Men harvest fonio in Bolimasso, Mali. Credit G. Meldrum/ Bioversity International

Underutilized crops in the livelihoods, diets, and adaptation practices of smallholders in Sikasso and Ségou, Mali

Baseline results from the programme "Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk"

Table of contents

Contributors

This analysis and report were prepared in the context of the Project “Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk” supported by the International Fund for Agricultural Development (IFAD), the European Union, and the CGIAR Research Programme on Climate Change, Agriculture and Food Security (CCAFS) from 2015-2018. The analysis has been made possible by the efforts of the Project coordination and implementation teams from Bioversity International and l’Institut d’Economie Rurale (IER), as well as many contributors to the design of the survey tools.

Project coordinators

Stefano Padulosi (Global Project Coordinator, Bioversity International)

Amadou Sidibe (Project Coordinator for Mali, IER)

Implementation and field teams

Harouna Coulibaly, Souleymane Dembélé, Brahima Dembélé, Adizatou Sogodogo, Siaka Samaké (IER)

Gaoussou Diawara (Centre d'Appui à l'Autopromotion pour le Développement)

Oumar K. Coulibaly (Aide au Sahel et à l’Enfance au Mali)

Analysis and report

Gennifer Meldrum, Gaia Lochetti, Gaia Gullotta, and Annelie Bernhart (Bioversity International)

Key advisors

Jessica Raneri, Gina Kennedy, Jacob van Etten, Elisabetta Gotor (Bioversity International)

The questionnaires were designed in a consultative process starting with working groups on best indicators at the Project launch conference, followed by rounds of comments on the questionnaires by the Project coordination team and conference participants (Padulosi et al 2016). The translation of the survey into French was performed by Helène Botreau (Bioversity International) with support from the team in Mali.

Citation

Bioversity International and IER. 2017. Underutilized crops in the livelihoods, diets, and adaptation practices of smallholders in Sikasso and Ségou, Mali: Baseline results from the programme “Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk”. Rome, Italy.

Abbreviations

Bom	Boumboro village, Cercle de Tominian, Ségou region, Mali
Bol	Bolimasso village, Cercle de Tominian, Ségou region, Mali
Bun	Bountenisso village, Cercle de Tominian, Ségou region, Mali
CBO	Community based organization
CGIAR	Consultative Group for International Agricultural Research
DAP	Diammonium phosphate
EU	European Union
Excl	Excluding
Fin	Finkoloni village, Cercle de Koutiala, Sikasso region, Mali
Ha	Hectares
HFIAS	Household food insecurity and access scale
IER	Institut d'Economie Rurale
IFAD	International Fund for agricultural development
Incl	Including
Kan	Kaniko village, Cercle de Koutiala, Sikasso region, Mali
NGu	N'Gountjina village, Cercle de Koutiala, Sikasso region, Mali
NGO	Non-governmental organization
PPI	Progress out of poverty Index
Project	The IFAD and EU supported initiative "Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk"
Seg	Villages surveyed in Ségou region of Mali
Sik	Villages surveyed in Sikasso region of Mali
Sir	Siramana village, Cercle de Sikasso, Sikasso region, Mali
Som	Somo village, Cercle de San, Ségou region, Mali
UACT	Union des Agriculteurs du Cercle de Tominian

Executive summary

The programme “Linking agrobiodiversity value cahins, climate adaptation and nutrition: Empowering the poor to manage risk” funded by IFAD and the European Union from 2015 to 2018 aims to strenghten the capacities of farmers to manage risks associated with climate change, poor nutrition status, and economic disempowerment through agrobiodiversity-based solutions. Enhancing productivity and promoting use of nutritious and climate-hardy underutilized species is the core of the initiative, which is focusing on fonio, Bambara groundnut and native vegetables in six villages in Sikasso and Segou regions of Mali. The approach is two-prong, involving on one hand, targeted value chain interventions for fonio and Bambara groundnut, and on the other hand, exploratory work to prioritize native vegetables and other underutilized crops that can fill nutrition gaps in critical seasons. A holistic approach addressing multiple bottlenecks in supply and demand is being applied for fonio and Bambara groundnut, engaging consultation and participation of multiple stakeholders to ensure the interventions are pro-poor and gender-sensitive and to advocate for supportive policies.

This baseline household assessment provided an overview of the production and livelihood systems of 414 households in the six villages targeted by the project and two control villages. This analysis is a beginning point for more detailed analysis on the value chains of our target species, the varieties cultivated and their unique characteristics, the native vegetables collected for consumption and sale, the relevance of these species in the livelihoods of men and women, and adaptation to the threats of climate change.

