronomic practices and linkages with input sources and output markets. The adopters also considered high yield potential and seed availability to be more important when they were selecting maize varieties to plant. This implied that these characteristics were necessary for consideration in any breeding program of improved maize to ensure wider acceptability by farmers. The classification of household wealth groups into adopters and non-adopters showed that a larger percentage of the adopters within the poorly endowed households belonged to associations, had extension contact, and were wealthier than the non-adopters. On the other hand, age, membership of associations, yield potential, and seed availability were significantly different between adopters and non-adopters within the well endowed wealth group. For the sampled households, farm size, extension contact, distance to market, perception of yield potential, seed availability, and WI were the major factors that influenced the probability of adoption of improved maize varieties. Membership in an association was the only additional variable that significantly influenced the use intensity of improved maize after adoption.

These findings have economic implications for development programs aimed at promoting and targeting new technologies to specific wealth categories for improved livelihood of the farming households.

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