Baseline Survey of Sorghum and Pearl Millet Production in Mali, Niger and Northern Nigeria (2009/2010)

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Abbreviations and acronyms

ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
WCA	West and Central Africa
ESA	Eastern and Southern Africa
SA	South Asia
SSA	Sub-Saharan Africa
FAO	Food and Agricultural Organization of the United Nations
FAOSTAT	FAO Statistics
IER	Institut d'Economie Rurale
INRAN	Institut National de la Recherche Agronomique du Niger
NGO	Non-Governmental Organization
FCFA	Franc de la Communauté Française Africaine
US$	United States dollar
NARS	National Agricultural Research Systems
ADP	Agricultural Development Project
ICMV-IS	ICRISAT Millet Variety - ICRISAT Sahelian
ICSV	ICRISAT Sorghum Variety

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Executive Summary

The HOPE project is an ICRISAT assisted project implemented in West and Central Africa (Mali, Niger, Burkina Faso, Nigeria), Eastern and Southern Africa (Ethiopia, Eritrea, Kenya, Southern Sudan, Tanzania, Uganda), and South Asia (India). The project aims to increase the productivity of dryland sorghum, pearl millet and finger millet cereal production systems in dryland South Asia and sub-Saharan Africa, increasing incomes and food security.

In its first 4 years, the project intends to increase farmer yields by 30% or more, benefiting 110,000 households in sub-Saharan Africa and 90,000 in South Asia. Within ten years the project will benefit 1.1 million households in sub-Saharan Africa and 1.0 million in South Asia. Project progress will be measured from results of baseline surveys conducted in the areas of project implementation.

This report presents a reference situation of intervention sites of the HOPE project in West and Central Africa. It highlights the socio-demographic and economic characteristics of pearl millet and sorghum producers in Mali, Niger and Northern Nigeria. The report has been written using baseline surveys of pearl millet and sorghum producers conducted in Mali, Niger and Northern Nigeria in 2009/2010. Other information has been obtained from project documentation, national partner organizations and discussions with ICRISAT scientists.

The report has been divided in six sections. Section 1 introduces the HOPE project by giving the intervention sites of project, the key beneficiaries, the global objective and the specific objectives of project. Section 2 describes the study area – infrastructure and production environment in Mali, Niger and Nigeria. Section 3 reviews sorghum and pearl millet projects and programs implemented in West and Central Africa and that could directly affect the success of the HOPE project. Section 4 presents survey methodology by emphasizing the objectives of the survey, sampling procedure and data collection. Section 5 provides the statistical results and discussions. Several points are discussed in this fifth section. First, the section describes socio-demographic profile of households and livelihood assets. These assets include natural assets, physical assets, social assets and financial assets. Second, the section provides the details of market transactions of pearl millet and sorghum producers. Third, it throws light on exposure and adoption of the improved pearl millet and sorghum varieties: proportion of households having known the modern varieties, proportion of households having adopted the modern varieties, the ratio of area planted with modern varieties and the constraints to adoption of modern varieties. Fifth, the section emphasizes on pearl millet and sorghum production systems: pearl millet and sorghum plots characteristics, perception that pearl millet and sorghum producers have of their production and soil fertility, proportion of plots using fertilizers and manure, proportion of plots under local and improved varieties, production levels, and per hectare yields. Sixth, it describes food security situation, vulnerability status, causes of household food insecurity and sources of off-farm incomes. Section 6 concludes the baseline report.

The results showed that pearl millet and sorghum in Mali, Niger and Northern Nigeria were poor in terms of number and value of their livelihood assets. Few members in household received a formal education. For example in Mali, on a total of 25 members in household, about 6 received a formal education. Agricultural equipment was mainly consisted of traditional equipment (plough, hoe, etc.) and animal traction. The main durable assets owned by households were bicycle, motorcycle, radio, television and telephone. The total value of durable assets is estimated to $US 245 in Niger, $US 1,041 in Mali and $US 1,375 in Northern Nigeria. The surveyed households in the three countries had a limited access to credit (30% in Mali and Niger, and 10% in Northern Nigeria). This is a major difficulty in increasing of smallholders' incomes. The proportion of households having access to market was low. The marketable surpluses of pearl millet and sorghum were low compared to those of other products such as groundnut, maize and rice. This is due to the fact that pearl millet and sorghum are self-consumption products in most of West African countries. The results highlighted a low use of improved varieties due to low yielding of varieties, late maturity of varieties, highly sensitive of varieties to drought and non-availability of seeds. The low rate of adoption of modern varieties could also explained by the low education level of farmers. Less educated households are less receptive to new technologies. The varieties the most adopted in Mali in 2009/2010 were Sanioba03 (21%) and Sanioteli53 (7%) for pearl millet, and Kenikedje (10%) and Seguetana (10%) for sorghum. In Niger, Ankoutes (6%) was the pearl millet variety the most adopted. In Northern Nigeria, the varieties the most adopted were Sosat (37%) and Ex Borno (20%) for pearl millet, and ICSV400 (14.25%) and ICSV111 (14.71%) for sorghum. With regard to soil fertility, on average, the surveyed households thought that their plots had a medium fertility. Intercropping system was the dominant system on plots in Niger (88%) and Northern Nigeria (67%). In Mali, intercropping was only practiced on 25% of plots. The results also showed that 41%, 75% and 18% of the surveyed households in Mali, Niger and Northern Nigeria respectively have experienced food insecurity problem during at least 15 days in 2009.

Overall, efforts are to make in the framework of the HOPE project for a wide adoption of improved of pearl millet and sorghum and use of modern technologies. There is also a need to facilitate access to credit and access to market to enable to farmers to increase their production and incomes, and to improve food security.

1. Introduction

The HOPE project is an ICRISAT assisted project that officially started July 1, 2009. This project is being implemented in three regions of world: West and Central Africa (Mali, Niger, Burkina Faso, Nigeria), Eastern and Southern Africa (Ethiopia, Eritrea, Kenya, Southern Sudan, Tanzania, Uganda), and South Asia (India). The direct beneficiaries of the project are poor smallholder farmers producing millets and sorghum and their households, and others involved in the crop commodity value chain. Consumers benefit indirectly through more stable and lower prices and better quality grain and products for their essential foodstuffs.

The main objective of the HOPE project is to increase the productivity of dryland sorghum, pearl millet and finger millet cereal production systems in dryland South Asia and sub-Saharan Africa, increasing incomes and food security. To achieve this vision, six specific objectives have been defined: 1) target opportunities for technology development and delivery to maximize adoption and impacts of innovations on livelihoods in WCA, ESA and SA; 2) improve sorghum cultivars and management options to increase productivity in WCA, ESA and SA; 3) improve pearl millet cultivars and management options to increase productivity in WCA and SA; 4) improves finger millet cultivars and management options to increase productivity and production in ESA; 5) discover and develop improved market strategies for sorghum, pearl millet and finger millet to stimulate adoption of improved technologies in WCA, ESA and SA; 6) enable technology adoption of sorghum, pearl millet, and finger millet by improving access to inputs and markets differentiated according to both women and men's needs in WCA, ESA and SA.

In its first 4 years, the project intends to increase farmer yields by 30% or more, benefiting 110,000 households in sub-Saharan Africa and 90,000 in South Asia. Within ten years the project will benefit 1.1 million households in sub-Saharan Africa and 1.0 million in South Asia.

Project progress will be measured from results of baseline surveys conducted in the areas of project implementation. The baseline surveys were carried out at village, household and plot levels. They contain information on monitoring-evaluation indicators that will enable to provide a reference situation of the sites where the HOPE project started its activities.

The rest of report focuses on the data analysis of baseline surveys conducted in Mali, Niger and Northern Nigeria. The report is organized as follow: In section two, background information on pearl millet and sorghum in Mali, Niger and Nigeria is provided. In section three, surveys methodologies in three countries are described. In section four, surveys data are analyzed. Finally, some concluding remarks are given in the section five.

2. The study area – Infrastructure and production environment in Mali, Niger and Nigeria

Cereals production is extremely widespread in West Africa countries. Pearl millet and sorghum remain the main crops in this part of the world especially in Sahelian countries such as Mali, Niger and Northern Nigeria. This section presents production and infrastructure environment in these three countries.

Pearl millet and sorghum are staple food of the Malian population. These two cereals occupy 80% of cultivated areas and contribute to 49% of food consumption needs. The main production regions are Mopti, Segou, Sikasso, Koulikoro and Kayes occupying between 82% and 92% of the pearl millet and sorghum production in 2009 (Fall, 2011). The yield levels remain low. They are estimated to less than 800 kg/ha for pearl millet and less than 1000 kg/ha for sorghum. In 2009/2010, overall supply of pearl millet and sorghum is estimated to 3 million tons: 35% is sold and the rest is self-consumed. There is almost no structured market for certified seeds due to the nature of self-consumption of these two cereals. Farmers use their own seeds, which are often of poor quality. About 5% of farmers use certified seeds, in particular farmers supervised by NGOs and development projects (Fall, 2011). This leads to the low production levels and limits the producers' ability to meet domestic demand. Consequently, the volume of production allocates to market is low, and processing companies experience difficulties to access to commodity (pearl millet and sorghum). In terms of cropping practices, pearl millet and sorghum producers are generally smallholder farmers with a low level of equipment (animal traction, plough, hoe, etc.). Use of fertilizers is important in cotton regions producing pearl millet (50kg/ha of complex and 50kg/ha of urea). Use of fertilizer is also important among sorghum producers using modern technologies (100kg/ha). Increase in pearl millet and sorghum production requires improvement access to credit. Less than 2% of rural households have access to formal credit in Mali (World Bank, 2011). The rate is lower for pearl millet and sorghum producers.

The main cereal grown in Niger is millet. It is often cultivated in association with cowpea, groundnut or sorghum. Pearl millet occupies most of cultivable land. It is grown in regions with annual rainfall between 250 mm and 650 mm. The main producing regions include Maradi, Dosso, Tillabery and Tahoua. Over the period 2007-2008, pearl millet production was estimated to 631.090 tons in Maradi, 511.155 tons in Dosso, 523.368 tons in Tillabery and 584.108 tons in Tahoua (Sani and Salifou, 2010). Niger is the second producer of pearl millet in West Africa after Nigeria. However, pearl millet yields remain low. They are estimated to about 500 kg/ha in 2009 at the national level. Millet production in Niger is strongly dependent on precipitations while the country is characterized by an erratic and irregular rainfall. Use of fertilizer remains low due to prices which are often very high in Niger. Some farmers use organic fertilizers obtained from animal excrement. Other factors limit pearl millet productivity in Niger. These constraints include widespread incidence of pests, infertile soils, low use of improved varieties, predominance of equipment traditional, and limited access to credit.

Nigeria is the largest cereals producer in West Africa with a level of production estimated to 25 543 600 tons in 2010. The main production regions are the northern states. The volume of cereal production has experienced rapid growth over the last thirty years. However, sorghum remains the main cereal produced in Nigeria accounting for about 71% of the regional sorghum production in 2006 (RECA Niger, 2010). In the same year, pearl millet production accounted for 50% of the regional pearl millet output. The average yield of pearl millet and sorghum was of 1000 kg/ha over the period 2000-2006 (Soule et al., 2010). Few pearl millet and sorghum producers use improved varieties. Pear millet and sorghum are generally grown by smallholder farmers with basic equipment. The inputs used in the production of these two cereals include seeds, labour, land and a limited quantity of fertilizers. In Nigeria, most of households produce pearl millet and sorghum for self-consumption, only a small proportion is allocated to local markets. Smallholders experience difficulties to increase their production. These constraints include the lack of agricultural credit, inadequate extension services and the poorly developed market linkages.

3. Sorghum and pearl millet projects and programs in West and Central Africa countries

This section presents sorghum and pearl millet projects and programs implemented in West and Central Africa countries and that could directly affect the success of the HOPE project.

- **West Africa Community of Practice (WAf-CoP)** is part of McKnight Foundation Collaborative Crop Research Program. The WAf-CoP includes a series of projects that focus on improving food security and nutrition for smallholder farming families in Burkina Faso, Mali, and Niger through projects on sorghum- and pearl millet-based agricultural systems.
- **Program for African Seed Systems (PASS)** is funded by B&MGF, under the umbrella of the Alliance for a Green Revolution for Africa (AGRA). PASS has for objective to train scientists to breed improved varieties of Africa's 10 indigenous and staple food crops in 15 Sub-Saharan Africa countries and to build the capacity of national research systems in plant breeding and seed production. PASS also helps private African seed companies and farmer cooperatives to produce, distribute and market improved seed. The project contributes to strengthen networks of village-based agro-dealers. PASS promotes policies that accelerate the release of new varieties, strengthens seed regulatory systems and harmonizes regional seed laws.
- **Integrated Striga Management in Africa (ISMA)** is a project funded by the Bill & Melinda Gates Foundation. ISMA aims through strategic partnerships and an integrated approach for managing Striga to improve soil fertility and reduce the Striga seed bank for sustainable increases in crop yields. This project is led by International Institute of Tropical Agriculture (IITA) and shares several common goals in Striga management with the HOPE project.

- **Sorghum and Millets Innovation Laboratory (INTSORMIL)** is funded by United States Agency for International Development (USAID). This project has for objective to provide research, training and capacity building that addresses hunger and poverty where sorghum and millet are important food crops. INTSORMIL and HOPE project involved in almost the same countries.
- **PROMISO2** is jointly funded by European Union and Food Facility program for West and Central Africa of International Fund for Agricultural Development (IFAD). PROMISO2 is the second phase of PROMISO. It is a project targeting seed delivery to rural communities through participatory variety selection and farmer cooperative seed production systems.
- **West African Seed Alliance (WASA)** was funded by USAID and AGRA and implemented with ICRISAT partners and Iowa State University. This project had to objective to modernize seed distribution systems, facilitate access to improved seed varieties, improve seed production technologies, strengthen links to credit and markets, improve seed policy and harmonize release procedures.

4. Overview of survey methodology

4.1. Objectives of the survey

The main objective of the surveys was to collect the monitoring indicators which will provide an effective baseline data and information for assessing project progress towards its objectives. The major evaluation questions include:

- Estimate the value of livelihood assets owned by pearl millet and sorghum producing households in 2009/10;
- Estimate the level of investment (cost of pearl millet or sorghum production) made by households on sorghum and pearl millet production
- Estimate the yield/productivity from pearl millet and sorghum production at farm level;
- Estimate the pearl millet or sorghum production at household level
- Assess the level of exposure and adoption of improved varieties;
- Identify the pearl millet and sorghum traits preferred by households;
- What are the proportions of households using organic and inorganic fertilizer use?
- What are the proportion and level of pearl millet or sorghum marketable surpluses derived by households?
- Where are farmers sourcing sorghum and pearl millet seed?
- What are the different seed transactions used by households to obtain their seed?
- What is the proportion of households who has access to credit from formal sources?
- What are the major sources of credit –and amount obtained from different sources of households in the project and non-project sites?
- What are the predominant sorghum and pearl millet based production systems?

- Estimate the levels of profitability of pearl millet and sorghum with respect to other products;
- Estimate the total value of production (agriculture, livestock and non-agricultural activities);
- Estimate the welfare of households producing pearl millet and sorghum.
- Estimate the food security indexes of pearl millet an sorghum producing households

4.2. Sampling procedure and data collection

The surveys were carried out in project and non-project sites from December 2010 to January 2011 in Mali, from February to March 2011 in Niger and from December 2009 to January 2011 in Nigeria where the HOPE project started its activities. The data were collected by Agricultural Extension Services in Nigeria, National Agricultural Research Systems in Mali (IER) and Niger (INRAN) in collaboration with ICRISAT. In Mali and Niger, surveyed villages were selected based on proximity to project villages. Villages located around 10 to 20 km from project villages were considered to be diffusion villages i.e. villages where technologies and innovations will easily spill-over and control villages are those located 40 to 60 km from control villages where it is assumed that technologies being developed in project villages cannot easily spill-over in those villages.

Project villages were purposely selected by biophysical scientists except in Nigeria. In Mali and Niger, project villages were randomly selected. Diffusion and control villages were selected using propensity score matching methods. Characteristics considered in the matching included the soil types from FAO database, existence of the variety/seed dissemination project, agro-ecological zone, distance to major towns (more 5000 inhabitants), road accessibility, population size, population density, presence of rural radios, and existence of a market. In each stratum, villages that have the same probability i.e. the same score were selected as matching village. This methodology may have some drawbacks as information collected from the villages dated far back as 1990s and may have changed dramatically in 2010. In addition, information collected on the projects that have been implemented in the villages may have been incomplete. In Nigeria, the situation was different. A nationwide survey was carried out in Northern Nigeria where sorghum and pearl millet are grown.

In Mali, the survey covered 78 villages and 728 households in 6 regions where pearl millet and sorghum are grown (table 1). The selected regions accounted for about 96% of pearl millet area harvested and 95% of pearl millet production in 2009. These regions accounted for about 97% of sorghum area harvested and 93% of sorghum production in 2009. The selected villages consisted of 38 project villages, 22 diffusion villages, and 18 control villages. Thus, 14 villages were selected in Kayes, 30 villages in Koulikoro, 10 villages in Mopti, 10 villages in Segou and 14 villages in Sikasso. On average 10 households were randomly selected in each village. Most of households interviewed are both sorghum and pearl millet producers. A total of 728 households were interviewed of which 531 households were pearl millet producers and 702 were sorghum producers. Table 2 below presents the

distribution of households producing pearl millet and sorghum by region and by type of village.

Table 1: Distribution of households by region in Mali, 2009/2010

	Surveyed Regions					
Type of producer/type of village	Kayes	Koulikoro	Mopti	Segou	Sikasso	Total
Pearl millet producers						
Project village	37	74	78	52	61	302
Diffusion village	52	17	0	30	25	124
Non-project village	15	26	20	10	34	105
Sub-Total	104	117	98	92	120	531
Sorghum producers						
Project village	38	127	71	51	68	355
Diffusion village	58	65	0	28	29	180
Non-project village	28	74	15	10	40	167
Sub-Total	124	266	86	89	137	702

Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria in 2009-2010.

In Niger, 439 households producing pearl millet were interviewed in 3 regions (table 2). The selected regions accounted for about 60% of pearl millet area harvested and 65% of pearl millet production in 2009. On a total of 68 selected villages, there were 27 project villages, 23 diffusion villages and 18 control villages. Seventeen (17) villages were selected in Dosso, 20 villages in Maradi and 29 villages in Tillabery. The number of selected households by village ranged from 1 to 12. Table 3 below presents the distribution of households producing pearl millet by region and by type of village.

Table 2: Distribution of households by region in Niger, 2009/2010

	Surveyed Regions			
Pearl millet producer/type of village	Dosso	Maradi	Tillabéry	Total
Project village	50	83	126	257
Diffusion village	19	36	50	107
Non-project village	30	20	25	75
Total	99	139	201	439

Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

In Nigeria, the survey covered 123 villages and 1205 households in 6 states of Northern Nigeria. The selected states accounted for about 74% of pearl millet area cultivated and 49% of pearl millet production in Nigeria in 2010. These states accounted for about 50.30% of sorghum area cultivated and 48.85% sorghum production in Nigeria in 2010. The selected villages were consisted of 78 project villages and 45 non-project villages. Thus, 18 villages were selected in Borno state, 12 villages in Yobe, 23 villages in Katsina, 30 villages in Kano, 20 villages in Jigawa and 20 villages in Zamfara state. On average 10 households were randomly selected in each village. Most of households interviewed are both sorghum and pearl millet producers. On a total of 1205 households were interviewed, 1047 households were pearl millet and 1081 households as sorghum producers. Table 3 below presents the distribution of households producing pearl millet and sorghum by state.

Table 3: Distribution of households by region in Nigeria, 2009/2010

	Surveyed States						
Type of producer/type of village	Borno	Jigawa	Kano	Katsina	Yobe	Zamfara	Total
Pearl millet producers							
Project village	98	89	226	93	30	118	654
Non-project village	16	89	26	110	85	67	393
Sub-Total	114	178	252	203	115	185	1047
Sorghum producers							
Project village	120	81	230	88	29	119	667
Non-project village	19	87	29	127	88	64	414
Sub-Total	139	168	259	215	117	183	1081

Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

In all the 3 countries, data were collected at village, household and plot levels. Village information included village profile, access to roads, markets and services, village population where necessary, village land occupation and relative importance of crops, land tenure systems, projects and programs that have been implemented in the village, prices of input and product markets, and factors of production, livestock prices, wages, credit sources, and units of measurements.

At household level, data were gathered on household socio-demographic and economic profile, land stocks and agricultural equipment, diffusion mechanism of sorghum and pearl millet varieties, varieties grown during the last 5 years, participation in technology transfer activities, social capital, crop production and stocks, livestock production and stocks, assets owned, sources and access to credit, crop and livestock transactions and household perception of welfare changes.

Plot information included plot characteristics, use of inputs (seed, organic and inorganic fertilizers), sources of seed, organic and inorganic fertilizers, period of application, quantities of inputs applied, farmers' perception of fertility level, production level, and finally farmers' perception of welfare changes.

5. Results and discussions

A household can be defined as an economic unit where the members are linked by an economic relationship such as producing together, sharing the money earned and sharing the home. In this part, it will be presented descriptive statistics on demographic and socio-economic characteristics of households producing pearl millet and sorghum in Mali, Niger and Northern Nigeria in 2009-2010.

5.1. Livelihood assets owned by households

This section presents the different types of livelihood assets[1] owned by households. These assets include human capital, natural assets, physical assets, social assets and financial assets.

5.1.1. Human capital: Socio-demographic profile of Sorghum and pearl millet producers in Mali, Niger and Nigeria

The human capital is the set of skills, knowledge, ability to labour and good health important to the ability to pursue different livelihood strategies. This section presents the socio-demographic profile of pearl millet and sorghum producers in terms of: household size, gender composition, education, sex and age of household head and marital status.

a) Household size and gender composition

Table 4 presents the household size of the surveyed farmers in Mali, Niger and Northern Nigeria. The results showed that that the highest household size was recorded among pearl millet and sorghum producers in Mali, with an average of 26 members per household. There are however significant differences between villages-clusters or strata. The estimated

[1] Livelihood assets represent the five types of capital upon which livelihoods are built (human capital, natural capital, physical capital, social capital and financial capital).

household size was 24 members in project villages against about 29 members in diffusion villages.

In Niger and Nigeria, the household size was estimated to 13 and 10 members among pearl millet producers respectively. In Niger, there are differences between villages-clusters. The average household size is significantly higher in diffusion villages than project villages. The results obtained in the case of Mali is not surprising, it is the same that those obtained in the previous studies.

The total workforce proxied by the number of adult equivalents is estimated to about 12, 6 and 2 adult equivalents among pearl millet producers in Mali, Niger and Nigeria respectively. Diffusion villages in Niger had a workforce[2] above the average of overall sample (7). Dependency ratio[3] was above 1 in the three countries. This low ratio means that the population is young in Mali, Niger and Northern Nigeria. This is an advantage in terms of production.

Table 4 presents the gender composition among surveyed households. Results indicate that there are more men than women among pearl millet producers in Mali (49.17%), Niger (49.39%) and Northern Nigeria (36.26%), except in Mali where there are more women (52.60%) in diffusion villages. Among sorghum producers in Mali, the proportion of female members is estimated to about 47%. However, same as in the case of pearl millet producers, women accounted for more than 50% of household members among sorghum farmers living in diffusion villages in Mali. The other results are almost similar than those obtained for pearl millet producers.

[2] The workforce is the labour pool in unemployment. It generally implies people involved in manual labour or people available for work.

3 The dependency ratio is a measure showing the number of dependents (aged 0-14 and over the age of 65) to the total population (aged 15-64).

Table 4: Size and gender composition of households producing pearl millet and sorghum in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Household size	24.36[a**]	24.54	28.70	26.53	26.77	25.84	25.85	25.36
Number of adult equivalent	12.01	11.86	13.64	13.21[c*]	12.10	11.24	12.41	12.06
Percentage of women (%)	48.74[a*]	47.06	52.60[c**]	49.54	46.82	46.09	49.17	47.40
Dependency ratio	1.70	1.74	1.65	1.63	1.78	1.75	1.71	1.71
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Household size	12.27[a**]	n/a	15.57[c**]	n/a	10.91	n/a	12.82	n/a
Number of adult equivalent	5.44[a*]	n/a	6.76[c***]	n/a	4.55	n/a	5.60	n/a
Percentage of women (%)	49.49	n/a	49.23	n/a	49.24	n/a	49.39	n/a
Dependency ratio	1.83	n/a	1.60	n/a	2.02	n/a	1.80	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Household size	9.94	9.90	n/a	n/a	10.19	9.92	10.03	9.91
Number of adult equivalent	2.23	2.21	n/a	n/a	2.26	2.24	2.24	2.22
Percentage of women (%)	36.53	36.44	n/a	n/a	35.81	35.56	36.26	36.10
Dependency ratio	1.25[a***]	1.22[a***]	n/a	n/a	1.49	1.50	1.34	1.32

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

b) Level of education of pearl millet and sorghum producers

The level of education plays is a major factor explaining uptake of technologies and innovations. More educated members are more receptive to technology adoption than those that are not. Table 5 presents the distribution of households by level of education and education of household heads. The number of educated members among pearl millet and sorghum farmers varies according to the gender. The results indicate that the number of educated males was higher than that of females in the three countries. In the surveyed villages in Mali, there were on average 3.67 educated male against 2.36 educated female among pearl millet farmers. However, results indicate that there were more educated members both among men and women in diffusion villages than in the other villages-types in Mali. In addition, the number of educated members in diffusion villages estimated to 7.40, was above the average of sample overall (6.03). In Niger, the number of educated male and female among pearl millet producers is estimated to 3.12 and 2.07 respectively in 2009-2010. In the surveyed villages in Northern Nigeria, the number of educated male and female was of 2.78 and 1.34 respectively. Similar results are recorded for sorghum producers in Mali and Northern Nigeria. Overall, the level of education was low among pearl millet and sorghum producers in Mali, Niger and Northern Nigeria. This could negatively influence the adoption of improved varieties because less educated members are less receptive to new technologies.

In the 3 countries, results showed that 11.89%, 18.22% and 26.65% of household heads producing pearl millet in Mali, Niger and Northern Nigeria respectively received formal education in 2009. More than half of household heads producing pearl millet in Northern Nigeria received koranic education (56.20%). They were about 12% and 23% in Mali and Niger respectively who received koranic education. However, the results indicate a high proportion of household heads illiterate among the pearl millet producers in Mali (62.26%) and Niger (42.14%) compared to those in Northern Nigeria (8.79%). In the case of Niger, one notes that the proportion of household heads illiterate was high in control villages (54.67%). The results obtained for sorghum producers in Mali and Northern Nigeria are almost similar.

Table 5: Education of households producing pearl millet and sorghum in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Number of educated members	6.07[b**]	6.25	7.40[c***]	7.61	4.33	7.32	6.03	6.86
Number of educated male	3.70	3.84	4.34[c**]	4.53	2.81	4.54	3.67	4.18
Number of educated female	2.37[a*]	2.42	3.06[c***]	3.08	1.52[b**]	2.78	2.36	2.67
Educated household head (%)	12.29	11.61	11.29	10.00	11.43	10.78	11.89	11.00
Illiterate (%)	63.12	65.63	62.10	65.00	60.00	63.47	62.26	64.95
Koranic education (%)	11.96	11.65	13.71	14.44[c*]	10.48	7.19	12.08	11.30
Adult literate (%)	12.29	10.80[b*]	12.10	10.00[c*]	18.10	17.96	13.40	12.30
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Number of educated members	5.00	n/a	5.62	n/a	5.30	n/a	5.19	n/a
Number of educated male	2.93	n/a	3.37	n/a	3.45	n/a	3.12	n/a
Number of educated female	2.07	n/a	2.24	n/a	1.85	n/a	2.07	n/a
Educated household head (%)	18.15	n/a	18.10	n/a	18.67	n/a	18.22	n/a
Illiterate (%)	40.15[b*]	n/a	38.10[c*]	n/a	54.67	n/a	42.14	n/a
Koranic education (%)	23.55	n/a	29.52	n/a	16.00	n/a	23.69	n/a
Adult literate (%)	16.60	n/a	12.38	n/a	10.67	n/a	14.58	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Number of educated members	3.96	3.86[a*]	n/a	n/a	4.39	4.34	4.12	4.04
Number of educated male	2.71	2.63	n/a	n/a	2.89	2.85	2.78	2.71
Number of educated female	1.25[a**]	1.23[a**]	n/a	n/a	1.50	1.49	1.34	1.33
Educated household head (%)	25.54	25.64	n/a	n/a	28.5	30.43	26.65	27.47
Illiterate (%)	6.73[a***]	7.50[a**]	n/a	n/a	12.21	11.59	8.79	9.07
Koranic education (%)	59.35[a***]	59.00[a***]	n/a	n/a	50.91	50.37	56.2	55.71
Adult literate (%)	7.42	7.11	n/a	n/a	6.49	5.90	7.07	6.65

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

c) Sex, Age and marital status of household head

Many studies on gender issue in the African context highlight the fact that the majority of households are headed by a man. Table 6 shows that both pearl millet and sorghum farmers in Mali were headed by a male in 2009-2010. In Niger and Northern Nigeria, more than 90% of household heads producing pearl millet and sorghum were male. The results confirm those obtained in the previous studies on the gender. Table 6 also shows that the average age of pearl millet producers was about 54, 52 and 51 years in Mali, Niger and Northern Nigeria respectively. However, there are significant differences between villages in Mali. The average age of pearl millet farmers living in control villages (51 years) was lower than the overall average (54 years). The results also showed that 92%, 91% and 98% of pearl millet farmers in Mali, Niger and Northern Nigeria are married. The same results are recorded for sorghum farmers. On average, the surveyed households in the three countries are young, headed by a man and the household heads are married. The fact that the household heads are young and married is a real advantage in terms of production. Indeed, in the African context, women play an important role in production activities.

Table 6: Age, sex and marital status of household heads producing pearl millet and sorghum in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Age of household head (years)	53.89[b*]	54.82[b**]	55.48[c**]	55.44[c**]	50.70	51.34	53.63	54.15
Gender of household head (% male)	100.00	100	100.00	100	100.00	100	100.00	100
Household head married (%)	91.36	91.22	95.16	91.11	88.57	85.63	91.70	89.86
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Age of household head (years)	51.92	n/a	52.89	n/a	49.31	n/a	51.70	n/a
Gender of household head (% male)	94.21[a**]	n/a	100.00	n/a	97.33	n/a	96.13	n/a
Household head married (%)	91.51	n/a	88.57	n/a	92.00	n/a	90.89	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Age of household head (years)	50.90	50.93	n/a	n/a	50.33	49.98	50.69	50.57
Gender of household head (% male)	99.39	99.55	n/a	n/a	97.20	96.86	98.57	98.52
Household head married (%)	99.08	99.10	n/a	n/a	96.44	96.14	98.09	97.96

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

5.1.2. Natural capital

The natural capital represents the stocks of natural resource from which resource flows useful for livelihoods are derived (e.g. land, water, wildlife, biodiversity, environmental resources). In this study, the natural assets are depicted by land stocks of different types owned by households. The types of land include cultivable land, irrigated land, land for rain-fed crops, garden and fallow land. Table 7 shows that pearl millet producers in Mali owned on average 9.90 ha of cultivable land, cultivate on average 8.59 ha of rain-fed land, put on average 1.95 ha of land into fallow, had 0.34 ha of irrigated land 0.34 ha, and 0.04 ha of gardens.

Nigerien pearl millet producers owned on average 7.50 ha of cultivable land. They however cultivate 7.63 ha of rain-fed crops, put 1.34 ha of land into fallow land and had 0.26 ha of irrigated land. However, in Niger, pearl millet producers do not possess land for gardening. In Northern Nigeria, land stocks owned by households include 5.18 ha of cultivable land, 5.01 ha of rain-fed crop land and 0.71 ha of land into fallow. In terms of adult equivalent, there was less than 1 ha per adult equivalent in Mali (table 8). This is explained by the fact that household size is high among pearl millet and sorghum producers in Mali in 2009-2010 than in other countries. In Niger, cultivable land and land for rain-fed crops owned by each adult equivalent are estimated to 2.86 ha and 3.04 ha respectively. In Northern Nigeria, adult equivalents producing pearl millet owned on average 2.76 ha and 2.63 ha of cultivable land and land for rain-fed crops respectively. The same results are recorded for sorghum farmers in Mali and Northern Nigeria.

Table 7: Land stocks owned by households producing pearl millet and sorghum in Mali, Niger and Northern Nigeria, 2009/2010

	Type of village							
Country name / variables	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Cultivable	9.52	8.69	11.50	9.99	9.84	9.35	9.90	9.16
Irrigated	0.25	0.22	0.11	0.17	0.66	0.41	0.34	0.27
Rain-fed crops	8.32	7.43	8.76	6.44	9.06	8.13	8.59	7.48
Fallow	1.49	1.60	3.34	2.97	2.17	2.13	1.95	2.04
Garden	0.05	0.04	0.00	0.03	0.06	0.09	0.04	0.05
Total owned	11.50	9.96	15.63	17.85	15.40	19.49	13.17	14.67
Other land	0.09	0.13	0.45	0.27	0.01	0.02	0.12	0.12
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Cultivable	7.22	n/a	8.22	n/a	7.48	n/a	7.50	n/a
Irrigated	0.23	n/a	0.38	n/a	0.22	n/a	0.26	n/a
Rain-fed crops	7.25	n/a	8.48	n/a	7.73	n/a	7.63	n/a
Fallow	1.50	n/a	1.30	n/a	0.83	n/a	1.34	n/a
Total owned	8.98	n/a	9.41	n/a	9.34	n/a	9.15	n/a
Other land	0.00	n/a	0.03	n/a	0.00	n/a	0.01	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Cultivable	4.72^{a***}	4.59^{a***}	n/a	n/a	5.95	5.85	5.18	5.07
Fallow	0.60	0.62	n/a	n/a	0.90	0.89	0.71	0.72
Rain-fed crops	4.56^{a***}	4.62^{a***}	n/a	n/a	5.76	5.69	5.01	5.03
Total owned	5.67^{a***}	5.64^{a***}	n/a	n/a	7.05	6.99	6.19	6.16

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Table 8: Land stocks owned by adult equivalents producing pearl millet and sorghum in Mali, Niger and Northern Nigeria, 2009/2010

	Type of village							
Country name / variables	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Cultivable	0.50	0.48	0.50	0.44	0.44	0.39	0.49	0.44
Irrigated	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01
Rain-fed crops	0.47	0.43	0.39	0.30	0.38	0.34	0.43	0.38
Fallow	0.08	0.09	0.10	0.12	0.19	0.11	0.11	0.10
Garden	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total owned	0.65	0.56	0.67	0.74	0.90	0.81	0.72	0.68
Other land	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Cultivable	2.84	n/a	2.33	n/a	3.67	n/a	2.86	n/a
Irrigated	0.18	n/a	0.33	n/a	0.07	n/a	0.20	n/a
Rain-fed crops	2.69	n/a	3.41	n/a	3.69	n/a	3.04	n/a
Fallow	0.50	n/a	0.81	n/a	0.35	n/a	0.55	n/a
Total owned	3.29	n/a	2.64	n/a	4.21	n/a	3.29	n/a
Other land	0.00	n/a	0.00	n/a	0.00	n/a	0.00	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Cultivable	2.48^{a**}	2.41^{a**}	n/a	n/a	3.23	3.16	2.76	2.69
Fallow	0.30	0.33	n/a	n/a	0.65	0.64	0.43	0.45
Rain-fed crops	2.39^{a***}	2.44^{a**}	n/a	n/a	3.04	2.96	2.63	2.64
Total owned	2.88^{a***}	2.91^{a***}	n/a	n/a	3.85	3.82	3.25	3.26

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

5.1.3. Physical assets

The physical assets depict the basic infrastructure (transport, shelter, water, energy and communications) and the production equipment and means which enable people to pursue livelihoods. Physical assets owned by pearl millet and sorghum farmers included agricultural equipment, livestock, and durable assets.

a) Agricultural equipment

Table 9 indicates that several types of agricultural equipment[4] were used by the surveyed households for their production activities. Among pearl millet producers in Mali, more than half owned at least a plough (74.72%), a donkey cart (63.58%), a draft oxen (70%) and a draft donkey (65.66%), with significant differences between villages. For example, the proportion of households who had at least one plough in control villages (65.71%) was significantly lower than other villages, where the proportions were respectively of 77.42% and 76.74% in diffusion and project villages. Fewer households owned at least one seeder (39.62%) and sprayer (14.53%). The total value of agricultural equipment owned by households is estimated to 713,995 FCFA (US$1,460 with US$1 = 490 FCFA in 2010) with significant differences between project villages and control villages. In terms of agricultural equipment, households living in project villages were relatively better equipped than those of other villages.

In Niger, pearl millet producers owned in majority draft oxen (46%), followed by oxen carts (40%), ploughs (21%), draft donkeys (18%) and donkey carts (16%). One notes that there were less than 10% of pearl millet farmers from diffusion villages who owned at least a plough. The total value of agricultural equipment is estimated to about 286,514 FCFA (US$586).

In Northern Nigeria, pearl millet producers owned at least a plough (43%), a pair of draft oxen (41%), an oxen cart (27%), a wheelbarrow (21%), a sprayer (15%) and a donkey cart (11%). The total value of agricultural equipment is estimated to about 521,557 Naira (US$3,44 with US$1 = 151.82 Naira in 2010). The results obtained for sorghum farmers in Mali show that the total value of their agricultural equipment is estimated to 637,341 FCFA (US$1,302 with US$1 = 490 FCFA in 2010). However, one observes that non-project villages were better equipped than project villages. The other results are almost similar to those obtained for the pearl millet farmers. Overall, production equipment of the surveyed households in Mali, Niger and Northern Nigeria are mainly consisted of animal traction and traditional equipment.

[4] There are also the traditional equipment such as daba, machete, hoe. We present here agricultural equipment more and less modern.

Table 9: Agricultural equipment owned by households producing pearl millet and sorghum in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Plough	76.74[b*]	71.19	77.42	66.67	65.71	62.87	74.72	68.05
Donkey cart	65.78	62.15	64.52	60.56	56.19	56.89	63.58	60.49
Seeder	37.54	37.57	42.74	38.89	41.90	40.72	39.62	38.66
Sprayer	11.30[b*]	12.43	17.74	14.44	20.00	15.57	14.53	13.69
Oxen cart	10.96	10.73	5.65	8.33	5.71	5.99	8.68	8.99
Wheelbarrow	9.97[b*]	9.60[b*]	8.06	7.78	2.86	4.19	8.11	7.85
Sheller	4.65	3.95	8.06	5.56	3.81	3.59	5.28	4.28
Water pump	3.99	3.95	4.03	2.78	4.76	4.79	4.15	3.85
Cultivator	2.33[a**]	1.98[a***]	7.26[c*]	6.67[c***]	1.90	1.20	3.40	3.00
Horse cart	1.99	1.69	4.03[c*]	2.22	0.00	0.00	2.08	1.43
Tractor	0.66	0.56	0.81	0.56	0.00	0.60	0.57	0.57
Thresher	0.00	0.00	0.81	0.56	0.00	0.00	0.19	0.14
Draft oxen	74.42[b***]	69.21	72.58[c***]	65.00	54.29	59.88	70.00	65.91
Draft donkey	68.77[b**]	66.10[b**]	68.55[c**]	62.22	53.33	54.49	65.66	62.34
Draft horse	8.97	7.91[b***]	9.68	6.67[c**]	2.86	1.20	7.92	5.99
Mule	0.33	0.28	1.61	1.11	0.00	0.00	0.57	0.43
Camel	0.00[b*]	0.00	0.81	0.00	1.90	0.60	0.57	0.14
Total value of equipment (FCFA)	776104[b**]	692087	749683	602151	493802	559223	713995	637341
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Oxen cart	39.92	n/a	37.14	n/a	45.33	n/a	40.18	n/a
Plough	24.81[a***]	n/a	8.57[c**]	n/a	24.00	n/a	20.78	n/a

Donkey cart	18.60	n/a	13.33	n/a	10.67	n/a	15.98	n/a
Seeder	3.88	n/a	2.86	n/a	5.33	n/a	3.88	n/a
Water pump	3.49	n/a	0.95	n/a	4.00	n/a	2.97	n/a
Wheelbarrow	0.78[b*]	n/a	0.00[c**]	n/a	4.00	n/a	1.14	n/a
Sprayer	0.39	n/a	0.95	n/a	0.00	n/a	0.46	n/a
Generator	0.00	n/a	0.95	n/a	0.00	n/a	0.23	n/a
Draft oxen	47.29	n/a	41.90	n/a	46.67	n/a	45.89	n/a
Draft donkey	21.71	n/a	12.38	n/a	13.33	n/a	18.04	n/a
Draft horse	1.16	n/a	1.90	n/a	2.67	n/a	1.60	n/a
Draft camel	0.00	n/a	0.95	n/a	0.00	n/a	0.23	n/a
Total value of equipment (FCFA)	279781	n/a	281583	n/a	316581	n/a	286514	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Donkey cart	10.09[a*]	9.75	n/a	n/a	13.49	12.32	11.37	10.73
Oxen cart	23.39[a***]	22.19[a***]	n/a	n/a	32.32	29.47	26.74	24.98
Plough	39.76[a***]	38.98[a**]	n/a	n/a	49.36	46.62	43.36	41.91
Seeder	0.76	0.75	n/a	n/a	1.02	0.72	0.86	0.74
Sheller	1.38	1.65	n/a	n/a	2.04	3.14	1.62	2.22
Sprayer	13.30[a**]	13.94	n/a	n/a	18.07	16.67	15.09	14.99
Tractor	0.00	0.00	n/a	n/a	0.00	0.00	0.00	0.00
Water pump	9.63	9.60	n/a	n/a	8.14	7.97	9.07	8.97
Wheelbarrow	21.10	22.19	n/a	n/a	19.85	19.81	20.63	21.28
Draft oxen	35.32[a***]	34.63[a***]	n/a	n/a	51.65	48.79	41.45	40.06
Draft camel	0.61	0.75	n/a	n/a	0.25	0.24	0.48	0.56
Draft donkey	7.19	6.75	n/a	n/a	6.62	6.28	6.97	6.57
Total value of equipment (FCFA)	425066[a***]	419540[a***]	n/a	n/a	682130	648449	521557	507207

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011

b) Livestock

Tables 10 and 11 highlight the proportion of households who owned at least one type of livestock in 2009/10 for pearl millet and sorghum producers respectively. The proportion of households who had at least one beef, one sheep, one donkey or one pig is estimated to 7.17%, 6.60%, 5.65%, and 4.32% respectively. Households engaged in poultry and cattle had on average 21 chickens, 10 beefs, 9 sheep, 4 donkey, and 8 pigs. The results also show that there were more pearl millet farmers engaged in livestock in Niger and Northern Nigeria than in Mali. There were respectively 50.11%, 43.96%, 47.61%, 21.18%, and 34.85% of Nigerien pearl millet producers who owned at least one cattle, one goat, one sheep, one donkey, and one chicken respectively. In Northern Nigeria, 40.50%, 52.15%, 56.26%, and 43.08% of pearl millet farmers who had at least one cattle one goat, one sheep, and one chicken respectively in 2009-2010. The same results are recorded for sorghum farmers in Mali and Northern Nigeria.

Table 10: Proportion of pearl millet households who own at least one type of livestock in Mali, Niger and Northern Nigeria, 2009/2010.

	Type of village							
Country name / variables	Project village		Diffusion village		Control village		Sample overall	
	%	Mean	%	Mean	%	Mean	%	Mean
Mali	(302)		(124)		(105)		(531)	
Beef	6.31	8.26	6.45	20.00^{c*}	10.48	6.10	7.17	10.11
Goats	2.33	1.43	0.00	0.00	0.95	1.00	1.51	1.38
Sheep	6.64	8.65	4.84	12.67	8.57	9.67	6.60	9.60
Donkey	5.65	5.89	3.23	1.75	8.57	2.23	5.66	4.24
Pork	4.32	8.70	4.84	10.50	7.62	6.12	5.09	8.34
Niger	(259)		(105)		(75)		(439)	
Beef	46.33	2.64^{a**}	50.48	4.94	62.67	4.47	50.11	3.59
Goats	44.79	5.41	40.00	6.55^{c**}	46.67	3.77	43.96	5.36
Sheep	45.56	4.88	53.33	5.55	46.67	3.46	47.61	4.82
Donkey	23.17	1.64	18.10	2.00	18.67	1.21	21.18	1.65
Camel	0.77	2.50	0.95	1.00	0.00	0.00	0.68	2.00
Horse	1.16	1.34	0.95	1.00	4.00	1.34	1.59	1.29
Poultry	34.75	11.00	37.14	10.90	32.00	6.71	34.85	10.30
Nigeria	(654)		(393)		n/a		(1047)	
Beef	40.06	4.56	41.22	3.62	n/a	n/a	40.50	4.20
Goats	50.15	8.54	55.47	8.41	n/a	n/a	52.15	8.49
Sheep	53.67	7.57	60.56	7.74	n/a	n/a	56.26	7.64
Poultry	42.2	24.07	44.53	20.33	n/a	n/a	43.08	22.62

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011

Table 11: Proportion of sorghum households who own at least one type of livestock in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		Control village		Sample overall	
	%	Mean	%	Mean	%	Mean	%	Mean
Mali	(355)		(180)		(167)		(702)	
Beef	5.65	7.85[a*]	5.00	18.22	11.98	5.65[b**]	6.99	8.86
Goats	1.98	1.43	0.00	0.00	0.60	1.00	1.14	1.38
Sheep	5.65	9.35	3.89	11.43	6.59	9.09	5.42	9.66
Donkey	5.08	8.95	2.78	1.60	8.98	2.54	5.42	5.44
Poultry	6.21	18.27	4.44	25.37	7.78	20.23	6.13	20.19
Pork	3.67	9.08	3.89	9.43	5.39	5.56	4.14	8.07
Nigeria	(667)		(414)		n/a		(1081)	
Beef	38.83	4.54	37.92	3.71	n/a	n/a	38.48	4.23
Goats	51.42	8.54	54.83	8.30	n/a	n/a	52.73	8.45
Sheep	53.82	7.57	56.76	7.88	n/a	n/a	54.95	7.69
Poultry	42.88	23.06	41.79	19.77	n/a	n/a	42.46	21.82

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011

c) Durable assets

Table 12 presents the proportion of households owning at least one type of durable assets in Mali, Niger and Northern Nigeria in 2009-2010. About 87% and 57% of pearl millet farmers in Mali owned at least one bicycle or one motorcycle respectively as major means of transport. Among pearl millet farmers in Niger, it is estimated to about 17% and 11% those who owned at least one bicycle or one motorcycle respectively. However, in project villages in Niger, the proportion of pearl millet producers who have one bicycle (21%) was above the average of overall sample. About 48%, 40% and 3% of pearl millet farmers in Northern Nigeria used bicycle, motorcycle and vehicle respectively as means of transport. The results are almost similar for sorghum farmers in Mali and Northern Nigeria. Overall, the results showed that in the three countries the vehicle was rarely used as means of transport among pearl millet and sorghum producers in 2009-2010. The main mean of transport was the bicycle.

To access information, 88% of pearl millet farmers in Mali owned at least one radio or 26% had at least one television. In Niger, 70% and 4% of pearl millet farmers own at least one radio and one television in 2009-2010 respectively, with significant differences between project villages and other villages. In Northern Nigeria, pearl millet farmers having access information through radio and television in 2009-2010 are estimated to about 77% and 11% respectively. The same results are found for households producing sorghum in Mali and

Northern Nigeria. The radio was the main means to access information in the surveyed villages in 2009-2010.

Other durable assets owned by households were consisted of telephone, bed, improved stove, video player, milling machine and other thinks. The cell phone penetration in West Africa has been relatively high. Results showed that the proportion of pearl millet farmers using telephone as means of communication in 2009-2010 is estimated to about 69%, 57% and 37% in Mali, Niger and Northern Nigeria respectively. The total value of durable assets is estimated to about 510,000 FCFA (US$ 1,041) in Mali, 120,000 FCFA (US$ 245) in Niger and 208,638 Naira (US$ 1,374) in Northern Nigeria. There are significant differences between project villages and non-project villages in Northern Nigeria. In terms of durable assets, project villages seemed to be wealthier than non-project villages. Similar trend is recorded for households producing sorghum in Mali and Northern Nigeria. However, the value of durable assets of sorghum farmers (440,000 FCFA ~ US$ 898) was relatively low compared to that of pearl millet farmers in Mali. Overall, durable assets owned by pearl millet and sorghum in Mali, Niger and Northern are mainly consisted of transport and communication means (bicycle, motorcycle, radio and telephone).

Table 12: Durable assets owned by households producing pearl millet and sorghum in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Radio	87.58	88.29	88.52	85.23	90.20	84.47	88.31	86.61
Bicycle	85.91	85.43	90.16	89.77	85.29	83.85	86.78	86.17
Telephone	72.82	74.00[a**]	63.11	63.07	66.67	69.57	69.35	70.16
Wood bed	53.36	56.00	45.90	54.55	54.90	62.73	51.92	57.21
Motorcycle	55.70	53.71	63.93	55.11	54.90	47.83	57.47	52.69
Improved stove	30.54	29.14	26.23	28.41	25.49	27.33	28.54	28.53
Television	27.52	31.43	22.95	23.30	25.49	26.09	26.05	28.09
Video player	14.77[a***]	12.29[a***]	4.92	3.41	7.84	6.83	11.11	8.73
Sewing machine	10.07	8.57	7.38	5.68	6.86	5.59	8.81	7.13
Metal bed	4.70	5.71	4.10	5.11	4.90	3.73	4.60	5.09
Milling machine	8.05[a**]	6.86[a**]	2.46	2.27	0.98[b***]	1.86[b**]	5.36	4.51
Kerosene stove	3.02	4.29	1.64	3.41	2.94	4.35	2.68	4.08
Mecca	3.02	2.57	2.46	1.70	2.94	1.86	2.87	2.18
Battery	0.34	0.29	1.64	1.14	0.98	0.62	0.77	0.58
Vehicle	0.67	0.57	0.82	0.57	0.00	0.00	0.57	0.44
Wood chairs	0.34	0.29	0.00	0.00	0.00	0.00	0.19	0.15
Total value of durable assets (FCFA)	500000	490000[b*]	490000	420000	550000	370000	510000	440000
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Mecca	0.77	n/a	2.86	n/a	0.00	n/a	1.14	n/a
Bicycle	20.85[a**]	n/a	8.57	n/a	16.00	n/a	17.08	n/a
Video player	1.16	n/a	0.00	n/a	2.67	n/a	1.14	n/a
Improved stove	7.72	n/a	5.71	n/a	5.33	n/a	6.83	n/a
Wood bed	48.26	n/a	49.52	n/a	38.67	n/a	46.92	n/a
Metal bed	79.15	n/a	69.52[c**]	n/a	85.33	n/a	77.90	n/a
Sewing machine	3.86	n/a	3.81	n/a	1.33	n/a	3.42	n/a
Pots	3.86	n/a	3.81	n/a	4.00	n/a	3.87	n/a
Mattress	4.25	n/a	5.71	n/a	4.00	n/a	4.56	n/a

Motorcycle	12.36	n/a	10.48	n/a	9.33	n/a	11.39	n/a
Milling machine	1.16	n/a	1.90	n/a	1.33	n/a	1.37	n/a
Radio	74.13[b*]	n/a	66.67	n/a	61.33	n/a	70.16	n/a
Kerosene stove	3.09	n/a	1.90	n/a	1.33	n/a	2.51	n/a
Telephone	59.07	n/a	54.29	n/a	52.00	n/a	56.72	n/a
Television	3.47	n/a	2.86	n/a	6.67	n/a	3.87	n/a
Vehicle	0.00	n/a	0.95	n/a	0.00	n/a	0.23	n/a
Total value of durable assets (FCFA)	110000	n/a	170000	n/a	99203	n/a	120000	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Bicycle	46.64	49.18	n/a	n/a	49.36	49.03	47.66	49.12
Motorcycle	37.77	37.93[a*]	n/a	n/a	42.49	43.00	39.54	39.87
Vehicle	3.36	3.00	n/a	n/a	2.80	2.66	3.15	2.87
Radio	76.61	77.21	n/a	n/a	77.35	76.81	76.89	77.06
Video player	4.28	4.50	n/a	n/a	4.33	5.56	4.30	4.90
Television	11.93	12.14	n/a	n/a	8.91	9.18	10.79	11.01
Telephone	35.93	35.23	n/a	n/a	39.44	38.89	37.25	36.63
Kerosene stove	25.99[a***]	26.09[a***]	n/a	n/a	18.07	18.84	23.02	23.31
Wood stove	17.28[a***]	15.29[a***]	n/a	n/a	25.45	23.43	20.34	18.41
Metal bed	62.54[a***]	62.37[a***]	n/a	n/a	72.77	72.71	66.38	66.33
Wood bed	49.85	50.07	n/a	n/a	46.06	45.65	48.42	48.38
Milling machine	2.91	2.70[a*]	n/a	n/a	4.83	4.59	3.63	3.42
Mecca	5.96[a**]	6.00[a*]	n/a	n/a	9.67	8.94	7.35	7.12
Total value of durable assets (Naira)	215169[a**]	215777[a***]	n/a	n/a	197771	190888	208638	206245

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.

Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011

5.1.4. Social assets

The social capital which represents the social resources (networks, membership of groups, relationships of trust, access to wider institutions of society) upon which people draw in pursuit of livelihoods. In this study, social asset is defined as a set of social relations that the household head or household members have with farmers' associations or other groups.. Social assets are proxied by the proportion of households having at least one member affiliated to social group or economic interest group in 2009-2010. Table 13 shows social assets of households producing pearl millet and sorghum. The results obtained in Mali indicate that all pearl millet farmers had at least one member affiliated to one social or economic group. Pearl millet producers in Mali tended to be affiliated to agricultural production associations (47%), religious groups (20%), mutual aid groups (17%), and credit institutions (12%). About 48% of pearl millet farmers in Niger had at least one member affiliated to one institution, with significant differences between villages. There were significant differences in affiliation between pearl millet households in project villages than other villages. In effect, households in project villages recorded more affiliations than farmers in diffusion and control villages. In 20% of households, at least one member is affiliated to credit institutions and 17% to agricultural production associations (17%). In Northern Nigeria, less than 25% of households producing pearl millet had one member affiliated to one social or economic group. However, there are relatively more households whose members are affiliated to one association (30%) and agricultural production association (23%) in project villages than diffusion or control villages. Among sorghum farmers in Mali, 40% of households who had at least one member affiliated to agricultural production associations. Similar results are recorded for pearl millet farmers in Mali and Northern Nigeria. Overall, the results showed that pearl millet and sorghum producers tended to be affiliated to agricultural and credit associations.

Table 13: Proportion of households producing pearl millet and sorghum having at least one member affiliated to one social group in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
UPA affiliated to at least one org.	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Agricultural production	47.84	42.37	48.39	40.56	43.81	34.73	47.17	40.09
Religious	24.25[b*]	23.16[b**]	16.13	18.33	14.29	13.77	20.38	19.69
Mutual aid group	17.61	17.23	18.55	22.22[c**]	15.24	11.38	17.36	17.12
Nonagricultural eco. Interest group	6.98	8.19	12.90	11.11	9.52	11.98	8.87	9.84
Credit	9.97	8.76	15.32	10.00	12.38	8.98	11.70	9.13
Production and marketing	6.64	5.65	8.06	6.67	5.71	4.19	6.79	5.56
Agricultural production marketing	4.98	4.24	4.84	3.89	1.90	2.99	4.34	3.85
Training in seed production	3.65	3.67	0.81	1.67	1.90	1.20	2.64	2.57
Seed production	3.99	3.95[a**]	0.81	0.56	0.95	0.60[b**]	2.64	2.28
Other agricultural activities	1.00	0.85	0.00	0.00	0.95	1.20	0.75	0.71
Shea butter production	1.99	1.69	0.00	0.00	0.00	0.00	1.13	0.86
Market gardening	0.66	0.56	0.81	1.67	0.00	0.00	0.57	0.71
Association against soil erosion	1.00	0.85	0.00	0.00	0.00	0.00	0.57	0.43
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
UPA affiliated to at least one org.	58.30[a***]	n/a	40.00[c**]	n/a	21.33[b***]	n/a	47.61	n/a
Credit	22.78[b*]	n/a	20.00	n/a	10.67	n/a	20.05	n/a
Agricultural production	23.55[a***]	n/a	10.48	n/a	4.00[b***]	n/a	17.08	n/a
Mutual aid group	8.88	n/a	6.67	n/a	4.00	n/a	7.52	n/a
Religious	8.11	n/a	10.48[c*]	n/a	1.33	n/a	7.52	n/a
Production and marketing	8.49	n/a	8.57	n/a	1.33	n/a	7.29	n/a

Marketing of agricultural products	8.11	n/a	4.76	n/a	2.67	n/a	6.38	n/a
Training in seed production	7.72[b*]	n/a	2.86	n/a	1.33	n/a	5.47	n/a
Seed production	5.79[a*]	n/a	0.95	n/a	1.33	n/a	3.87	n/a
Nonagricultural eco. Interest group	3.09	n/a	0.95	n/a	0.00	n/a	2.05	n/a
Cereal bank (inventory)	0.77	n/a	0.00	n/a	2.67	n/a	0.91	n/a
Farmer field school	1.16	n/a	0.00	n/a	0.00	n/a	0.68	n/a
Inventory credit (warrantage)	0.77	n/a	0.00	n/a	0.00	n/a	0.46	n/a
Market gardening	0.00[b***]	n/a	0.00[c**]	n/a	2.67	n/a	0.46	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
UPA affiliated to at least one org.	31.04[a***]	29.09[a***]	n/a	n/a	10.69	12.8	23.40	22.85
Agricultural production	23.55a***	16.95	n/a	n/a	5.09	11.72	16.62	14.94
Production and marketing	0.15	0.15	n/a	n/a	0.25	0.36	0.19	0.23
Mutual aid group	0.00	2.40	n/a	n/a	0.00	1.69	0.00	2.13
Credit	1.99	0.08	n/a	n/a	3.31	0.00	2.48	0.05
Marketing of agricultural products	1.38	0.00	n/a	n/a	1.02	0.24	1.24	0.09
Nonagricultural eco. Interest group	0.00	1.73	n/a	n/a	0.00	4.96	0.00	2.96
Zacarep	1.53	1.20	n/a	n/a	0.51	0.60	1.15	0.97
Fadama user	0.46	0.53	n/a	n/a	0.25	0.12	0.38	0.37
Fisher organization	0.00	0.45	n/a	n/a	0.00	0.00	0.00	0.28
LGA	1.38	1.43	n/a	n/a	1.53	1.81	1.43	1.58
Religious	0.15	0.15	n/a	n/a	0.00	0.00	0.10	0.09
Other organization	5.81	5.25	n/a	n/a	5.34	6.16	5.64	5.60

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011

5.1.5. Financial assets/capital

The financial capital depicts the financial resources which are available to people (whether savings, supplies of credit or regular remittances or pensions) and which provide them with different livelihood options. This section describes the sources and use of credit contracted by pearl millet and sorghum farmers from Mali, Niger and Northern Nigeria in 2009-2010. The sources of credit will be presented, followed by the amount and maturity of loans, and finally the use of credit.

a) Credit institutions

A better access to credit can enable to farmers to develop their production activity by investing in agricultural inputs. Table 14 presents the sources of credit contracted by households producing pearl millet and sorghum. In Mali and Niger, about 30% of surveyed pearl millet producers had contracted loans in 2009-2010. About 10% of pearl millet producers in Northern Nigeria contracted credit in the same year. The main credit sources were friends/family and micro finance institutions. However, development projects were an important credit source for pearl millet producers in Niger. Pearl millet farmers in Mali who borrowed from friends and micro-finance institutions in 2009-2010 are estimated to about 29% and 49% respectively. In Niger, pearl millet farmers tended to borrow from friends or family (43%) with significant differences between the villages. A large share of credits of pearl millet producers living in project villages was derived from friends (60%). Among pearl millet farmers in Niger, there were respectively 12% and 22% who contracted credit from micro finance institutions and development projects in 2009-2010. In Northern Nigeria, they were respectively 34% and 13% to having contracted credit from friends and loan associations respectively. The results obtained for sorghum farmers are not very different to those of pearl millet farmers. Overall, pearl millet and sorghum farmers in Mali, Niger and Northern Nigeria have a limited access to credit. The previous studies obtained the same result in the context West African (Fall, 2011; MAFAP, 2013). The lack of credit is a constraint to the increase in productivity and incomes. This could have a negative effect on the achievement of objectives of the HOPE project.

b) Amount and maturity of loan

Table 15 presents amounts of loans contracted, proportion by credit source, and loan maturity in 2009-2010. The results indicate that pearl millet farmers in Northern Nigeria benefited from better credit terms compared to those in Mali and Niger. In Northern Nigeria, pearl millet producers contracted on average US$ 197 (31,359 Naira) over 21 months. In Mali and in Niger, pearl millet producers contracted on average US$ 137 (66,369 FCFA) over about 7 months and US$ 114 (55,494 FCFA) over 4 months respectively. However, there are significant differences between village types. In project villages in Northern Nigeria, the loan maturity was estimated to 30 months against 4 months in non-project villages. The results also reveal that in Niger and Northern Nigeria, a large share of credit was provided by friends with the proportions of 43% and 33% respectively. In the case of Mali, a large share of credit

contracted was provided by microcredit institutions (49%). The same results are recorded for sorghum farmers in Mali and Northern Nigeria. In addition to limited access to credit, the amounts of loans are low. These effects combined are the major constraints to development of pearl millet and sorghum sector in West Africa and particularly in Mali, Niger and Northern Nigeria.

Table 14: Credit sources of households producing pearl millet and sorghum in Mali, Niger and Northern Nigeria, 2009/2010

	Type of village							
Country name / variables	Project village		Diffusion village		control village		Sample overall	
Type of crops	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Household contracting credit	28.24	27.97	37.90	35.00	36.19	36.53	32.08	31.81
Friends	34.12	34.34	19.15	28.57	31.58	39.34	29.41	34.08
Microcredit institution	47.06	45.45	53.19	46.03	50.00	42.62	49.41	44.84
Banks	4.71	7.07	8.51	6.35	7.89	6.56	6.47	6.73
NGOs	0.00	0.00	0.00	0.00	2.63	1.64	0.59	0.45
Development projects	3.53	4.04	0.00	0.00	0.00	0.00	1.76	1.79
Other credit sources	10.59	9.09	19.15	19.05	10.53	11.48	12.94	12.56
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Household contracting credit	30.12	n/a	25.71[c*]	n/a	41.33	n/a	30.98	n/a
Friends	37.18	n/a	44.44	n/a	58.06	n/a	43.38	n/a
Microcredit institution	16.67	n/a	11.11	n/a	3.23	n/a	12.50	n/a
Banks	1.28	n/a	3.70	n/a	3.23	n/a	2.21	n/a
NGOs	3.85	n/a	0.00	n/a	3.23	n/a	2.94	n/a
Development projects	26.92	n/a	18.52	n/a	12.90	n/a	22.06	n/a
Other credit sources	14.10	n/a	22.22	n/a	19.35	n/a	16.91	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Household contracting credit	10.70	10.04	n/a	n/a	9.67	8.21	10.32	9.34
Friends	31.43	29.85	n/a	n/a	39.47	41.18	34.26	33.66
Savings and loan associations	7.14[a**]	7.46[a**]	n/a	n/a	23.68	23.53	12.96	12.87
Banks	7.14	7.46	n/a	n/a	5.26	2.94	6.48	5.94
NGOs	2.86	2.99	n/a	n/a	2.63	2.94	2.78	2.97
Development projects	2.86	2.99	n/a	n/a	5.26	5.88	3.70	3.96
Other credit sources	42.86[a***]	43.28[a***]	n/a	n/a	7.89	8.82	30.56	31.68

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Table 15: Amount of credit and proportion by source of households producing pearl millet and sorghum in Mali, Niger and Northern Nigeria, 2009/2010

	Type of village							
Country name / variables	Project village		Diffusion village		control village		Sample overall	
Type of crops	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Friends	34.12	34.34	19.15	28.57	29.87	38.28	29.03	33.79
Microcredit institution	47.06	45.45	53.19	46.03	49.08	42.05	49.21	44.69
Banks	4.71	7.07	8.51	6.35	7.89	6.56	6.47	6.73
NGOs	0.00	0.00	0.00	0.00	2.63	1.64	0.59	0.45
Development projects	3.53	4.04	0.00	0.00	0.00	0.00	1.76	1.79
Other credit sources	10.59	9.09	19.15	19.05	10.53	11.48	12.94	12.56
Total credit contracted (FCFA)	70378	76082	57270	67408	71342	61623	66969	69676
Credit duration (months)	6.85	6.78	6.38	6.28	6.97	6.60	6.74	6.59
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Friends	37.18	n/a	44.44	n/a	58.06	n/a	43.38	n/a
Microcredit institution	16.67	n/a	11.11	n/a	3.23	n/a	12.50	n/a
Banks	1.28	n/a	3.70	n/a	3.23	n/a	2.21	n/a
NGOs	3.85	n/a	0.00	n/a	3.23	n/a	2.94	n/a
Development projects	26.92	n/a	18.52	n/a	12.90	n/a	22.06	n/a
Other credit sources	14.10	n/a	22.22	n/a	19.35	n/a	16.91	n/a
Total credit contracted (FCFA)	47875	n/a	70941	n/a	61210	n/a	55494	n/a
Credit duration (months)	4.81[b**]	n/a	4.60	n/a	2.68	n/a	4.28	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Friends	30.13	28.49	n/a	n/a	39.47	41.18	33.42	32.76

Savings and loan associations	7.01[a**]	7.33[a**]	n/a	n/a	23.68	23.53	12.88	12.78
Banks	7.14	7.46	n/a	n/a	3.29	0.74	5.79	5.20
NGOs	2.86	2.99	n/a	n/a	2.63	2.94	2.78	2.97
Development projects	2.86	2.99	n/a	n/a	5.26	5.88	3.70	3.96
Other credit sources	42.86[a***]	43.28[a***]	n/a	n/a	6.18	6.91	29.95	31.04
Total credit contracted (FCFA)	31613	31673	n/a	n/a	30892	30703	31359	31346
Credit duration (months)	29.83	30.97	n/a	n/a	4.61	4.18	20.95	21.95

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

c) Use of credit contracted

Table 16 below shows the use of credit contracted by pearl millet and sorghum producers. In Mali and Niger, credit contracted by pearl millet farmers was mainly used for purchase of food and other goods, petty trade, and other needs. The shares of credit used for food and goods consumption, petty trade, and other needs are estimated to 23.77%, 21.03%, and 31.32% respectively in Mali. They were of 37.92%, 16.73%, and 33.93% respectively in Niger. In these two countries, the share of credit used for agricultural inputs was relatively low in 2009-2010 (6%). In Northern Nigeria, pearl millet farmers have mainly used their credit for agricultural inputs (50.29%), with a large share used for purchase of fertilizers (47%). However, one notes significant difference between project villages and non-project villages. Households living in project villages in Northern Nigeria have used more than 58% of loans to purchase of fertilizers against 26% in non-project villages. About 16% of credit contracted by Nigerian pearl millet farmers was used for food and other goods. The results obtained for sorghum farmers in Mali and Northern Nigeria are relatively similar. The results showed that in Mali and Niger, a large share of credit contracted is used for consumption needs.

Table 16: Use of credit of households producing pearl millet and sorghum in Mali, Niger and Northern Nigeria, 2009/2010

	Type of village							
Country name / variables	Project village		Diffusion village		control village		Sample overall	
Type of crops	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Food	23.82	23.48	20.57	20.11	10.53	11.48	19.95	19.25
Hire labor	1.95	1.67	2.13	1.59	0.00	0.00	1.56	1.19
Dowry	1.95	0.66	0.00	1.59	5.26	3.28	2.15	1.64
Health	6.97	7.76	6.38	6.35	13.52	15.23	8.27	9.40
School fees	1.76	1.52	2.66	1.98	0.88	0.55	1.81	1.38
Trade	22.66	21.47	21.28	19.19	17.11	13.93	21.03	18.77
Fertilizers	2.50	3.16	6.38	4.76	0.00	3.28	3.01	3.64
Livestock	1.18	1.01	0.00[c*]	0.99	6.58	4.10	2.06	1.85
Build house	1.18	1.01	4.26	3.17	0.00	0.00	1.76	1.35
Reimbursed other credits	2.61	2.24	4.26	3.17	0.00	0.00	2.48	1.89
Consumption goods	6.47	5.56	2.13	3.17	0.00	3.40	3.82	4.29
Other uses of credit	26.62[b*]	29.92	27.84	32.33	46.13	44.75	31.32	34.66
Investment (fertilizers, equipment and livestock)	4.85	5.18	10.64	8.93	6.58	7.38	6.84	6.84
Consumption (food and consumption goods)	30.29[b**]	29.04	22.70	23.28	10.53	14.88	23.77	23.54
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Food	42.31a*	n/a	19.07	n/a	40.05	n/a	37.18	n/a
Hire labor	0.32	n/a	3.17	n/a	3.23	n/a	1.55	n/a
Dowry	1.28	n/a	0.00	n/a	0.00	n/a	0.74	n/a
Health	0.00	n/a	0.00	n/a	3.23	n/a	0.74	n/a
School fees	0.00	n/a	0.00	n/a	0.00	n/a	0.00	n/a
Trade	17.63	n/a	14.81	n/a	16.13	n/a	16.73	n/a
Fertilizers	1.28	n/a	0.00	n/a	0.00	n/a	0.74	n/a
Livestock	3.53[a**]	n/a	17.96[c***]	n/a	0.00	n/a	5.59	n/a

Build house	0.00	n/a	0.00	n/a	0.00	n/a	0.00	n/a
Reimbursed other credits	1.28	n/a	0.00	n/a	0.00	n/a	0.74	n/a
Pay taxes	0.32	n/a	0.00	n/a	0.00	n/a	0.18	n/a
Migration	0.00	n/a	0.00	n/a	0.81	n/a	0.18	n/a
Saving	0.00	n/a	0.00	n/a	0.00	n/a	0.00	n/a
Celebrate birth	1.28	n/a	0.00	n/a	1.08	n/a	0.98	n/a
Consumption goods	0.00	n/a	0.00	n/a	3.23	n/a	0.74	n/a
Other uses of credit	30.77	n/a	44.97	n/a	32.26	n/a	33.93	n/a
Investment (fertilizers, equipment and livestock)	4.81[a**]	n/a	17.96[c**]	n/a	0.00	n/a	6.32	n/a
Consumption (food and consumption goods)	42.31[a*]	n/a	19.07	n/a	43.28	n/a	37.92	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Food	13.58	13.39	n/a	n/a	20.24	12.67	15.91	13.14
Hired labor	10.14	10.76	n/a	n/a	15.74	17.62	12.10	13.08
Health	4.65[a*]	3.91[a*]	n/a	n/a	13.39	13.00	7.71	6.98
School fees	0.00	0.00	n/a	n/a	0.00	0.00	0.00	0.00
Trade	0.96[a**]	0.51[a***]	n/a	n/a	10.12	11.33	4.17	4.17
Fertilizers	58.17[a***]	58.16[a**]	n/a	n/a	26.41	29.58	47.06	48.51
Livestock	1.92	2.04	n/a	n/a	0.00	0.00	1.25	1.35
Build house	2.56	2.72	n/a	n/a	0.89	1.00	1.98	2.14
Reimbursed other credits	3.37	3.57	n/a	n/a	2.74	3.07	3.15	3.40
Saving	0.00[a*]	0.00[a*]	n/a	n/a	2.43	2.72	0.85	0.92
Other uses of credit	4.65	4.93	n/a	n/a	8.04	9.00	5.83	6.31
Investment (fertilizers, equipment and livestock)	62.66[a***]	62.93[a***]	n/a	n/a	27.30	30.58	50.29	52.00
Consumption (food and consumption goods)	13.58	13.39	n/a	n/a	20.24	12.67	15.91	13.14

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

5.2. Market transactions of sorghum and millet producers in Mali, Niger and Nigeria

This section focuses on the analysis of market transactions of pearl millet and sorghum producers in 2009-2010. First the market position of farmers is presented, followed by the amount of marketable surplus, the sales of agricultural products, the sales of livestock products, and food expenditures.

5.2.1. Net seller / net buyer of agricultural products

Households who sold more of a product than they purchase during the cropping season are considered net sellers of the product and those who purchased more of a product than they sold are net buyers. Table 17 indicates that pearl millet farmers in Mali were net sellers of groundnut (28.11%), maize (4.53%), pearl millet (8.87%), cowpea (5.85%) and rice (5.09%). However, there were more than 40% of net sellers of groundnut in diffusion villages against about 23% and 25% in project villages and control villages respectively. Otherwise, the results emphasize that pearl millet producers in Mali were net buyers of sorghum. Pearl millet farmers in Niger were net sellers of groundnut (19.36%), cowpea (17.31%), and rice (1.82%). For other goods, they were net buyers (for example pearl millet with 12.07%). In Northern Nigeria, households producing pearl millet were net sellers of 5 goods including groundnut, maize, pearl millet, cowpea, and sorghum, except rice for which households were net buyers (10.22%). The results also indicate that the proportions of net sellers in Northern Nigeria are higher than in Mali and Niger whatever the crop. The similar results are obtained for sorghum farmers from Mali and Northern Nigeria (table 18). Overall, the results showed that the proportion of market participants was low in Mali and Niger. One of reasons is that most of pearl millet and sorghum farmers in these two countries produce for self-consumption.

Table 17: Proportion of net seller/net buyer of pearl millet producers in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		Control village		Sample overall	
	Net seller	Net buyer	Net seller	Net buyer	Net seller	Net buyer	Net seller	Net buyer
Mali	(302)		(124)		(105)		(531)	
Groundnut	23.92[a***]	0.66	40.32[c**]	0.00	25.71	0.00	28.11	0.38
Maize	2.33[b***]	2.33	5.65	4.03	9.52	4.76	4.53	3.21
Pearl millet	6.64[b***]	7.97	7.26[c**]	6.45	17.14	3.81	8.87	6.79
Cowpea	4.98	0.66	5.65	0.00	8.57	0.95	5.85	0.57
Rice	6.98[a*]	3.65	1.61	2.42	3.81	1.90	5.09	3.02
Sorghum	3.32[a*]	9.30	8.87	16.13	11.43[b***]	16.19	6.23	12.26
Niger	(259)		(105)		(75)		(439)	
Groundnut	17.37	0.77	20.00	0.00	25.33	1.33	19.36	0.68
Maize	0.00	5.02	0.95	1.90	1.33	8.00	0.46	4.78
Pearl millet	12.36[b*]	12.74	8.57	10.48	4.00	12.00	10.02	12.07
Cowpea	15.44	1.54	18.10	1.90	22.67	1.33	17.31	1.59
Rice	0.77[b***]	0.77[c***]	0.00	2.86	8.00	1.33	1.82	1.37
Sorghum	0.77	1.93	1.90	1.90	0.00	4.00	0.91	2.28
Nigeria	(654)		n/a		(393)		(1047)	
Groundnut	33.49	2.14	n/a	n/a	41.22	1.02	36.39	1.72
Maize	14.98[a***]	7.95[a*]	n/a	n/a	9.67	9.16	12.99	8.40
Pearl millet	43.43	4.59	n/a	n/a	42.24	3.56	42.98	4.20
Cowpea	33.33	6.27	n/a	n/a	50.64	3.56	39.83	5.25
Rice	3.67	12.23[a*]	n/a	n/a	5.34	6.87	4.30	10.22

Sorghum	39.14[a*]	4.59	n/a	n/a	38.17	2.29	38.78	3.72	

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Table 18: Proportion of net seller/net buyer of sorghum producers in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		Control village		Sample overall	
	Net seller	Net buyer	Net seller	Net buyer	Net seller	Net buyer	Net seller	Net buyer
Mali	(355)		(180)		(167)		(702)	
Groundnut	22.60[a**]	0.56	32.78	0.00	23.35	0.00	25.39	0.29
Maize	1.98[b***]	3.39	3.89[c*]	2.78	8.38	5.39	3.99	3.71
Pearl millet	5.65	7.34[b*]	5.00	5.00	10.18	2.40	6.56	5.56
Cowpea	4.24	0.56	3.33	0.00	5.39	0.60	4.28	0.43
Rice	7.06[a**]	2.82	1.11[c*]	1.67	6.59	1.80	5.42	2.28
Sorghum	3.67[b**]	11.86	7.78	15.56	9.58	17.37	6.13	14.12
Nigeria	(667)		n/a		(414)		(1081)	
Groundnut	33.13	1.65	n/a	n/a	39.37	1.21	35.52	1.48
Maize	16.19[a***]	7.05	n/a	n/a	14.01	9.66	15.36	8.05
Pearl millet	39.73	3.60	n/a	n/a	38.41	4.11	39.22	3.79
Cowpea	34.33	5.40	n/a	n/a	49.28	3.62	40.06	4.72
Rice	4.20	11.69[a*]	n/a	n/a	5.07	7.00	4.53	9.90
Sorghum	40.78	4.65	n/a	n/a	39.13	2.17	40.15	3.70

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

5.2.2. Marketable surplus and agricultural products sales

Marketable surplus is defined as the share of production allocated to market. Table 19 shows marketable surplus of the pearl millet and sorghum producers in Mali, Niger and Northern Nigeria. The results indicates that pearl millet producers in Mali allocated to market on average 51.06%, 32.77%, 29.63%, 49.86%, 35.45%, and 26.23% of their production of groundnut, maize, pearl millet, cowpea, rice and sorghum respectively. In Niger, pearl millet farmers allocated to market more than half of their production of groundnut and cowpea (71.62% and 60.75% respectively). For pearl millet, rice, and sorghum, the marketable surplus is estimated to 16.66%, 34.12%, and 22.80% respectively. The results also show that pearl millet farmers in Northern Nigeria sold on average 70.41%, 63.10%, 55.09%, 71.34%, 56.47%, and 49.52% of their production of groundnut, maize, pearl millet, cowpea, rice, and sorghum respectively in 2009-2010. However, there are significant differences between project villages and non-project villages for pearl millet and cowpea. In the three countries, the marketable surplus for pearl millet and sorghum were lower. The similar results are obtained for sorghum farmers in Mali and Northern Nigeria. Overall, results showed that marketable surpluses of pearl millet and sorghum are the lowest in the three countries. This

explains by the fact that in most of the sub-Saharan Africa countries, millet and sorghum are grown for food.

With regard to agricultural products sales, table 20 shows that pearl millet farmers in Mali sold on average 1.73 tons of rice, 1.41 tons of sorghum and 1.22 tons of maize. The sales were about 784 kg, 769 kg, and 322 kg for groundnut, pearl millet and cowpea respectively. However, project villages recorded sales lower than diffusion villages for maize and cowpea. The average value of sales is estimated to US$ 691 (336590 FCFA). Table 20 shows pearl millet producers in Niger sold 1.03 tons of their rice production in 2009-2010. The sales recorded for other products were of 565 kg, 500 kg, 287 kg, and 183 kg for groundnut, pearl millet, sorghum, and cowpea respectively. The value of sales is estimated to US$ 1311(639018 FCFA). Table 20 also indicate that pearl millet producers in Northern Nigeria sold 2.90 tons, 1.37 tons, 1.14 tons and 1.05 tons of maize, pearl millet, rice and sorghum respectively. There are however significant difference between project villages and non-project villages. The sales recorded in project villages in Northern Nigeria were above the average of overall sample (3.28 tons and 1.13 tons for maize and sorghum respectively). The sales of groundnut and cowpea were about 964 kg and 612 kg respectively. The average value of sales is estimated to US$ 640 (102225 Naira). The similar results are recorded for households producing sorghum in Mali and Northern Nigeria. Overall, results showed that cash crops such as maize and rice recorded significant sales in Mali, Niger and Northern Nigeria in 2009-2010. Pearl millet and sorghum farmers in these three countries don't derive enough income from pearl millet and sorghum production. One of the objectives of the HOPE project is to promote the adoption of improved pearl millet and sorghum varieties in order to increase productivity and household's income.

Table 19: Marketable surplus of agricultural products of pearl millet and sorghum producers in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Groundnut	53.04	51.66	52.71	52.65	43.49	43.82	51.06	50.13
Maize	23.89	23.88	33.65	33.65	36.59	31.03	32.77	30.34
Pearl millet	35.01	36.47	33.59	33.59	23.69	22.15	29.63	29.46
Cowpea	48.43	48.43	62.20	62.20	45.84	45.84	49.86	49.86
Rice	30.08	41.31	0.00	0.00	10.25	30.24	35.45	38.36
Sorghum	33.60	33.78	28.94	24.37	19.41	19.25	26.23	25.23
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Groundnut	72.76	n/a	67.70	n/a	74.72	n/a	71.62	n/a
Maize	0.00	n/a	0.00	n/a	0.00	n/a	0.00	n/a
Pearl millet	12.37[b**]	n/a	24.88	n/a	33.63	n/a	16.66	n/a
Cowpea	58.84	n/a	69.21	n/a	55.95	n/a	60.75	n/a
Rice	17.83	n/a	0.00	n/a	40.64	n/a	34.12	n/a
Sorghum	11.30	n/a	45.81	n/a	0.00	n/a	22.80	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Groundnut	71.56	71.56	n/a	n/a	68.75	67.37	70.41	69.83
Maize	60.39	59.79	n/a	n/a	68.53	59.68	63.10	59.74
Pearl millet	57.32[a*]	56.71	n/a	n/a	52.05	51.69	55.09	54.56
Cowpea	68.47[a*]	68.86	n/a	n/a	74.91	73.80	71.34	71.09
Rice	60.68	69.33	n/a	n/a	52.72	54.62	56.47	62.41
Sorghum	47.76	47.93	n/a	n/a	52.36	52.25	49.52	49.64

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Table 20: Sales of agricultural products (kg and FCFA) of pearl millet and sorghum producers in Mali, Niger and Northern Nigeria, 2009/2010

	Type of village							
Country name / variables	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Groundnut	641.47[a**]	645.32[a**]	1136.20[c**]	1112.03[c**]	509.89	583.30	783.64	785.30
Maize	470.00[a*]	470.00	2185.71	2185.71	1080.00	1160.94	1224.58	1241.51
Pearl millet	872.85	863.34[a*]	1141.67	1141.67	461.12	482.35	768.85	778.83
Cowpea	192.06[a**]	192.06[a*]	814.28[c*]	833.34[c*]	155.84	155.84	322.04	309.45
Rice	2127.72	1954.23	350.00	350.00	260.00	1217.27	1733.92	1664.10
Sorghum	1066.67	1160.00	2181.81	1782.14	1138.25	1405.60	1410.56	1438.00
Total value of sales (FCFA)	300969	298168	420169	402596	301817	394509	336590	353128
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Groundnut	756.56	n/a	381.35	n/a	291.64	n/a	565.34	n/a
Maize	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Pearl millet	504.07	n/a	493.75	n/a	483.34	n/a	500.20	n/a
Cowpea	134.06	n/a	246.50	n/a	221.82	n/a	182.63	n/a
Rice	1001.00	n/a	0.00	n/a	1043.42	n/a	1030.70	n/a
Sorghum	403.64	n/a	82.18	n/a	0.00	n/a	286.75	n/a
Total value of sales (FCFA)	126830	n/a	2584089	n/a	103060	n/a	639018	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Groundnut	1036.64	1041.00	n/a	n/a	865.68	858.90	963.81	963.35
Maize	3286.48[a**]	2875.89[a**]	n/a	n/a	1882.63	1518.96	2900.92	2407.98
Pearl millet	1454.41	1399.13	n/a	n/a	1229.81	1230.46	1372.07	1336.41
Cowpea	596.86	577.21	n/a	n/a	629.42	610.41	612.26	592.76
Rice	1365.56	1348.56	n/a	n/a	892.87	898.09	1143.68	1153.07
Sorghum	1129.41[a**]	1092.02	n/a	n/a	927.67	953.20	1054.55	1040.00
Total value of sales (Naira)	108511	104558	n/a	n/a	92570	91036	102225	99183

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

5.2.3. Sales of livestock heads

Table 21 below presents the sales of animals recorded in 2009-2010. The results indicate that animals sold by pearl millet farmers in Mali were mainly consisted of cattle, pig, poultry, sheep and goat for a total value of US$ 566 (276103 FCFA). Table 21 shows that pearl millet farmers in Niger sold cattle, goat, sheep, donkey, horse, and poultry for a total value of US$ 467 (227770 FCFA). Pearl millet farmers in Northern Nigeria sold cattle, goat, sheep, donkey, horse, poultry, and rabbit for a total value of US$ 935 (149168 Naira). However, there are differences between village types in Northern Nigeria. The value of sales is significantly lower in non-project villages (US$ 544) than in project villages (US$ 1160). Overall, results showed that cattle, pig, poultry and horse recorded the most significant sales. The results obtained for sorghum farmers in Mali and Northern Nigeria are almost similar.

5.2.4. Food expenditures

Table 22 depicts expenditures food of pearl millet and sorghum farmers in 2009/2010. The results indicate that the average food expenditures of pearl millet farmers were of US$ 200 (97871 FCFA) in Mali, US$ 290 (141772 FCFA) in Niger, and US$ 426 (67876 Naira) in Northern Nigeria. Food expenditures were mainly consisted of the purchases of groundnut, maize, pearl millet, cowpea, rice and sorghum. Table 22 also shows that the purchases of maize and sorghum were significantly different between village types. The purchases of maize and sorghum were respectively of 463 kg and 563 kg in project villages against 762 kg and 936 kg respectively in non-project villages. The similar are obtained for households producing sorghum in Mali and Northern Nigeria.

Table 21: Sales of livestock of pearl millet and sorghum producers in Mali, Niger and Northern Nigeria, 2009/2010

	Type of village							
Country name / variables	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Beef	68.89	71.10	40.83	40.83	47.89	64.39	54.00	62.21
Goat	3.75	3.75	19.33	19.33	31.14	32.40	17.33	19.58
Sheep	33.43	38.00	24.17	21.43	28.75	47.67	30.11	38.00
Donkey	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Horse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Poultry	12.92	13.64	11.11	14.00	13.80	16.15	12.83	14.95
Pig	54.83	54.83	40.67	31.50	3.00	31.50	41.55	41.50
Total value of sales (FCFA)	240313	186500	418438	409412	214435	316027	276103	295133
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Beef	3.58	n/a	1.56	n/a	1.44	n/a	2.62	n/a
Goat	2.93	n/a	7.10	n/a	1.57	n/a	3.81	n/a
Sheep	2.88	n/a	6.38	n/a	2.00	n/a	3.79	n/a
Donkey	1.50	n/a	1.00	n/a	1.00	n/a	1.33	n/a
Camel	0.00	n/a	0.00	n/a	0.00	n/a	0.00	n/a
Horse	11.00	n/a	0.00	n/a	1.00	n/a	6.00	n/a
Poultry	20.62	n/a	9.16	n/a	6.75	n/a	15.37	n/a
Total value of sales (FCFA)	240519	n/a	263219	n/a	119296	n/a	227770	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Beef	2.80	2.85	n/a	n/a	2.20	2.04	2.67	2.68
Goat	3.60	3.55	n/a	n/a	3.56	3.44	3.58	3.51
Sheep	3.19	3.11	n/a	n/a	3.14	3.63	3.17	3.30
Donkey	1.50	1.50	n/a	n/a	3.00	3.00	2.00	2.00
Camel	0.00	0.00	n/a	n/a	0.00	0.00	0.00	0.00
Horse	0.00	0.00	n/a	n/a	10.00^{a***}	10.00^{a***}	10.00	10.00
Poultry	9.84^{a***}	9.44^{a**}	n/a	n/a	6.36	6.47	8.47	8.32
Rabbit	0.00	0.00	n/a	n/a	5.00^{a***}	3.50^{a***}	5.00	3.50
Total value of sales (Naira)	184937^{a***}	181115^{a***}	n/a	n/a	86710	82088	149168	145289

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Table 22: Food expenditures (kg and FCFA) of pearl millet and sorghum producers in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Groundnut	206.25	206.25	400.00	400.00	1000.00	1000.00	370.84	370.83
Maize	505.71	411.67	348.40	186.20	300.00	275.00	393.45	319.30
Pearl millet	414.58	400.31	287.50	277.78	371.42	328.57	380.77	362.10
Cowpea	112.50	112.50	0.00	0.00	400.00	400.00	208.34	208.33
Rice	305.00	323.63	122.34	122.34	400.00	375.00	290.39	301.50
Sorghum	627.93	532.90	456.00	367.14	422.35	636.55	522.88	516.72
Food expenditures (FCFA)	109955	117301	79753	67530	92323	118521	97871	104816
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Groundnut	1685.62	n/a	200.00	n/a	100.00	n/a	1173.75	n/a
Maize	469.23	n/a	150.00	n/a	370.84	n/a	410.71	n/a
Pearl millet	653.29	n/a	544.55	n/a	321.00	n/a	578.52	n/a
Cowpea	29.06	n/a	388.12	n/a	20.00	n/a	187.64	n/a
Rice	125.00	n/a	166.67	n/a	50.00	n/a	133.34	n/a
Sorghum	570.00	n/a	100.00	n/a	75.00	n/a	327.50	n/a
Food expenditures (FCFA)	159075	n/a	136192	n/a	85300	n/a	141772	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Groundnut	551.96	586.32	n/a	n/a	566.67	618.18	556.73	596.94
Maize	563.15[a**]	580.19	n/a	n/a	936.49	844.05	710.11	696.84
Pearl millet	563.91	469.88	n/a	n/a	635.48	706.06	592.73	575.20
Cowpea	686.25	723.02	n/a	n/a	868.06	889.29	735.83	777.58
Rice	753.21	807.18	n/a	n/a	724.14	764.52	745.55	795.05
Sorghum	463.44[a*]	401.17[a**]	n/a	n/a	761.76	770.00	545.24	511.27
Food expenditures (Naira)	68361	69294.27	n/a	n/a	67029	47825.37	67876	61109.25

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

5.3. Exposure and adoption of improved sorghum and pearl millet varieties in Mali, Niger and Nigeria

This section analyzes the exposure and adoption of improved sorghum and pearl millet varieties by pearl millet and sorghum producers in Mali, Niger and Northern Nigeria in 2009-2010. Exposure to modern varieties will be presented, followed by the adoption of the improved varieties by type of variety, and finally the constraints to adoption of improved varieties.

5.3.1. Exposure of farmers to improved sorghum and pearl millet varieties

Exposure to improved varieties is one of the first essential factors to adoption of these varieties. A modern or improved variety is an ICRISAT or NARS variety less than 20 years. Farmers must first know about the variety and after take the decision to adopt or not. The rate of exposure to a variety is defined as the proportion of pearl millet and sorghum producers who have heard or seen the seeds and/or cultural management practices.

Tables 23 and 24 present the rate of exposure to improved pearl millet and sorghum varieties in Mali in 2009-2010. The results show that 30% of pearl millet farmers were exposed to Sanioba 03 and about 10% to Sanioteli 53. There are however differences between village types. The rate of exposure to Sanioba 03 was significantly lower in project villages (26%) than in diffusion villages (38%) and control villages (35%). Fewer pearl millet farmers were exposed to other modern varieties such as Benkadiono, Toroniou C1, Indiana, Djiguifa, and Guefoue 16. About 45% of pearl millet farmers knew at least one modern variety, with differences between villages. The rate of exposure was significantly lower in project villages (40%) than in diffusion villages (52%) and control villages (50%). Among sorghum farmers, about 15% were exposed to Kenikedje and 12% to Seguetana. The rate of exposure to Kenikedje was significantly lower in control villages (10%) than in project and diffusion villages where the rates were above 15%. Fewer sorghum producers were exposed to other modern varieties such as Bobodje, Marakanio, Ngolofing, Djeman, Ips 0001, and Zarra. The results also indicate that 31% of sorghum farmers were exposed to at least one improved sorghum variety in 2009-2010. Overall, the rate of exposure to improved varieties considerably varies according to variety. Sanioba 03 and Kenikedje were respectively the improved pearl millet and sorghum varieties the most knew.

Table 23: Proportion of farmers reporting knowing pearl millet varieties in Mali, 2009/2010

Pearl millet varieties	Type of village			
	Project village (302)	Diffusion village (124)	Control village (105)	Sample overall (531)
Benkadiono	0.33	0.81	0.95	0.56
Toroniou C1	3.64[a*]	0.00	0.95	2.26
Djiguifa	0.99	0.00	0.95	0.75
Guefoue 16	4.97	6.45	2.86	4.90
Indiana 05	0.33	0.00	0.00	0.19
Sanioba 03	26.49[a*]	37.90	35.24	30.89
Souna 3	11.26	12.10	9.52	11.11
Sanioteli 53	6.29[b**]	12.10	14.29	9.23
Mankasanio	5.30[a***]	15.32[c***]	0.00	6.59
Sanio	3.64[a*]	9.68	14.29[b***]	7.16
Gaouri	8.94[a***]	0.00	0.00[b***]	5.08
Guegne	5.3	1.61	2.86	3.95
Djiko	5.96[a***]	0.00	0.95[b**]	3.58
Boboni	5.30[a**]	0.00	2.86	3.58
Soulafinikou	4.64	1.61	3.81	3.77
Gamako	1.32[a*]	4.84	1.90	2.26
Toutoukou	1.99	2.42	0.00	1.69
Baroba	0.33[a***]	4.84[c**]	0.95	1.51
Saniochima	1.99	2.42	0.95	1.88
Kolnan	2.32	0.00	0.00	1.32
Other local varieties	24.50[a*]	14.52[c*]	26.67	22.60
At least one ICRISAT variety	3.97	0.81	1.90	2.82
At least one NARS variety	44.70[a**]	58.06	57.14[b*]	50.28
At least one ICRISAT or NARS variety	47.35	58.06	59.05[b**]	52.17
Only local varieties	59.6[a**]	44.35	43.81	52.92
At least one recent ICRISAT variety (less than 20 years)	3.97	0.81	1.90	2.82
At least one recent NARS variety (less than 20 years)	36.42[a***]	52.42	48.57[b*]	42.56
At least one recent ICRISAT NARS variety (less than 20 years)	40.07[a*]	52.42	50.48	45.01

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Table 24: Proportion of farmers reporting knowing sorghum varieties in Mali, 2009/2010

	Type of village			
Pearl millet varieties	Project village	Diffusion village	Control village	Sample overall
	(355)	(180)	(167)	(702)
Bobodje	0.56	0.00	0.00	0.28
67-31	0.28	0.00	0.00	0.14
Djakele	0.00[a***]	2.22[c**]	0.00	0.57
Djeman	1.13	0.56	0.00	0.71
Douzou A	0.28	0.00	0.00	0.14
Foulatieba	0.56	0.56	0.60	0.57
Ips 0001	0.00	0.00	0.60	0.14
Jacumbe	3.10[a**]	0.00	0.60	1.71
Kassaroka	0.28	0.00	1.20	0.43
Kenikedje	17.46[b*]	13.33	10.18	14.67
Marakanio	0.56	0.56	0.60	0.57
Ngolofing	0.28	0.00	0.60	0.28
Seguetana	13.24	10.56	11.98	12.25
Seguifa	0.28	0.00	0.00	0.14
Tieble	0.85	0.00	0.00	0.43
Tiemantieteli	0.00	0.56	0.00	0.14
Tiemarifing	3.10	4.44	2.99	3.42
Toroba	0.28	0.00	0.60	0.28
Zara	0.00[a*]	2.22	2.40[b**]	1.14
Grinkan	0.00	0.56	0.00	0.14
Sakoykaba	0.56	0.00	0.00	0.28
Soumalemba	1.13	0.00	0.60	0.71
Gadiaba	0.28	0.56	0.60	0.43
Bimbiri	7.89[b***]	8.33[c***]	17.96	10.40
Dongon	10.99[b**]	11.67[c**]	3.59	9.40
Sonikouradji	6.76	11.11	5.99	7.69
Falomba	1.97[a**]	7.78[c***]	8.98	5.13
Gesekede	5.07	3.89	3.59	4.42
Gnaigneble	2.25	0.56[c**]	4.79	2.42
Kalandjigua	1.97	1.67	4.19	2.42
Kende	2.25	2.22	2.40	2.28
Magnaoule	1.41[b***]	0.00[c***]	5.99	2.14
Other local varieties	43.94[a*]	33.89	38.32	40.03
At least one ICRISAT variety	16.06	11.11	13.77	14.25
At least one NARS variety	24.79	21.67	18.56	22.51
At least one ICRISAT or NARS variety	38.31	30.56	30.54	34.47
Only local varieties	70.14[b*]	70.00	79.04	72.22
At least one recent ICRISAT variety (less than 20 years)	16.06	11.11	13.77	14.25
At least one recent NARS variety (less than 20 years)	19.72	18.33	14.37	18.09
At least one recent ICRISAT NARS variety (less than 20 years)	34.93	28.89	26.35	31.34

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels. Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Table 25 shows that 8% of pearl millet farmers in Niger were exposed to Ankoutes, 5% to Zatib and 4% to Sosank in 2009/2010. The results also indicate that the majority of pearl millet farmers were exposed to HKP Hainikiri (85%). There were only few farmers exposed to other modern varieties such as Sosat C88, and ICMVIS 99001. Overall, about 18% of pearl millet farmers knew at least one modern variety in 2009-2010. The rate of exposure was above 18% in project villages against 10% in control villages.

Table 25: Proportion of farmers reporting knowing pearl millet varieties in Niger, 2009/2010

	Type of village			
Pearl millet varieties	Project village	Diffusion village	Control village	Sample overall
	(259)	(105)	(75)	(439)
Ankoutes	7.34	12.50	5.33	8.22
ICMV IS 99001	1.16	0.96	1.33	1.14
ICMV IS 89305	1.54	0.00	0.00	0.91
Sosank	6.18[a*]	0.96	0.00[b**]	3.88
Sosat C-88	1.54	0.00	1.33	1.14
Zatib	6.95	1.92	4.00	5.25
Ba-angoure	1.16	2.88	0.00	1.37
CIVT- Tarna	0.77[b***]	0.00[c***]	5.33	1.37
DG-P1: Dan gombe	1.16	0.00	1.33	0.91
GR-P1: Guerguera	0.39	0.96	0.00	0.46
HKP Hainikire	89.19[b**]	81.73	76.00	85.16
P3 Kolo	22.01	24.04	18.67	21.92
Souna-3	0.77	0.00	0.00	0.46
Somno	44.79	39.42	40.00	42.69
Zamfarawa	6.95	2.88	1.33	5.02
Gnai	6.18[a**]	0.00	0.00[b**]	3.65
Tchouma	1.54[b***]	3.85	9.33	3.42
Wiyan bijini	1.54[b***]	1.92[c***]	12.00	3.42
Kolala	4.25	0.00	0.00	2.51
Other local varieties	17.37	16.35	24.00	18.26
At least one ICRISAT variety	16.99	14.42	8.00	14.84
At least one NARS variety	95.37[b***]	97.12[c***]	85.33	94.06
At least one ICRISAT or NARS variety	95.75[b***]	97.12[c***]	85.33	94.29
Only local varieties	60.62[a*]	47.12[c***]	72.00	59.36
At least one recent ICRISAT variety (less than 20 years)	15.83	14.42	8.00	14.16
At least one recent NARS variety (less than 20 years)	6.95	1.92	4.00	5.25
At least one recent ICRISAT NARS variety (less than 20 years)	20.46	16.35	10.67	17.81

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Tables 26 and 27 present the rate of exposure to pearl millet and sorghum varieties in Northern Nigeria in 2009-2010. Among pearl millet farmers, about 43% were exposed to Sosat C88 and 24% to ex-Borno. There are however differences between village types. The rate of exposure to Sosat C88 was significantly lower in control villages (27%) than in project villages (53%). Fewer farmers were exposed to other varieties such as GB 8735, LCIC9702, LCIC 9703, Zatib, and Ankoutes. Overall, about 42% of pearl millet farmers knew at least one modern variety. The results indicate that pearl millet farmers from project villages (52%) were significantly more exposed to modern varieties than those from control villages (26%). Among sorghum producers, about 18% were exposed to ICSV 400, and 17% to ICSV 111. The project villages had the rates of exposure to improved varieties significantly higher than control villages. For example, the rate of exposure to ICSV 400 and ICSV 111 were about 22% and 21% respectively in project villages while they were about 12% each in control villages. Fewer sorghum farmers knew other modern varieties such as SK 5912, Hybrid, Zabua, and Zamani. Overall, about 38% of sorghum producers were exposed to at least one modern variety in 2009-2010. However, the rate of exposure to modern varieties was significantly higher in project villages (44%) than in control villages (28%). The results also show that almost half of sorghum farmers were exposed to Kaura. Finally, Sosat C88 was the improved pearl millet variety the most known in Northern Nigeria and particularly in the villages where HOPE project started its activities in 2009-2010. ICSV 400 and ICSV 111 were the improved sorghum varieties the most knew both in project and non-project villages in Northern Nigeria.

Given the low rates of exposure, there is a need of wide diffusion of modern technologies in Mali, Niger and Northern Nigeria in the framework of the HOPE project in order to increase the rate of exposure to improved varieties.

Table 26: Proportion of farmers reporting knowing pearl millet varieties in Nigeria, 2009/10

	Type of village			
Pearl millet varieties	Project village	Diffusion village	Control village	Sample overall
	(654)	n/a	(393)	(1047)
Sosat C88	53.21[a***]	n/a	26.97	43.36
GB8735	1.38	n/a	1.27	1.34
ICSM IS 86305	0.61	n/a	0.25	0.48
LCIC 9702	0.46	n/a	0.25	0.38
LCIC 9703	0.31	n/a	0.76	0.48
Zatib	0.15	n/a	0.25	0.19
Ankoutes	0.46	n/a	0.00	0.29
Ex Borno	25.54	n/a	21.37	23.97
Gwagwa	3.06[a***]	n/a	7.89	4.87
Badume	3.06	n/a	4.33	3.53
Zango	45.11	n/a	48.09	46.23
Lawur	5.81[a**]	n/a	9.67	7.26
Mewa	2.14	n/a	2.29	2.20
Matstangari	1.22[a***]	n/a	4.33	2.39
Moro	4.13	n/a	4.07	4.11
Dan Gombe	0.61[a***]	n/a	2.54	1.34
Dan Kakan Jali	0.31	n/a	0.00	0.19
Danbade	2.75	n/a	2.29	2.58
Dandigale	3.52[a***]	n/a	14.25	7.55
Karan jau	2.60	n/a	3.31	2.87
Tamgayi	4.13[a*]	n/a	2.04	3.34
Wame	9.94[a**]	n/a	6.36	8.60
Wuyan bijini	5.96	n/a	4.83	5.54
Zamfarawa	4.89[a***]	n/a	10.18	6.88
Pudewa	0.76[a*]	n/a	0.00	0.48
Other local varieties	8.72[a*]	n/a	12.47	10.12
At least one ICRISAT variety	51.68[a***]	n/a	25.95	42.02
At least one NARS variety	24.77[a*]	n/a	19.85	22.92
At least one ICRISAT or NARS variety	65.60[a***]	n/a	37.40	55.01
Only local varieties	73.55[a***]	n/a	88.80	79.27
At least one recent ICRISAT variety (less than 20 years)	51.38[a***]	n/a	25.95	41.83
At least one recent NARS variety (less than 20 years)	0.31	n/a	0.25	0.29
At least one recent ICRISAT NARS variety (less than 20 years)	51.68[a***]	n/a	26.21	42.12

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Table 27: Proportion of farmers reporting knowing sorghum varieties in Nigeria, 2009/2010

	Type of village			
Pearl millet varieties	Project village	Diffusion village	Control village	Sample overall
	(667)	n/a	(414)	(1081)
ICSV 400	22.24[a***]	n/a	12.11	18.34
ICSV 111	21.03[a***]	n/a	12.11	17.60
Hybride	1.21[a***]	n/a	4.12	2.33
SK 5912	8.47	n/a	7.26	8.01
Kaura	51.74[a***]	n/a	38.50	46.65
Bargon zaki	11.80	n/a	12.11	11.92
Farafara	28.90	n/a	32.69	30.35
Ja dawa	11.80[a***]	n/a	24.21	16.57
Yar falgori	2.57[a***]	n/a	7.51	4.47
Yar dangagerei	1.66	n/a	3.15	2.23
Yar gaya	2.42	n/a	3.63	2.89
Yar ruruka	3.48[a***]	n/a	9.69	5.87
Yar wuri	2.12[a**]	n/a	0.24	1.40
Yar abuba	0.76	n/a	0.24	0.56
Janjare	3.18	n/a	4.12	3.54
Yar washa	1.66	n/a	1.94	1.77
Ajama	1.36[a**]	n/a	0.00	0.84
Zabua	3.03	n/a	2.66	2.89
Kwakwai	0.15[a***]	n/a	4.36	1.77
Cida gero	0.00	n/a	0.00	0.00
Yar tawa	0.61[a**]	n/a	1.94	1.12
Roka	0.76	n/a	0.24	0.56
Bes	1.82[a***]	n/a	0.00	1.12
Bambalasta	0.76[a*]	n/a	0.00	0.47
Chunchu	0.15	n/a	0.00	0.09
Rosoba	0.91	n/a	1.69	1.21
Yar likori	0.76	n/a	0.97	0.84
Gizon arne	2.42[a**]	n/a	0.48	1.68
KSV-2	0.30	n/a	0.24	0.28
KSV-5	0.30	n/a	0.00	0.19
KSV-7	0.61	n/a	0.00	0.37
KSV-8	0.15	n/a	0.00	0.09
Tankoshi	1.06[a***]	n/a	3.39	1.96
Yar dalama	0.30[a***]	n/a	2.18	1.02
Yar jafaru	0.30	n/a	0.73	0.47
Machako dawayo	1.51[a***]	n/a	5.81	3.17
Zamani	1.06[a*]	n/a	2.42	1.58
Yar tsanyawa	3.18	n/a	3.15	3.17
Wame	0.45	n/a	0.24	0.37

Bul wala	0.45	n/a	0.24	0.37
Yar gani	1.36	n/a	0.73	1.12
Bauchi early	0.30	n/a	0.24	0.28
Yar charanchi	0.61[a**]	n/a	0.24	0.47
Ashekara gona	1.06	n/a	0.00	0.65
Warwara bashi	0.76[a*]	n/a	0.00	0.47
Shekar kurciya	0.45[a*]	n/a	1.45	0.84
Matshe da arziki	0.45	n/a	0.00	0.28
Male	1.97[a*]	n/a	0.48	1.40
Dan gogiya	0.76	n/a	1.21	0.93
Chacalari	0.61[a**]	n/a	2.42	1.30
Yafi moro	6.35	n/a	4.60	5.68
Ngolda	0.00[a**]	n/a	0.73	0.28
Hannu giwa	1.21[a**]	n/a	0.00	0.74
Korombasau	0.00[a***]	n/a	1.21	0.47
P 9404	0.15	n/a	0.00	0.09
Kitsen damo	0.00	n/a	0.00	0.00
Zago	4.99[a**]	n/a	2.18	3.91
Ta kamba	0.15	n/a	0.24	0.19
Lara	2.42[a*]	n/a	0.97	1.86
Shambul	2.42[a***]	n/a	0.00	1.49
Jalof	0.15[a***]	n/a	2.91	1.21
Other varieties	16.64[a***]	n/a	25.18	19.93
At least one ICRISAT variety	36.43[a***]	n/a	20.05	30.16
At least one NARS variety	64.77	n/a	65.94	65.22
At least one NARS or ICRISAT variety	83.06[a***]	n/a	72.71	79.09
Local varieties only	53.07[a***]	n/a	72.95	60.68
At least one recent ICRISAT variety (less than 20 years)	37.63[a***]	n/a	20.77	31.17
At least one recent NARS variety (less than 20 years)	11.99	n/a	11.84	11.93
At least one recent ICRISAT or NARS variety (less than 20 years)	44.08[a***]	n/a	28.02	37.93

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

5.3.2. Adoption of improved sorghum and pearl millet varieties

Exposure is highly correlated with adoption of improved varieties. This section will first present the proportion of farmers having adopted improved pearl millet and sorghum varieties, followed by the proportion of areas planted with improved varieties and the seed sources in 2009-2010.

a) Household having adopted improved varieties

Tables 28 and 29 present the proportions of pearl millet and sorghum farmers in Mali having adopted the modern varieties by variety in 2009-2010. Among pearl millet producers, about 34% adopted the modern varieties. However, there are differences between village types. The rate of adoption was significantly lower in project villages (28%) than in diffusion villages (44%) and control villages (39%). Table 28 also shows that 21% of farmers adopted Sanioba 03, and 7% Sanioteli 53. Among sorghum farmers, the rate of adoption was about 10% for the varieties Kenikedje and Seguetana (table 29). Overall, about 23% of sorghum producers adopted the modern varieties, with no significant differences between village types.

Table 28: Proportion of farmers having planted pearl millet varieties in Mali, 2009/2010

	Type of village			
Pearl millet varieties	Project village	Diffusion village	Control village	Sample overall
	(302)	(124)	(105)	(531)
Benkadiono	0.33	0.81	0.95	0.56
Toroniou C1	1.99	0.00	0.95	1.32
Djiguifa	0.66	0.00	0.95	0.56
Guefoue 16	4.64	5.65	2.86	4.52
Indiana 05	0.33	0.00	0.00	0.19
Sanioba 03	17.55[a**]	29.03	22.86	21.28
Souna 3	6.95	4.84	6.67	6.40
Sanioteli 53	3.97[b***]	9.68	12.38	6.97
Mankasanio	4.64	8.87[c***]	0.00	4.71
Sanio	2.32[b***]	7.26	12.38	5.46
Gaouri	8.61[a***]	0.00	0.00[b***]	4.90
Guegne	5.30[a***]	0.00	0.00[b**]	3.01
Djiko	2.98[a*]	0.00	0.00	1.69
Boboni	4.64[a**]	0.00	0.95	2.82
Soulafinikou	2.98	0.81	2.86	2.45
Gamako	1.32	4.03	1.90	2.07
Toutoukou	0.33	1.61	0.00	0.56
Baroba	0.00[a**]	2.42	0.95	0.75
Saniochima	0.66	0.81	0.95	0.75
Kolnan	2.32	0.00	0.00	1.32
Other local varieties	15.23[a*]	7.26[c*]	17.14	13.75
At least one ICRISAT variety	2.32	0.81	1.90	1.88
At least one NARS variety	31.46[a***]	47.58	44.76[b**]	37.85
At least one ICRISAT or NARS variety	33.11[a***]	48.39	46.67[b**]	39.36
Only local varieties	48.34[a***]	32.26	37.14	42.37
At least one recent ICRISAT variety (less than 20 years)	2.32	0.81	1.90	1.88
At least one recent NARS variety (less than 20 years)	25.83[a***]	43.55	37.14[b*]	32.2
At least one recent ICRISAT NARS variety (less than 20 years)	27.81[a***]	44.35	39.05	33.90

Table 29: Proportion of farmers having planted sorghum varieties in Mali, 2009/2010

Pearl millet varieties	Type of village			
	Project village (355)	Diffusion village (180)	Control village (167)	Sample overall (702)
Bobodje	0.28	0.00	0.00	0.14
67-31	0.28	0.00	0.00	0.14
Djakele	0.00[a*]	1.11	0.00	0.28
Djeman	1.13	0.56	0.00	0.71
Douzou A	0.28	0.00	0.00	0.14
Foulatieba	0.00	0.00	0.60	0.14
Ips 0001	0.00	0.00	0.00	0.00
Jacumbe	3.10[a**]	0.00	0.60	1.71
Kassaroka	0.00	0.00	0.60	0.14
Kenikedje	11.27	7.78	7.19	9.40
Marakanio	0.56	0.00	0.60	0.43
Ngolofing	0.00	0.00	0.60	0.14
Seguetana	9.86	9.44	8.98	9.54
Seguifa	0.28	0.00	0.00	0.14
Tieble	0.56	0.00	0.00	0.28
Tiemantieteli	0.00	0.56	0.00	0.14
Tiemarifing	0.56[a**]	2.78[c**]	0.00	1.00
Toroba	0.00	0.00	0.00	0.00
Zara	0.00	0.00	0.00	0.00
Grinkan	0.00	0.00	0.00	0.00
Sakoykaba	0.00	0.00	0.00	0.00
Soumalemba	1.13	0.00	0.60	0.71
Gadiaba	0.28	0.56	0.60	0.43
Bimbiri	6.76[b**]	6.67[c**]	14.37	8.55
Dongon	8.17[b**]	7.78[c*]	1.80	6.55
Sonikouradji	6.48	10.56	5.99	7.41
Falomba	1.69[a**]	6.67	7.19[b**]	4.27
Gesekede	3.38	1.11	1.80	2.42
Gnaigneble	1.41	0.56	2.40	1.42
Kalandjigua	1.41	1.67	2.40	1.71
Kende	0.56	1.67	0.60	0.85
Magnaoule	1.13[b***]	0.00[c***]	5.39	1.85
Other local varieties	36.90	29.44	29.34	33.19
At least one ICRISAT variety	12.11	9.44	10.78	11.11
At least one NARS variety	16.06	13.89	10.18	14.10
At least one ICRISAT or NARS variety	27.89	22.78	21.56	25.07
Only local varieties	61.69	60.00	67.07	62.54
At least one recent ICRISAT variety (less than 20 years)	12.11	9.44	10.78	11.11
At least one recent NARS variety (less than 20 years)	12.68	11.67	8.38	11.40
At least one recent ICRISAT NARS variety (less than 20 years)	25.07	21.11	19.16	22.65

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels. Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Table 30 shows that the proportion of pearl millet farmers in Niger having adopted modern varieties was about 13%. There are not significant differences between villages. The results also indicate that about 6%, 2.73% and 3.19% of pearl millet producers adopted the varieties Ankoutes, Sosank and Zatib respectively. However, the variety Sosank was only adopted in project villages.

Table 30: Proportion of farmers having planted pearl millet varieties in Niger, 2009/2010

	Type of village			
Pearl millet varieties	Project village	Diffusion village	Control village	Sample overall
	(259)	(105)	(75)	(439)
Ankoutes	5.41	9.52	2.67	5.92
ICMV IS 99001	0.77	0.95	0.00	0.68
ICMV IS 89305	1.16	0.00	0.00	0.68
Sosank	4.63[a**]	0.00	0.00[b*]	2.73
Sosat C-88	0.00	0.00	0.00	0.00
Zatib	3.86	0.95	4.00	3.19
Ba-angoure	0.77	1.90	0.00	0.91
CIVT- Tarna	0.39[b**]	0.00[c**]	4.00	0.91
DG-P1: Dan gombe	0.77	0.00	0.00	0.46
GR-P1: Guerguera	0.39	0.00	0.00	0.23
HKP Hainikire	71.81	66.67	64.00	69.25
P3 Kolo	16.22	20.95	9.33	16.17
Souna-3	0.00	0.00	0.00	0.00
Somno	37.45	29.52	33.33	34.85
Zamfarawa	4.25	2.86	1.33	3.42
Gnai	1.93	0.00	0.00	1.14
Tchouma	0.39[b*]	2.86	4.00	1.59
Wiyan bijini	0.77[b***]	0.95[c***]	9.33	2.28
Kolala	1.16	0.00	0.00	0.68
Other local varieties	7.72[b**]	11.43	18.67	10.48
At least one ICRISAT variety	12.36	10.48	4.00	10.48
At least one NARS variety	90.73[b***]	93.33[c***]	78.67	89.29
At least one ICRISAT or NARS variety	91.89[b***]	94.29[c***]	78.67	90.21
Only local varieties	47.88	38.10[c**]	60.00	47.61
At least one recent ICRISAT variety (less than 20 years)	11.58	10.48	4.00	10.02
At least one recent NARS variety (less than 20 years)	3.86	0.95	4.00	3.19
At least one recent ICRISAT NARS variety (less than 20 years)	14.67	11.43	6.67	12.53

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Tables 31 and 32 summarize the proportions of pearl millet and sorghum farmers in Northern Nigeria having adopted modern varieties by variety in 2009-2010. About 35% of pearl millet

farmers adopted modern varieties, with differences between village types. About 44% pearl millet producers from project villages adopted improved varieties against 21% in control villages. Table 31 shows that on average 37% and 20% of pearl millet producers adopted the varieties Sosat C88 and ex-Borno respectively. However, the rate of adoption of Sosat C88 in project villages is largely above sample average (46%). Table 32 shows that 32% of sorghum farmers adopted the improved varieties. ICSV400 and ICSV111 were the improved varieties the most adopted with the average rates of adoption of 14.25% and 14.71% respectively. Project villages had the highest rates (18% for ICSV400 and 17% for ICSV111).

Table 31: Proportion of farmers having planted pearl millet varieties in Nigeria, 2009/2010

Pearl millet varieties	Type of village			
	Project village (654)	Diffusion village n/a	Control village (393)	Sample overall (1047)
Sosat C88	45.87[a***]	n/a	22.39	37.06
GB8735	0.61	n/a	1.02	0.76
ICSM IS 86305	0.31	n/a	0.25	0.29
LCIC 9702	0.00	n/a	0.25	0.10
LCIC 9703	0.15	n/a	0.51	0.29
Zatib	0.15	n/a	0.25	0.19
Ankoutes	0.31	n/a	0.00	0.19
Ex Borno	21.25[a*]	n/a	16.54	19.48
Gwagwa	2.60[a***]	n/a	7.38	4.39
Badume	2.29	n/a	3.31	2.67
Zango	34.71[a*]	n/a	40.20	36.77
Lawur	4.59[a**]	n/a	7.63	5.73
Mewa	1.07	n/a	2.04	1.43
Matstangari	0.61[a***]	n/a	3.31	1.62
Moro	3.98	n/a	3.31	3.72
Dan Gombe	0.61	n/a	1.53	0.96
Dan Kakan Jali	0.15	n/a	0.00	0.10
Danbade	1.99	n/a	1.78	1.91
Dandigale	1.38[a***]	n/a	12.21	5.44
Karan jau	1.83	n/a	3.05	2.29
Tamgayi	2.91[a**]	n/a	1.02	2.20
Wame	7.34	n/a	5.60	6.69
Wuyan bijini	2.91	n/a	4.07	3.34
Zamfarawa	2.45[a***]	n/a	6.87	4.11
Pudewa	0.61	n/a	0.00	0.38
Other local varieties	3.98	n/a	5.34	4.49
At least one ICRISAT variety	43.58[a***]	n/a	21.12	35.15
At least one NARS variety	20.34[a**]	n/a	15.01	18.34
At least one ICRISAT or NARS variety	58.26[a***]	n/a	31.30	48.14
Only local varieties	63.15[a***]	n/a	78.88	69.05
At least one recent ICRISAT variety (less than 20 years)	43.43[a***]	n/a	21.12	35.05
At least one recent NARS variety (less than 20 years)	0.15	n/a	0.25	0.19
At least one recent ICRISAT NARS variety (less than 20 years)	43.58[a***]	n/a	21.37	35.24

Table 32: Proportion of farmers having planted sorghum varieties in Nigeria, 2009/2010

	Type of village			
Pearl millet varieties	Project village	Diffusion village	Control village	Sample overall
	(667)	n/a	(414)	(1081)
ICSV400	17.99[a***]	n/a	8.21	14.25
ICSV111	16.94[a***]	n/a	11.11	14.71
hybsorg	0.30[**]	n/a	1.45	0.74
SK5912	6.45	n/a	6.04	6.29
kaura	46.93[a***]	n/a	34.06	42.00
bargozak	9.75	n/a	11.11	10.27
farfara	19.34	n/a	17.39	18.59
jawa	8.10[a***]	n/a	19.32	12.40
yarfalgo	1.50[a***]	n/a	6.28	3.33
yardanga	0.30[a***]	n/a	2.42	1.11
dungogya	1.80	n/a	3.14	2.31
yarruruka	2.40[a***]	n/a	8.94	4.90
yarwuri	0.75	n/a	0.24	0.56
yarabuba	0.45	n/a	0.24	0.37
janjare	1.50[a*]	n/a	3.14	2.13
yarwasha	1.05	n/a	1.93	1.39
ajama	1.35[a**]	n/a	0.00	0.83
zabua	1.80	n/a	1.69	1.76
kwakwi	0.15[a***]	n/a	3.86	1.57
yartawa	0.15[a***]	n/a	1.93	0.83
roka	0.60	n/a	0.00	0.37
bes	1.80[a***]	n/a	0.00	1.11
bambalasta	0.15	n/a	0.00	0.09
chanchu	0.15	n/a	0.00	0.09
rosoba	0.15[a*]	n/a	0.97	0.46
danlikori	0.75	n/a	0.72	0.74
gizonarne	1.35[a*]	n/a	0.24	0.93
ksv2	0.30	n/a	0.24	0.28
ksv5	0.15	n/a	0.00	0.09
ksv7	0.60	n/a	0.00	0.37
ksv8	0.15	n/a	0.00	0.09
tankawashe	1.05[a***]	n/a	3.38	1.94
yardalama	0.15	n/a	0.00	0.09
yarjafaru	0.00[a**]	n/a	0.48	0.19
makahodaw	0.90[a***]	n/a	4.59	2.31
zamani	0.60[a**]	n/a	2.17	1.20
yartsnyawa	2.25	n/a	1.21	1.85
wame	0.15	n/a	0.00	0.09
bulwala	0.45	n/a	0.24	0.37

yar_gani	1.20[a**]	n/a	0.48	0.93
ashekara_gona	0.15	n/a	0.00	0.09
yar_charanchi	0.90[a*]	n/a	0.00	0.56
warwara_bashi	0.00	n/a	0.00	0.00
shekar_kurciya	0.30	n/a	0.00	0.19
matshe_da_arziki	0.30	n/a	0.00	0.19
male	1.95[a**]	n/a	0.24	1.30
dan_gogiya	0.30a*	n/a	1.21	0.65
chacalari	0.60[a**]	n/a	2.17	1.20
yafimoro	5.25[a*]	n/a	2.90	4.35
ngolda	0.00[a**]	n/a	0.72	0.28
hannu_giwa	0.90[a*]	n/a	0.00	0.56
korombasau	0.00[a**]	n/a	0.97	0.37
p_9404	0.00	n/a	0.00	0.00
kitsen_damo	0.00	n/a	0.00	0.00
zago	4.50[a**]	n/a	1.69	3.42
ta_kamba	0.15	n/a	0.00	0.09
lara	0.90	n/a	0.24	0.65
shambul	1.65[a***]	n/a	0.00	1.02
jalof	0.00[a***]	n/a	2.66	1.02
bauchi_early	0.00	n/a	0.00	0.00
cidagero	0.00	n/a	0.00	0.00
othsorg	12.59[a***]	n/a	19.08	15.08
At least one ICRISAT variety	30.88[a***]	n/a	16.67	25.44
At least one NARS variety	57.57	n/a	53.38	55.97
At least one NARS or ICRISAT variety	76.31[a***]	n/a	61.59	70.68
Local varieties only	46.03[a***]	n/a	65.70	53.56
At least one recent ICRISAT variety (less than 20 years)	32.08[a***]	n/a	17.39	26.46
At least one recent NARS variety (less than 20 years)	8.40	n/a	9.42	8.79
At least one recent ICRISAT or NARS variety (less than 20 years)	37.48[a***]	n/a	23.43	32.10

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Results showed that in Mali, Niger and Northern Nigeria, the rates of adoption of improved pearl millet and sorghum varieties were low in 2009/2010. The previous studies highlighted this result in the context West African. For example, Fall (2011) concludes that the lack of improved seed suppliers in Mali is a constraint to development of pearl millet and sorghum sector. A particular attention should be focused on this aspect in the framework of HOPE

project in the order to increase the rate of adoption of new pearl millet and sorghum varieties and to improve the productivity of these crops.

b) Area planted with improved varieties

Area planted with improved varieties is the most important indicator of adoption of improved varieties. The rate of adoption of modern varieties is calculated as the ratio of area planted with modern varieties on the total area planted to sorghum.

Tables 33 and 34 present the rates of adoption of improved sorghum and pearl millet varieties in Mali. Table 34 indicates that about 43% of pearl millet areas were planted with modern varieties. There are however significant differences between village types. Control and diffusion villages had respectively 50% and 59% of pearl millet areas planted with improved varieties against 35% in project villages. The variety Sanioba 03 was the most adopted accounting for 28% of areas planted with modern varieties. The other improved pearl millet varieties including Sanioteli 53, Guefoue 16, and Toroniou C1 accounted for 8%, 6% and 1.14% of areas respectively. Table 35 shows that about 25% of sorghum areas were planted with modern varieties. However, there were 28% of areas planted with improved varieties in project villages against 26% and 18% in diffusion and control villages respectively. Modern sorghum varieties the most adopted were Kenikedje and Seguetana with 13% and 8% the areas respectively. Overall, the results showed that the improved sorghum varieties were more adopted in project villages while areas under improved pearl millet varieties were more important in non-project villages.

Table 35 indicates that 3% of pearl millet areas in Niger were planted with modern varieties. There is no significant difference between village types. Ankoutes was the modern pearl millet variety the most adopted accounting for only 1.7% of areas. The other improved pearl millet varieties such as Zatib and Sosank accounted for less than 1% of areas.

Table 36 shows that about 25% of pearl millet area in Northern Nigeria were planted with modern varieties. There are however significant differences between village types. There was 32% of area under improved varieties in project villages against 11% in control villages. The varieties Sosat C88 and ex-Borno respectively accounted for 24% and 12% of pearl millet areas. Table 37 shows that 21% of sorghum area was planted with improved sorghum varieties. The rate of adoption of modern varieties was significant lower in control villages (14%) than in project villages where the rate was above 25%. The varieties ICSV 400 and ICSV 111 were the dominated varieties accounting for 8.35% and 8.65% respectively. For other improved sorghum varieties such Hybrid and SK 5912, they accounted for 0.27% and 2.76% of sorghum area respectively. Overall, there were more areas under improved pearl millet and sorghum varieties in project villages in Northern Nigeria.

Table 33: Proportion of area (%) planted with pearl millet varieties in Mali, 2009/2010

Pearl millet varieties	Type of village			
	Project village (302)	Diffusion village (124)	Control village (105)	Sample overall (531)
Benkadiono	0.51	1.18	1.54	0.86
Toroniou C1	1.60	0.00	1.23	1.14
Djiguifa	0.00	0.00	0.00	0.00
Guefoue 16	5.55	9.18	3.46	6.05
Indiana 05	0.29	0.00	0.00	0.16
Sanioba 03	22.60[b**]	38.82	29.23	27.81
Souna 3	3.26	3.18	2.31	3.06
Sanioteli 53	4.57[b**]	10.00	14.62	7.78
Mankasanio	4.82	8.24[c**]	0.00	4.76
Sanio	4.26[a*]	12.35	13.69[b**]	8.01
Gaouri	11.17[a***]	0.00	0.00[b***]	6.34
Guegne	6.09[a**]	0.00	0.00[b*]	3.46
Djiko	0.80	0.00	0.00	0.46
Boboni	5.66[a**]	0.00	1.54	3.50
Soulafinikou	3.13	0.00	4.62	2.64
Gamako	2.03	4.12	2.46	2.62
Toutoukou	0.00	1.18	0.00	0.29
Baroba	0.00	0.00	1.54	0.29
Saniochima	0.25	0.00	0.00	0.14
Kolnan	4.06	0.00	1.54	2.59
Other local varieties	19.34	11.76	22.23	18.03
At least one ICRISAT variety	2.11	1.18	2.77	2.01
At least one NARS variety	36.26[a***]	61.18	49.62	44.87
At least one ICRISAT or NARS variety	38.38[a***]	62.35	52.38	46.87
Only local varieties	61.62[a***]	37.65	47.62	53.13
At least one recent ICRISAT variety (less than 20 years)	2.11	1.18	2.77	2.01
At least one recent NARS variety (less than 20 years)	33.00[a***]	58.00	47.31	41.81
At least one recent ICRISAT NARS variety (less than 20 years)	35.11[a***]	59.18	50.08[b*]	43.81

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Table 34: Proportion of area (%) planted with sorghum varieties in Mali, 2009/2010

	Type of village			
Pearl millet varieties	Project village	Diffusion village	Control village	Sample overall
	(355)	(180)	(167)	(702)
Bobodje	0.00	0.00	0.00	0.00
67-31	0.00	0.00	0.00	0.00
Djakele	0.00[a***]	3.36[c***]	0.00	0.83
Djeman	1.12	0.42	0.00	0.70
Douzou A	0.10	0.00	0.00	0.05
Foulatieba	0.00	0.00	0.56	0.13
Ips 0001	0.00	0.00	0.00	0.00
Jacumbe	2.17	0.00	0.00	1.15
Kassaroka	0.00[b*]	0.00	0.93	0.21
Kenikedje	16.74	10.36	8.57	13.34
Marakanio	0.00	0.00	0.47	0.10
Ngolofing	0.00	0.00	0.62	0.14
Seguetana	8.93	7.98	5.49	7.93
Seguifa	0.10	0.84	0.00	0.26
Tieble	0.39	0.00	0.00	0.21
Tiemantieteli	0.00	0.84	0.00	0.21
Tiemarifing	0.39	0.56	0.00	0.35
Toroba	0.39	0.84	0.00	0.42
Zara	0.39	0.00	0.00	0.21
Grinkan	0.00[a*]	1.68	0.00	0.42
Sakoykaba	0.00	0.00	0.00	0.00
Soumalemba	0.13	0.00	0.93	0.28
Gadiaba	0.00	0.00	0.31	0.07
Bimbiri	6.96[b*]	10.08	14.68	9.45
Dongon	6.79	8.40	3.74	6.51
Sonikouradji	3.29[a***]	14.29	8.16	7.10
Falomba	1.64	5.17	3.08	2.84
Gesekede	8.19[a***]	0.00	0.00[b***]	4.34
Gnaigneble	1.46	0.00	1.40	1.08
Kalandjigua	1.73	1.68	3.74	2.17
Kende	1.18	1.68	0.51	1.16
Magnaoule	1.97	0.00[c**]	5.28	2.22
Other local varieties	35.92	31.81	41.51	36.15
At least one ICRISAT variety	9.85	8.82	7.52	9.07
At least one NARS variety	20.92[b**]	18.07	10.37	17.86
At least one ICRISAT or NARS variety	30.77[b**]	26.89	17.89	26.94
Only local varieties	69.23[b**]	73.11	82.11	73.06
At least one recent ICRISAT variety (less than 20 years)	9.85	8.82	7.52	9.07
At least one recent NARS variety (less than 20 years)	18.36	17.51	10.06	16.30
At least one recent ICRISAT NARS variety (less than 20 years)	28.21[b*]	26.33	17.58	25.37

Table 35: Proportion of area (%) planted with pearl millet varieties in Niger, 2009/2010

	Type of village			
Pearl millet varieties	Project village	Diffusion village	Control village	Sample overall
	(259)	(105)	(75)	(439)
Ankoutes	0.81[a***]	4.66[c**]	0.51	1.70
ICMV IS 99001	0.44	0.00	0.71	0.38
ICMV IS 89305	0.30	0.00	0.00	0.18
Sosank	0.51	0.00	0.00	0.30
Sosat C-88	0.12	0.00	0.00	0.07
Zatib	1.30	0.34	0.26	0.89
Ba-angoure	0.85	1.33	0.00	0.82
CIVT- Tarna	9.51	6.18	6.60	8.19
DG-P1: Dan gombe	0.34	0.00	0.00	0.20
GR-P1: Guerguera	0.00	0.00	0.00	0.00
HKP Hainikire	55.66	52.53	53.55	54.53
P3 Kolo	8.45[a**]	16.62	8.74	10.49
Souna-3	0.00	0.00	0.00	0.00
Somno	13.66	11.87	7.91	12.22
Zamfarawa	2.04	1.77	1.43	1.87
Gnai	1.62	0.00	0.00	0.94
Tchouma	0.07[b*]	0.36	1.68	0.42
Wiyan bijini	0.43[b***]	0.51[c**]	4.67	1.19
Kolala	0.57	0.00	0.00	0.33
Other local varieties	3.32[b***]	3.83[c***]	13.94	5.29
At least one ICRISAT variety	2.19	4.66	1.22	2.62
At least one NARS variety	76.93	81.66[c**]	69.66	76.82
At least one ICRISAT or NARS variety	78.31	81.66[c*]	70.37	77.74
Only local varieties	21.69	18.34[c*]	29.63	22.26
At least one recent ICRISAT variety (less than 20 years)	1.88	4.66	1.22	2.44
At least one recent NARS variety (less than 20 years)	1.30	0.34	0.26	0.89
At least one recent ICRISAT NARS variety (less than 20 years)	3.18	5.00	1.48	3.33

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Table 36: Proportion of area (%) planted with pearl millet varieties in Nigeria, 2009/2010

	Type of village			
Pearl millet varieties	Project village	Diffusion village	Control village	Sample overall
	(654)	n/a	(393)	(1047)
Sosat C88	32.12[a***]	n/a	10.34	23.95
GB8735	0.37	n/a	0.19	0.30
ICSM IS 86305	0.31	n/a	0.08	0.22
LCIC 9702	0.00	n/a	0.13	0.05
LCIC 9703	0.15	n/a	0.21	0.18
Zatib	0.00	n/a	0.01	0.00
Ankoutes	0.08	n/a	0.00	0.05
Ex Borno	13.50[a*]	n/a	9.84	12.13
Gwagwa	2.04[a***]	n/a	5.02	3.16
Badume	0.90[a*]	n/a	1.89	1.27
Zango	19.06[a*]	n/a	23.38	20.68
Lawur	2.53	n/a	4.01	3.09
Mewa	0.54	n/a	0.54	0.54
Matstangari	0.25[a***]	n/a	2.24	1.00
Moro	2.73	n/a	2.45	2.62
Dan Gombe	0.46	n/a	1.35	0.79
Dan Kakan Jali	0.15	n/a	0.00	0.10
Danbade	0.98	n/a	0.49	0.79
Dandigale	0.69[a***]	n/a	10.25	4.28
Karan jau	0.85[a**]	n/a	2.33	1.40
Tamgayi	1.77[a**]	n/a	0.30	1.22
Wame	4.27	n/a	3.04	3.81
Wuyan bijini	1.26	n/a	2.74	1.82
Zamfarawa	1.58[a***]	n/a	5.02	2.87
Pudewa	0.61	n/a	0.00	0.38
Other local varieties	1.64[a*]	n/a	2.71	2.04
At least one ICRISAT variety	32.95[a***]	n/a	10.96	24.70
At least one NARS variety	13.58[a*]	n/a	9.84	12.18
At least one ICRISAT or NARS variety	46.53[a***]	n/a	20.80	36.87
Only local varieties	42.31[a***]	n/a	67.75	51.86
At least one recent ICRISAT variety (less than 20 years)	32.65[a***]	n/a	10.87	24.47
At least one recent NARS variety (less than 20 years)	0.08	n/a	0.01	0.05
At least one recent ICRISAT NARS variety (less than 20 years)	32.72[a***]	n/a	10.88	24.52

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Table 37: Proportion of area (%) planted with sorghum varieties in Nigeria, 2009/2010

	Type of village			
Pearl millet varieties	Project village	Diffusion village	Control village	Sample overall
	(667)	n/a	(414)	(1081)
ICSV400	10.77[a***]	n/a	4.45	8.35
ICSV111	10.92[a***]	n/a	4.99	8.65
hybsorg	0.07[a**]	n/a	0.58	0.27
SK5912	3.05	n/a	2.28	2.76
kaura	27.48[a***]	n/a	19.62	24.47
bargozak	3.94[a***]	n/a	7.17	5.18
farfara	6.33	n/a	5.20	5.90
jawa	3.60[a***]	n/a	10.96	6.42
yarfalgo	0.65[a***]	n/a	2.69	1.43
yardanga	0.10[a**]	n/a	0.79	0.37
dungogya	1.29	n/a	1.85	1.50
yarruruka	1.12[a***]	n/a	5.97	2.98
yarwuri	0.67	n/a	0.04	0.43
yarabuba	0.15	n/a	0.12	0.14
janjare	0.59	n/a	0.77	0.66
yarwasha	0.47	n/a	0.70	0.56
ajama	0.71[a**]	n/a	0.00	0.44
zabua	0.86	n/a	1.20	0.99
kwakwi	0.07[a***]	n/a	2.68	1.07
yartawa	0.00[a**]	n/a	0.64	0.25
roka	0.08	n/a	0.00	0.05
bes	0.52[a**]	n/a	0.00	0.32
bambalasta	0.04	n/a	0.00	0.02
chanchu	0.15	n/a	0.00	0.09
rosoba	0.05[a*]	n/a	0.26	0.13
danlikori	0.27	n/a	0.28	0.27
gizonarne	0.47	n/a	0.12	0.34
ksv2	0.12	n/a	0.00	0.08
ksv5	0.08	n/a	0.00	0.05
ksv7	0.37	n/a	0.00	0.23
ksv8	0.15	n/a	0.00	0.09
tankawashe	0.30[a***]	n/a	1.66	0.82
yardalama	0.15	n/a	0.00	0.09
yarjafaru	0.00[a*]	n/a	0.20	0.08
makahodaw	0.05[a**]	n/a	0.49	0.22
zamani	0.24[a*]	n/a	0.72	0.42
yartsnyawa	0.77	n/a	0.97	0.85
wame	0.04	n/a	0.00	0.02

bulwala	0.21	n/a	0.12	0.17
yar_gani	1.20	n/a	0.48	0.93
ashekara_gona	0.00	n/a	0.00	0.00
yar_charanchi	0.19	n/a	0.00	0.12
warwara_bashi	0.00	n/a	0.00	0.00
shekar_kurciya	0.12	n/a	0.00	0.08
matshe_da_arziki	0.22	n/a	0.00	0.14
male	0.95[a**]	n/a	0.08	0.61
dan_gogiya	0.22	n/a	0.63	0.38
chacalari	0.60[a**]	n/a	1.93	1.11
yafimoro	3.46[a***]	n/a	0.60	2.37
ngolda	0.00[a**]	n/a	0.35	0.13
hannu_giwa	0.52[a*]	n/a	0.00	0.32
korombasau	0.00[a**]	n/a	0.34	0.13
p_9404	0.00	n/a	0.00	0.00
kitsen_damo	0.00	n/a	0.00	0.00
zago	3.04[a**]	n/a	1.09	2.29
ta_kamba	0.00	n/a	0.00	0.00
lara	0.27	n/a	0.04	0.18
shambul	1.21[a**]	n/a	0.00	0.75
jalof	0.00[a***]	n/a	1.69	0.65
bauchi_early	0.00	n/a	0.00	0.00
cidagero	0.00	n/a	0.00	0.00
Other local varieties	5.05[a***]	n/a	11.14	7.38
At least one ICRISAT variety	21.76[a***]	n/a	10.02	17.27
At least one NARS variety	43.24[a**]	n/a	36.19	40.54
At least one NARS or ICRISAT variety	65.01[a***]	n/a	46.21	57.81
Local varieties only	29.00[a***]	n/a	49.68	36.92
At least one recent ICRISAT variety (less than 20 years)	21.76[a***]	n/a	10.02	17.27
At least one recent NARS variety (less than 20 years)	4.16	n/a	4.20	4.17
At least one recent ICRISAT or NARS variety (less than 20 years)	25.92[a***]	n/a	14.22	21.44

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

c) Sources of seed supply

One of crucial elements of adoption of modern varieties is seed availability. This section presents the sources of seed supply in 2009-2010. Table 38 shows that 40% of pearl millet farmers in Mali used their own seed. Other farmers obtained the seeds from their colleagues

(27%) and relatives (30%). In Niger and Northern Nigeria, more than half of pearl millet farmers used their own seed (58% and 66% in Niger and Northern Nigeria respectively). In Niger, the results indicate that 14% of pearl millet farmers obtained the seeds from on-farm trials and 16% from relatives. There are however differences between villages. The on-farm trials were significantly lower in project and diffusion villages (11%) than in control villages (26%). In Northern Nigeria, some farmers obtained seeds from their colleagues (10%) and agricultural development projects (16%). The results indicate that about 20% of pearl millet farmers from project villages in Northern Nigeria obtained seeds from Agricultural Development Projects (ADP) against 8% in control villages. As regards the sorghum seeds, the supply sources were slightly different from those of pearl millet. Table 38 shows that 37% of sorghum producers in Mali obtained seeds from colleagues, 24% from relatives, and 33% used their own seeds. Among sorghum producers in Northern Nigeria, about 64% used their own seeds and the others obtained the seeds from colleagues (13%), relatives (12%), and ADPs (10%).

5.3.3. Constraints to adoption of improved sorghum and pearl millet varieties

Several constraints limit the adoption of the modern pearl millet and sorghum varieties. Table 39 presents the factors preventing the adoption of modern varieties in 2009-2010. The results show that the main reasons of the non-adoption of modern varieties by pearl millet producers in Mali were low yielding of varieties (18%), late maturity of varieties (13%), and high sensitivity of varieties to drought (24%). The same reasons were recorded for sorghum producers. In Niger, the main constraints to adoption were the non-availability of seeds (38%), sensitivity of varieties to diseases (23%), and late maturity of varieties (14%). In Northern Nigeria, pearl millet producers identified three main reasons that justified the non-adoption of the modern varieties: non-availability of seeds (25%), low yielding of varieties (23%), and late maturity of varieties (35%). There are however differences between village types. Table 39 shows that 37% of pearl millet producers from control villages in Northern Nigeria identified non-availability of seeds as main constraint to the non-adoption of the modern varieties against 18% in project villages. About 32% of pearl millet farmers from project villages justified the non-adoption of modern varieties by low yielding of these varieties while they were 8% in control villages. The results also indicate that 50% and 26% of pearl millet farmers from control and project villages respectively identified late maturity of varieties as a constraint to adoption. The same constraints were recorded for sorghum producers. Overall, almost the same factors have been identified as constraints to the adoption of improved pearl millet and sorghum varieties in the three countries. Efforts should be made in the framework of the HOPE project to eliminate all these constraints in order to facilitate a better adoption of modern pearl millet and sorghum varieties.

Table 38: Sources of seed supply of pearl millet and sorghum producers in Mali, Niger and Northern Nigeria, 2009/2010

	Type of village							
Pearl millet varieties	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
On-farm trials	2.59	3.41	1.10	0.00	2.94	3.15	2.30	2.54
Another farmer	25.00	35.84	29.67	39.39	27.94	37.80	26.60	37.14
Relative	31.90	25.94	29.67	24.24	22.06	20.47	29.67	24.28
Own saved seed	39.22	32.42	37.36	31.06	45.59	36.22	39.90	32.97
Grain trader	0.43	0.68	0.00	0.76	0.00	0.00	0.26	0.54
IER	0.00	0.68	0.00	0.00	0.00	0.00	0.00	0.36
ICRISAT	0.00	0.68	1.10	0.76	0.00	0.00	0.26	0.54
NGOs	2.16	2.05	0.00	1.52	0.00	0.00	1.28	1.45
Extension services	1.72	2.05	0.00	0.00	0.00	1.57	1.02	1.45
Cooperatives	0.00	0.00	0.00	0.76	0.00	0.00	0.00	0.18
Seed companies	0.43	0.34	0.00	0.00	0.00	0.00	0.26	0.18
Other sources of seed	1.72	2.05	3.30	3.79	2.94	3.15	2.30	2.72
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
On-farm trials	11.07^{b***}	n/a	11.00^{c**}	n/a	25.76	n/a	13.41	n/a
Another farmer	8.20	n/a	6.00	n/a	4.55	n/a	7.07	n/a
Relative	15.98	n/a	14.00	n/a	18.18	n/a	15.85	n/a
Own saved seed	57.79	n/a	64.00	n/a	51.52	n/a	58.29	n/a
Grain trader	6.15	n/a	4.00	n/a	3.03	n/a	5.12	n/a
IER	0.00^{b*}	n/a	0.00	n/a	1.52	n/a	0.24	n/a
ICRISAT	11.07^{a***}	n/a	0.00	n/a	0.00^{b***}	n/a	6.59	n/a
NGOs	0.82	n/a	1.00	n/a	0.00	n/a	0.73	n/a
Extension services	3.69	n/a	4.00	n/a	7.58	n/a	4.39	n/a
Cooperatives	1.64	n/a	0.00	n/a	1.52	n/a	1.22	n/a
Seed companies	0.00^{b*}	n/a	0.00	n/a	1.52	n/a	0.24	n/a
Other sources of seed	4.51	n/a	4.00	n/a	3.03	n/a	4.15	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
On-farm trials	2.33^{a***}	3.64	n/a	n/a	6.33	4.75	3.82	4.07
Another farmer	9.16	11.26^{a**}	n/a	n/a	12.05	15.30	10.24	12.82
Relative	7.36^{a**}	11.75	n/a	n/a	12.05	13.98	9.11	12.61
Own saved seed	66.61	66.56	n/a	n/a	64.76	61.48	65.92	64.60
Grain trader	0.18^{a**}	0.33^{a***}	n/a	n/a	1.51	2.90	0.67	1.32
IER	0.18	0.17	n/a	n/a	0.00	0.00	0.11	0.10
ICRISAT	0.36	0.00	n/a	n/a	0.00	0.00	0.22	0.00
NGOs	0.72	0.66	n/a	n/a	0.30	0.26	0.56	0.51
ADPs	20.47^{a***}	14.07^{a***}	n/a	n/a	8.13	5.54	15.86	10.78
Seed companies	0.00	0.17	n/a	n/a	0.00	0.00	0.00	0.10
Other sources of seed	0.36	0.17	n/a	n/a	0.90	0.26	0.56	0.20

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Table 39: Constraints to the adoption of improved pearl millet and sorghum varieties in Mali, Niger and Northern Nigeria, 2009/2010

Pearl millet varieties	Type of village							
	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Seed not available	6.38	5.88	11.76	3.13	5.56	10.00	7.32	6.19
Low yielding variety	17.02	19.61	23.53	25.00	16.67	36.67	18.29	25.66
Variety sensitive to diseases	0.00	1.96	0.00	3.13	5.56	3.33	1.22	2.65
Not good in intercropping	2.13	1.96	0.00	0.00	0.00	3.33	1.22	1.77
Lost due to drought	14.89	17.65	0.00	9.38	22.22	13.33	13.41	14.16
Consume all harvest	0.00	1.96	0.00	0.00	0.00	3.33	0.00	1.77
Lack of information on management.	2.13	3.92	0.00	0.00	0.00	0.00	1.22	1.77
Required much fertilizers	2.13	1.96	0.00	3.13	0.00	0.00	1.22	1.77
Late maturity	34.04	41.18	11.76	43.75	11.11	20.00	24.39	36.28
Unacceptable seed color	2.13	3.92	11.76	3.13	0.00	3.33	3.66	3.54
Small size seed	0.00	1.96	5.88	6.25	0.00	0.00	1.22	2.65
Low fodder yield	0.00	1.96	5.88	3.13	0.00	0.00	1.22	1.77
Attack by insects	6.38	1.96	17.65	0.00	0.00	3.33	7.32	1.77
Other constraints	29.79	15.69	17.65	18.75	38.89	6.67	29.27	14.16
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Seed not available	40.00	n/a	31.58	n/a	40.00	n/a	38.10	n/a
Low yielding variety	5.45	n/a	5.26	n/a	0.00	n/a	4.76	n/a
Variety sensitive to diseases	21.82	n/a	26.32	n/a	20.00	n/a	22.62	n/a
Not good in intercropping	3.64	n/a	0.00	n/a	0.00	n/a	2.38	n/a
Variety sensitive to drought	1.82	n/a	0.00	n/a	0.00	n/a	1.19	n/a
Lack of information on mag.	7.27	n/a	5.26	n/a	20.00	n/a	8.33	n/a
Required much fertilizers	1.82	n/a	5.26	n/a	0.00	n/a	2.38	n/a

Late maturity	14.55	n/a	15.79	n/a	10.00	n/a	14.29	n/a
Unacceptable seed color	1.82	n/a	0.00	n/a	0.00	n/a	1.19	n/a
Small size seed	1.82	n/a	5.26	n/a	0.00	n/a	2.38	n/a
Low fodder yield	0.00	n/a	5.26	n/a	0.00	n/a	1.19	n/a
Attack by insects	3.64	n/a	0.00	n/a	10.00	n/a	3.57	n/a
Other constraints	12.73	n/a	15.79	n/a	20.00	n/a	14.29	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Seed not available	17.71[a***]	11.57[a***]	n/a	n/a	37.10	26.36	25.32	18.61
Seed too expensive	2.08	0.83	n/a	n/a	1.61	1.82	1.90	1.30
Low yielding variety	32.29[a***]	36.36[a**]	n/a	n/a	8.06	21.82	22.78	29.44
Variety sensitive to diseases	1.04	2.48	n/a	n/a	0.00	2.73	0.63	2.60
Low market value	6.25	9.92[a***]	n/a	n/a	8.06	25.45	6.96	17.32
Not good in intercropping	2.08	0.83	n/a	n/a	1.61	0.00	1.90	0.43
Variety sensitive to drought	7.29	4.96	n/a	n/a	1.61	9.09	5.06	6.93
Consumed all harvest	8.33	6.61	n/a	n/a	3.23	8.18	6.33	7.36
Lack of information on management	1.04	3.31	n/a	n/a	3.23	0.91	1.90	2.16
Required much fertilizers	3.13	2.48[a*]	n/a	n/a	3.23	0.00	3.16	1.30
Late maturity of variety	26.04[a***]	28.10	n/a	n/a	50.00	37.27	35.44	32.47
Unacceptable seed color	0.00[a*]	1.65	n/a	n/a	3.23	0.00	1.27	0.87
Small size seed	9.38[a***]	4.13	n/a	n/a	0.00	0.91	5.70	2.60
Low fodder yield	0.00	0.83	n/a	n/a	0.00	1.82	0.00	1.30
Attack by insects	0.00	0.83	n/a	n/a	0.00	0.00	0.00	0.43
Other constraints	0.00	4.96[a*]	n/a	n/a	0.00	0.91	0.00	3.03

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

5.4. Sorghum and pearl millet production systems in Mali, Niger and Nigeria

This section presents plot characteristics and production systems of pearl millet and sorghum producers in Mali, Niger and Northern Nigeria in 2009-2010.

5.4.1. Sorghum and pearl millet plot characteristics

The plot characteristics include the number of varieties planted, cropping system, practice of rotation, plot status, and mode of appropriation of plots. As regards the number of improved and local varieties planted, one considers farmers who planted these varieties in their plot. Table 40 shows that pearl millet farmers in Mali planted on average 1.83 and 1.08 improved and local pearl millet varieties respectively. There are however significant differences between village types. The results indicate that the number of improved varieties was significantly higher in the plots located in diffusion villages (2.86) than those from project and control villages (1.35 and 1.50 respectively). Table 40 also shows that 25% of pearl millet plots were intercropped with other crops and 15% practiced crop rotation. The majority of plots were collective. The individual plots are estimated to 13%, inherited plots to 96%, purchased plots to 2.35% and rented plots to 1.18%.

In Niger, pearl millet farmers planted on average 1.25 and 1.11 improved and local varieties respectively. However, in the plots located in project villages, the average number of improved varieties is estimated to 1.32. Table 40 shows that 88% of pearl millet plots were intercropped with other crops and 4% practiced crop rotation. More than a third of plots were individual (38%). About 87% of pearl millet plots were inherited, 6% were rented, 4% were purchased, and 0.34% was the community plots.

Table 40 shows that the average number of improved and local varieties planted in pearl millet plots in Northern Nigeria was estimated to 1.10 and 1.16 respectively. The results also indicate that pearl millet farmers in Northern Nigeria practiced cropping systems and crop rotation over 67% and 28% of their plots respectively. On average 75% of pearl millet plots were individual. About 78% of plots were obtained by inheritance, 19% were purchased, 2% were rented, and 0.21% was the community plots. Similar results are recorded for sorghum plots except for rented and purchased plots located in Mali where the proportions were below 1%.

Table 40: Pearl millet and sorghum plots characteristics in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Number of modern varieties	1.35[a***]	1.70[b*]	2.86[c*]	2.12[c***]	1.50	1.00	1.83	1.59
Number of local varieties	1.09	1.13	1.11	1.12	1.05	1.20	1.08	1.15
Cropping system (%)	27.26	25.39[b**]	24.15	20.19	20.28	16.98	25.07	21.99
Practice of rotation	13.81	14.26[b*]	14.83	14.60[c*]	19.34	18.87	15.20	15.49
Plot status (% individual)	9.17[b***]	7.69[b***]	7.69[c***]	6.56[c***]	22.22	28.07	13.33	15.08
Inherited plot (%)	96.27	96.58	95.00	96.77	96.30	96.55	96.08	96.60
Rented plot (%)	2.24[a***]	2.05[a***]	0.00	0.00	0.00[b***]	0.00[b***]	1.18	0.93
Purchased plot (%)	0.75[a***]	0.68[a***]	5.00	0.00	3.70	0.00b***	2.35	0.31
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Number of modern varieties	1.32[a***]	n/a	1.05	n/a	1.22	n/a	1.25	n/a
Number of local varieties	1.12	n/a	1.06[c***]	n/a	1.17	n/a	1.11	n/a
Cropping system (%)	85.24[b***]	n/a	88.30[c**]	n/a	94.98	n/a	87.75	n/a
Practice of rotation	4.92	n/a	4.26	n/a	1.83	n/a	4.19	n/a
Plot status (% individual)	37.31[a*]	n/a	42.80[c**]	n/a	34.12	n/a	38.11	n/a
Inherited plot (%)	87.70	n/a	82.98[c**]	n/a	90.41	n/a	87.08	n/a
Rented plot (%)	5.93	n/a	8.51	n/a	4.57	n/a	6.29	n/a
Community land (%)	0.14[a*]	n/a	1.06	n/a	0.00	n/a	0.34	n/a
Purchased plot (%)	3.18	n/a	5.67	n/a	4.57	n/a	4.03	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Number of modern varieties	1.15[a***]	1.19[a***]	n/a	n/a	1.07	1.10	1.10	1.13
Number of local varieties	1.18	1.17	n/a	n/a	1.14	1.14	1.16	1.16

Cropping system (%)	61.57[a***]	56.53[a***]	n/a	n/a	74.21	74.22	67.02	63.64
Practice of rotation	28.53	30.25	n/a	n/a	28.00	29.60	28.31	29.99
Plot status (% individual)	79.71[a***]	80.53[a***]	n/a	n/a	69.80	68.19	75.53	75.66
Inherited plot (%)	79.33	74.46	n/a	n/a	77.12	75.89	78.40	75.02
Rented plot (%)	1.82	2.15	n/a	n/a	1.75	2.21	1.79	2.17
Community land (%)	0.18	0.24	n/a	n/a	0.25	0.25	0.21	0.24
Purchased plot (%)	18.58	22.67	n/a	n/a	20.25	20.91	19.28	21.98

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

5.4.2. Sorghum and pearl millet production systems

This section presents the perception of farmers of their production and soil fertility, the use of fertilizers on the pearl millet and sorghum plots, the type of variety and quantity of seeds used by farmers, per hectare yield and quantities produced in 2009-2010.

a) Perception of farmers on production and soil fertility

Table 41 presents the perception that pearl millet and sorghum producers had of their production and soil fertility. The results indicate that pearl millet farmers in Mali thought that 22% of their plots would give a good production against 47% of average production and 30% of low production. There are however significant differences between village types. The proportion of perceptions of good production was significantly low in diffusion villages (14%) than in project and control villages (24% and 27% respectively). Similar results were recorded for the sorghum producers. As regards soil fertility, pearl millet farmers thought that 44% of their plots would have medium fertility against 34% of low fertility, 20% of good fertility, and 2% of very good fertility. There are however significant difference between village types. The plots located in diffusion villages had a high medium fertility (68%) compared to those from project and control villages (45% and 34% respectively). Diffusion villages would have a low rate of good fertility compared to project and control villages where the rates were about 22% and 21% respectively. The results are similar for the sorghum plots.

In Niger, more than half of pearl millet farmers thought that their plots would give a low production in 2009/2010. There were about 34% and 8% of pearl millet plots that would give respectively good and average production. The results on soil fertility show that 47% of pearl millet plots would have a medium fertility against 39% of low fertility, 11% of good fertility, and 2% of very good fertility. However, the results indicate that the proportion of average fertility plots was below average of overall sample in project villages (45%).

Table 41 also shows that pearl millet farmers in Northern Nigeria thought that 44% of their plots would have a good production, 43% an average perception, and 12% a low perception in 2009/2010. However, there were more than 50% of plots located in project villages that would have a good production against 36% in control villages. The results indicate that pearl millet producers from project villages thought that 8% of their plots would have a low production against more than 17% in control villages. With regard to soil fertility, there were about 40% and 39% of pearl millet plots that would have medium and good fertility respectively. There were more good fertility plots in project villages (45%) than in control villages (31%). About 11% and 5% of plots would have very good and low fertility respectively. Similar results are recorded for sorghum plots.

Table 41: Perception of pearl millet and sorghum farmers of production and soil fertility in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Production								
Good production (%)	23.78[a***]	22.14[a***]	13.13[c***]	13.98[c***]	27.47	25.00	22.27	20.92
Average production (%)	48.60[b*]	49.62[b*]	50.51	52.69	40.66	40.00	47.48	48.51
Low production (%)	27.62[a**]	28.24	36.36	33.33	31.87	35.00	30.25	30.57
Soil fertility								
Low fertility (%)	31.75[a**]	37.04[a**]	22.58[c***]	26.92	41.56[b**]	30.91[b*]	33.76	33.00
Medium fertility (%)	45.24[a***]	42.96[a***]	67.74[c***]	57.69[c*]	33.77	50.00[b*]	44.44	48.15
Good fertility (%)	22.22[a***]	19.26[a**]	6.45[c***]	11.54	20.78	15.45	19.66	16.50
Very good fertility (%)	0.79[a***]	0.74[a***]	3.23	3.85	3.90[b***]	3.64[b***]	2.14	2.36
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Production								
Good production (%)	8.64	n/a	5.80	n/a	6.7	n/a	7.61	n/a
Average production (%)	34.39	n/a	37.32	n/a	30.93	n/a	34.51	n/a
Low production (%)	56.97	n/a	56.88	n/a	62.37	n/a	57.88	n/a
Soil fertility								
Low fertility (%)	39.36	n/a	41.13	n/a	34.70	n/a	38.93	n/a
Medium fertility (%)	45.30[b**]	n/a	48.23	n/a	53.42	n/a	47.48	n/a
Good fertility (%)	12.16	n/a	9.22	n/a	10.05	n/a	11.07	n/a
Very good fertility (%)	3.18[a***]	n/a	1.42	n/a	1.83[b**]	n/a	2.52	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)

Production								
Good production (%)	50.52[a***]	51.80[a***]	n/a	n/a	36.56	40.84	44.49	47.30
Average production (%)	40.98[a**]	40.00	n/a	n/a	46.11	42.10	43.19	40.86
Low production (%)	8.51[a***]	8.20[a***]	n/a	n/a	17.33	17.06	12.32	11.84
Soil fertility								
Low fertility (%)	4.06[a***]	3.50[a***]	n/a	n/a	6.88	6.82	5.28	4.83
Medium fertility (%)	32.33[a***]	32.89[a***]	n/a	n/a	49.47	47.17	39.72	38.63
Good fertility (%)	44.70[a***]	43.70[a***]	n/a	n/a	31.16	33.87	38.86	39.75
Very good fertility (%)	15.55[a***]	17.34[a***]	n/a	n/a	6.30	6.59	11.56	13.02

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

b) Use of inputs

This section presents the proportion of plots on which fertilizers and/or manure were used in 2009. Table 42 shows that 98% and 80% of plots of pearl millet producers in Mali were under fertilizer and manure respectively. About 96% and 73% of plots of sorghum producers in Mali were under fertilizer and manure respectively. In Niger, pearl millet farmers used fertilizer and manure on 37% and 86% of their plots respectively. However, fertilizer was relatively more used on plots located in project villages (46%) than those from diffusion and control villages (22% and 32% respectively). The plots under manure were more important in diffusion and control villages than in project villages. In Northern Nigeria, 74% and 57% of plots of pearl millet producers were under fertilizer and manure respectively. Similar results are recorded for sorghum plots. The high use rate of fertilizer and manure in these three countries could explain by the fact we considered the total quantity of fertilizer and manure used by producers on their plots. This includes fertilizer and manure used for other products such as maize, rice, groundnut, cotton, etc. A high use of fertilizers can have a positive effect on productivity and production. This contributes to achieve the objectives defined in the framework of the HOPE project.

Table 42: Proportion of pearl millet and sorghum plots under fertilizer and manure in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(567)	(640)	(236)	(322)	(212)	(318)	(1015	(1280)
Use of fertilizers	99.34	97.49	98.39	95.65	98.1	95.6	98.87	96.56
Use of manure	77.48	72.88	86.29	80.75	80.00	67.92	80.04	73.63
Niger	(691)	n/a	(282)	n/a	(219)	n/a	(1192	n/a
Use of fertilizers	45.73^{a***}	n/a	21.99^{c**}	n/a	32.42^{b***}	n/a	37.67	n/a
Use of manure	83.07^{a***}	n/a	91.84	n/a	89.04^{b**}	n/a	86.24	n/a
Nigeria	(857)	(865)	n/a	n/a	(1132)	(1286)	(1989	(2151)
Use of fertilizers	77.29	76.12^{a**}	n/a	n/a	69.89	71.56	74.1	74.29
Use of manure	56.97	55.75^{a**}	n/a	n/a	58.45	60.34	57.62	57.6

Note: number of plots in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

c) Type of variety used

This section presents the proportion of plots on which were planted local and improved varieties in 2009-2010. Table 43 shows that 67% of pearl millet plots in Mali were under local variety and 33% under improved variety. The results also indicate on average 75% and 24% of pearl millet plots were under local and improved varieties respectively in project

villages. About 45% and 55% of pearl millet plots were under improved and local varieties respectively in diffusion villages. It is estimated to 44% and 56% pearl millet plots under improved and local varieties respectively in control villages. Overall, there were less than pearl millet plots under improved varieties in project villages. The results are almost similar for sorghum plots. In Niger, about 86% and 14% of pearl millet plots were under local and improved varieties respectively. There were more than pearl millet plots in control villages under improved varieties compared to those in project and diffusion villages. About 85% and 15% pearl millet plots in Northern Nigeria were under local and improved varieties respectively in 2009-2010. Table 43 shows that more than 20% of pearl millet plots were under improved variety in project villages against 8% in control villages. The results obtained for sorghum plots are relatively higher than those of pearl millet plots. The sorghum plots under local and improved varieties are estimated to 77% and 23% respectively. The results also indicate that 74% and 26% of sorghum plots were under local and improved varieties in project villages. About 80% and 20% of sorghum plots were under local and improved varieties respectively in control villages.

Table 43: Proportion of pearl millet and sorghum plots under local and improved varieties in Mali, Niger and Northern Nigeria, 2009/2010

	Type of village							
Country name / variables	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(567)	(640)	(236)	(322)	(212)	(318)	(1015	(1280)
Local variety	75.51	75.98	54.67	53.62	55.93	51.92	67.27	66.67
Improved variety	24.49	24.02	45.33	46.38	44.07	48.08	32.73	33.33
Niger	(691)	n/a	(282)	n/a	(219)	n/a	(1192	n/a
Local variety	85.53	n/a	93.26	n/a	79.91	n/a	86.33	n/a
Improved variety	14.47	n/a	6.74	n/a	20.09	n/a	13.67	n/a
Nigeria	(857)	(865)	n/a	n/a	(1132)	(1286)	(1989	(2151)
Local variety	79.59	74.34	n/a	n/a	91.95	80.23	84.92	76.71
Improved variety	20.41	25.66	n/a	n/a	8.05	19.77	15.08	23.29

Note: number of plots in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

d) Yield and production

This section presents per hectare yields and pearl millet and sorghum productions in 2009-2010. Table 44 shows that pearl millet farmers in Mali produced 1.73 tons of pearl millet with yields of 716 kg/ha. Pearl millet production was significantly higher in project villages (1.93 tons) than in diffusion and control villages (1.31 tons and 1.65 tons respectively). Sorghum production is estimated to 1.90 tons with yields of 752 kg/ha. However, farmers from project villages produced about 2.03 tons of sorghum with yields of 719 kg/ha. Yields

obtained are below national averages that are estimated to 939 kg/ha and 1030.5 kg/ha in 2010 for pearl millet and sorghum respectively (FAOSTAT, 2013). In Niger, pearl millet farmers produced on average 1.61 tons of pearl millet with yields of 407 kg/ha. The average yield at the national level was of 530 kg/ha in 2010 (FAOSTAT, 2013). The project villages in Niger produced about 1.7 tons of sorghum. The results indicate that pearl millet farmers in Northern Nigeria produced on average 1.63 tons of pearl millet with yields of 911 kg/ha in 2009-2010. Pearl millet production was higher in non-project villages (1.76 tons) than in project villages (1.52 tons). Sorghum farmers in Northern Nigeria produced 1.45 tons of sorghum with yields of 977 kg/ha. Farmers from project villages had a production level above the average of overall sample (1.52 tons). At the national level, average yields were of 1185 kg/ha and 1440 kg/ha in 2010 for pearl millet and sorghum respectively (FAOSTAT, 2010). Overall, in the surveyed regions, yields of pearl millet and sorghum were low. These findings contribute to reinforce the implementation of the HOPE project in these three countries. One of objectives of this project is to help smallholder farmers increase pearl millet and sorghum productivity and increase their incomes.

Table 44: Pearl millet and sorghum production (kg) and yields (kg/ha) in Mali, Niger and Northern Nigeria, 2009/2010

	Type of village							
Country name / variables	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Production	1931[a***]	2037[a**]	1315	1602	1659	1930	1733	1900
Yield	711	719	654	821	799	752	716	752
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Production	1721	n/a	1495	n/a	1441	n/a	1619	n/a
Yield	415	n/a	388	n/a	407	n/a	407	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Production	1560[a*]	1529[a**]	n/a	n/a	1762	1327	1636	1452
Yield	984[a***]	1044[a***]	n/a	n/a	789	869	911	977

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

5.5. Food security, vulnerability and sources of off-farm income of sorghum and pearl millet producers in Mali, Niger and Nigeria

Improvement in food security is at the heart of all agricultural development programs in development countries. This section describes food security situation, vulnerability status, causes of food insecurity, and sources of off-farm income in Mali, Niger and Northern Nigeria.

5.5.1. Food security situation and vulnerability status

Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO 1996). Several indicators are defined to describe household food security. The indicator used in this study is Food Consumption Score that is defined as a score calculated using the frequency of consumption of different food groups consumed by a household during the 7 days before the survey. It has for objective to approach an indicator of food consumption that can be used to make comparisons between different zones and situations. In addition, food consumption score can be used to determine the vulnerability status of household.

Table 45 presents food security situation and vulnerability status of pearl millet and sorghum farmers in Mali, Niger and Northern Nigeria. The results show that 41% of pearl millet producers in Mali experienced a food security problem during more than 15 days in 2009. There are however significant difference between villages. About 33% of households were in food insecurity in project villages against 48% and 56% in control diffusion villages respectively. Table 45 also shows that food insecurity lasted less than 15 days in project villages in Mali against more than 21 days in diffusion and control villages. Consumption score is estimated to 47.53, which was above the standard cut-offs (28[5] and 42[6]) recommended by Vulnerability Analysis and Mapping Unit of World Food Programme. This means that pearl millet producers in Mali had acceptable food consumption. Food consumption score is estimated to 49.41 in project villages and was significantly higher than that obtained in diffusion villages (42.50). Vulnerability analysis show that 9% of pearl millet farmers were in food security, 34% were at risk i.e. they could any time be in food insecurity, 37% were in moderate food insecurity, and 20% in severe food insecurity in terms of food intake. The results obtained for sorghum producers are similar to those of pearl millet producers.

In Niger, more than 75% of pearl millet producers experienced food security problem during 1 month and 7 days in 2009. The proportions were of 78% in project villages, 73% in

[5] A score below 28 means that household is expected not to eat at least staple and vegetables on a daily base and therefore considered to have poor food consumption.

6 A score between 28 and 42, household is assessed having borderline food consumption, while households that score above 42 are estimated having acceptable food consumption.

diffusion villages, and 71% in control villages. Food consumption score is estimated about 45%. On average, pearl millet producers in Niger had acceptable food consumption. In terms of vulnerability, about 7% of pearl millet producers were in food security, 33% were at risk, 33% in moderate food insecurity, and 27% in severe food insecurity.

Given the missing data, it is impossible to analyze food consumption score and vulnerability status of households in Northern Nigeria. Table 45 shows that more than 18% of pearl millet producers experienced food security during 15 days in 2009. The rate was significantly lower in project villages (16%) than in diffusion villages (23%). The similar results are recorded for sorghum producers.

Table 45: Food security and vulnerability status of pearl millet and sorghum producers in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Food security								
Food security problem (%)	32.93[a***]	31.55[a***]	56.53	50.00	47.73[b**]	45.51[b***]	41.38	39.60
Number of hunger months	0.46[a**]	0.44[a***]	0.79	0.71	0.85[b***]	0.73[b***]	0.62	0.58
Food Consumption score	49.41[a**]	47.31	42.50	42.64	48.10	45.37	47.53	45.65
Vulnerability status								
Severe (%)	17.94	21.47	26.61	28.89	17.14	24.55	19.81	24.11
Moderate (%)	34.88	34.46	41.13	38.33	39.05	35.33	37.17	35.66
At risk (%)	36.88	35.31[a*]	26.61	26.11	35.24	29.94	34.15	31.67
Food secure (%)	10.30	8.76	5.65	6.67	8.57	10.18	8.87	8.56
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Food security								
Food security problem (%)	77.61	n/a	73.33	n/a	70.67	n/a	75.40	n/a
Number of hunger months	1.25	n/a	1.18	n/a	1.35	n/a	1.25	n/a
Food Consumption score	44.68	n/a	43.12	n/a	47.82	n/a	44.84	n/a
Vulnerability status								
Severe (%)	27.03	n/a	27.62	n/a	25.33	n/a	26.88	n/a
Moderate (%)	32.05	n/a	39.05	n/a	26.67	n/a	32.80	n/a
At risk (%)	33.59	n/a	26.67	n/a	38.67	n/a	32.80	n/a
Food secure (%)	7.34	n/a	6.67	n/a	9.33	n/a	7.52	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Food security								
Food security problem (%)	16.21[a***]	16.04[a***]	n/a	n/a	22.90	22.71	18.72	18.59
Number of hunger months	0.36[a***]	0.38[a***]	n/a	n/a	0.64	0.67	0.47	0.49

5.5.2. Causes of food insecurity

Table 46 depicts the causes of food insecurity among pearl millet and sorghum producers in 2009-2010. Production shortfall is appeared as the main cause of food insecurity among pearl millet producers in Mali (60%), Niger (92%) and Northern Nigeria (61%). There are however significant difference between villages in Niger. About 96% of pearl millet producers from diffusion villages identified production shortfall as main cause of food insecurity against 93% in project villages and 80% in control villages. The other causes of food insecurity identified by farmers include decrease in production prices, increase in market prices, and loss of off-farm income. The results are similar for sorghum producers in Mali and Northern Nigeria.

5.5.3. Alternative sources of income of sorghum and pearl millet producers

Pearl millet and sorghum farmers do not only depend on incomes from sales of agricultural products. They have other activities that generate them additional incomes. This section describes the alternative sources of income of pearl millet and sorghum producers in 2009/2010. Table 47 shows that the main sources of off-farm income of pearl millet producers in Mali include migration (26%), petty trade (17%) and agricultural labor (10%). For example, income from migration accounted for 26% of the total amount of off-farm income. Pearl millet farmers in Mali also derived incomes from the sale of shea butter, gold-washing, wood sales, and sewing. The same results are recorded for sorghum producers. The main off-farm incomes of pearl millet producers in Niger consisted of incomes from migration (52%) and petty trade (21%). Some pearl millet producers in Niger obtained additional income from agricultural labor, wood sales, donation, and sewing. Pearl millet producers in Northern Nigeria mainly derived additional incomes from wages (35%), petty trade (23%), and agricultural labor (15%). The other sources of off-farm income consisted of sewing, wood sales, and donation. The same results are recorded for sorghum producers from Northern Nigeria.

Table 46: Causes of food insecurity among pearl millet and sorghum producers in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Production shortfall	65.26	58.04	55.07	48.89	59.18	52.63	60.56	53.60
Decrease in output prices	3.16	2.68	2.90	4.44	4.08	3.95	3.29	3.60
Increase in food prices	8.42	8.04	8.70	10.00	4.08	6.58	7.51	8.27
Loss of non-farm income	8.42	6.25	5.80	4.44	8.16	10.53	7.51	6.83
Other reasons	17.89	27.68	27.54	32.22	28.57	28.95	23.47	29.50
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Production shortfall	93.50[b***]	n/a	96.05[c***]	n/a	80.00	n/a	92.02	n/a
Decrease in output prices	4.00[b*]	n/a	2.63[c*]	n/a	12.00	n/a	4.91	n/a
Increase in food prices	0.50	n/a	0.00	n/a	0.00	n/a	0.31	n/a
Loss of non-farm income	0.50	n/a	0.00	n/a	2.00	n/a	0.61	n/a
Other reasons	1.50	n/a	1.32	n/a	6.00	n/a	2.15	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Production shortfall	61.32	56.07	n/a	n/a	61.11	61.70	61.22	58.71
Decrease in output prices	13.21	14.02	n/a	n/a	14.44	12.77	13.78	13.43
Increase in food prices	12.26	16.82	n/a	n/a	10.00	9.57	11.22	13.43
Loss of non-farm income	3.77	3.74	n/a	n/a	5.56	7.45	4.59	5.47

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.
Source: constructed using survey data carried out in Mali, Niger and Northern Nigeria over the period 2009-2011.

Table 47: Sources of off-farm income of pearl millet and sorghum producers in Mali, Niger and Northern Nigeria, 2009/2010

Country name / variables	Type of village							
	Project village		Diffusion village		control village		Sample overall	
	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum
Mali	(302)	(355)	(124)	(180)	(105)	(167)	(531)	(702)
Shea butter	6907	6395	7665	6736	6343	6399	6973	6484
Migration	33206	27260	31815	28528	17795	13623	29827	24337
Pretty trade	16737	21561	15524	11250	24333	15599	17958	17493
Agricultural labor	7463[a*]	7900	24028	15789	6548	3368	11158	8846
Gold washing	1113[b**]	5282[b*]	1940	8697	10762	13973	3218	8230
Wood sales	3837	3333	5129	3533	2667	2874	3908	3275
Sewing	3023	2571	4032	2778	8476	6138	4340	3474
Other revenue sources	7716	7338	4032	4694	4981	2802	6312	5578
Total of non-farm revenues	108119	109107	109226	96353	99671	76863	106704	98150
Niger	(259)	n/a	(105)	n/a	(75)	n/a	(439)	n/a
Migration	40075	n/a	58429	n/a	32293	n/a	43136	n/a
Petty trade	21434	n/a	16143	n/a	6907	n/a	17686	n/a
Agricultural labor	5658	n/a	1333	n/a	133	n/a	3680	n/a
Wood sales	1366[a*]	n/a	6333[c*]	n/a	400	n/a	2389	n/a
Donation	2288	n/a	2333	n/a	2000	n/a	2250	n/a
Sewing	2799	n/a	1929	n/a	413	n/a	2183	n/a
Other revenue sources	10971	n/a	10333	n/a	1667	n/a	9229	n/a
Total of non-farm revenues	87493[b*]	n/a	99262[c**]	n/a	45480	n/a	83130	n/a
Nigeria	(654)	(667)	n/a	n/a	(393)	(414)	(1047)	(1081)
Petty trade	20650	20139	n/a	n/a	9242	7235	16368	15197
Sewing	8667[a***]	8120[a***]	n/a	n/a	2366	1543	6302	5601
Wages	31096	28796	n/a	n/a	13308	13078	24419	22776
Agricultural labor	4358	3366	n/a	n/a	20407	19341	10382	9484
Donation	2353	2253	n/a	n/a	2179	2158	2288	2217
Wood sales	1716	1549	n/a	n/a	1080	1081	1477	1370
Other revenue sources	2615	2563	n/a	n/a	7140	6898	4313	4223
Total of non-farm revenues	76403	71841	n/a	n/a	58868	54510	69821	65204

Note: Sample size in parentheses. n/a: Not applicable. a: difference between project village and diffusion project, b: difference between project village and control project, c: difference between diffusion village and control project. ***, **, * represent respectively significativity at 1%, 5% and 10% levels.

6. Concluding remarks

Household baseline surveys conducted in Mali, Niger and Northern Nigeria in 2009-2010 in the framework of the HOPE project are a component of the project monitoring and evaluation activities. They constitute a major reference that will enable to assess the performance and impact of project on its beneficiaries.

The surveys generated a lot of data of which analyses reveal interesting information on the socio-economic characteristics of pearl millet and sorghum producers in Mali, Niger and Northern Nigeria. In these three countries, pearl millet and sorghum producers are poor with regard to number and value of their livelihood assets. The rate of formal education is low. The yield levels of pearl millet and sorghum are low. This could explain by the lack of credit, low use of improved varieties, and use of traditional equipment in production systems. Only one third of the surveyed households have access to credit in Mali and Niger. The rate is of 10% in Northern Nigeria. The results showed that the marketable surpluses of pearl millet and sorghum are low compared to other products such rice, maize and groundnuts. This is due to the fact that pearl millet and sorghum are mainly self-consumption products in most of West African countries, only a small share is allocated to market.

With regards to rate of adoption of modern varieties, the results revealed that pearl millet and sorghum producers in Mali, Niger and Northern Nigeria have planted very little of improved varieties in their plots. Several reasons explain this low rate of adoption of modern varieties, the most known of which being low yielding of varieties, late maturity of varieties, highly sensitive of varieties to drought and non-availability of seeds. Other reasons could also explain the low ratio of adoption such as low education level of producers and limited access to credit. Less educated households are less receptive to new technologies. The lack of credit limits investment opportunities and forces the farmers to be limited to their production patterns.

Efforts should be made in the framework of the HOPE project for ensuring better access to good quality seeds and facilitate wider adoption of improved of pearl millet and sorghum and use of modern technologies. The challenges of access to credit and markets by pearl millet and sorghum producers should be addressed to enable to farmers to increase their volume of production and their incomes in order to improve household food security defined by the HOPE project managers.

As regards the data collection, project managers should be ensure that villages and households of baseline survey are selected and interviewed in future surveys that will serve to assess the impact of project. This is to ensure that, baseline data constitute a good benchmark to impact analysis.

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