The results reveal useful insights to guide project actions and provide a snapshot of the systems prior to intervention that can help in documenting the impact of the project. The survey documented the level of cultivation, commercialization and consumption of fonio and Bambara groundnut, as well as other crops cultivated in local production systems. Fonio and Bambara groundnut were by no means negligible in the livelihoods of the focal communities. Approximately half of the households were growing Bambara groundnut, albeit in a fairly small area (mean 0.4 Ha) and 18% were making an income from this crop. Fonio was a popular crop in Ségou, where it was grown by three quarters of surveyed households but it was much more rarely grown in the villages surveyed in Sikasso region. Fonio was grown in larger areas than Bambara groundnut (mean 0.8 Ha) but in smaller area than other cereals. Twelve percent of households were making an income from fonio. While fonio and Bambara groundnut made only a minor contribution to the incomes of the surveyed households, they did have distinct roles in the food security and nutrition. The consumption of fonio and Bambara groundnut was notably high during periods of food insufficiency, which peak in August but occur May to October.

The diet surveys conducted in October revealed relatively low consumption of dark green leafy vegetables, other vitamin-A rich fruits, vegetables, nuts and seeds, pulses, meat, poultry, fish, and dairy—especially among women who had not reached minimum dietary diversity. Underutilized foods in these food groups would be important to promote, along with fonio for more balanced nutrition. The potential for Native African vegetables to support increased consumption of vegetables under water-limited conditions will be explored further in the Project.

Introduction

Increasingly arid conditions and a delayed start to the rainy season are challenging agricultural production in Mali and exacerbating existing issues with chronic food insecurity and malnutrition. Native, underutilized crops, such as fonio (*Digitaria exilis*) and Bambara groundnut (*Vigna subterranea*) are well-adapted to the arid conditions of the Sahel and can help secure production under climate change (Butt et al 2005; Azam-Ali 2007; Traore et al 2017). Traditional crops have nevertheless received little attention from research and development efforts, which have focused on a narrow basket of commodities that have mostly been introduced from outside of Africa. Traditional crops face numerous constraints to enhance their use but with some attention can play key roles in diversifying farm systems for better nutrition and resilience (Tadele & Assefa 2012, Ebert 2014).

Holistic value chain approach

The programme "Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk" aims to strengthen the capacities of farmers to manage risks associated with climate change, poor nutrition status, and economic disempowerment through agrobiodiversity-based solutions. Enhancing productivity and promoting cultivation and use of nutritious and climate-hardy underutilized species is the core of the initiative, which is focusing on fonio (*Digitaria exilis*), Bambara groundnut (*Vigna subterranea*), and native vegetables. A holistic approach addressing multiple bottlenecks in supply and demand of the target crops is being applied, engaging consultation and participation of multiple stakeholders to ensure the value chain interventions are pro-poor and gender-sensitive and to advocate for supportive policies (Padulosi et al. 2014, 2015).

Fonio (*Digitaria exilis*, *Digitaria* sp.)


Fonio. Credit G. Meldrum/ Bioversity International

Fonio has been cultivated in Sahelian West Africa for thousands of years. Because of the short time to maturation, fonio holds a central place in the food security strategy of rural families during the lean period before millet and sorghum are harvested (Vall et al. 2011). Crops with shorter growth cycles, such as fonio, will be increasingly important to secure food production under climate change (Challinor et al. 2016). Fonio contains essential amino acids methionine and cysteine, which are deficient in rice (*Oryza sativa*), wheat (*Triticum* spp.), maize (*Zea mays*), and sorghum (*Sorghum bicolor*) (Tadele & Assefa 2012; Adoukonou-Sagbadja et al. 2006). It is considered one of the best tasting African cereals, appreciated by all levels of society (Adoukonou-Sagbadja et al. 2006). The grain carries a high market price, which is an income-earning opportunity for producers on marginal lands but also a barrier for cash-limited consumers (Foltz 2010). The small size of the grain and numerous seed coats makes fonio very tedious and time consuming to process and cook, which are primary constraints limiting use of the crop (Foltz 2010).

Bambara groundnut (*Vigna subterranea*)


Bambara groundnut. Credit S. Padulosi/ Bioversity International

Bambara groundnut, known as *voandzou* in Mali, is the third most important legume in Mali (Mkandawire 2007). It has an advantage over peanut (*Arachis hypogaea*) and cowpea (*Vigna unguiculata*) in terms of adaptation to poor fertility soil, drought tolerance, and resistance to pests and disease (Hillocks, Bennett & Mponda 2012; Brink & Belay 2006). This native crop was displaced in West African production systems when peanut was introduced from the Americas in the colonial period (Azam-Ali et al. 2001). Bambara groundnut is considered a 'complete food' with an adequate complement of protein, carbohydrates and fat (Azam-Ali et al. 2001). It is often cultivated by women subsistence farmers and could be an important income opportunity for these producers. Bambara groundnut is generally under-researched and the most important constraints in Mali are not well documented.

Native vegetables


West African sorrel. Credit G. Meldrum/ Bioversity International

Communities in Mali cultivate and collect a variety of vegetables that provide important sources of nutrients for more balanced diets (Nordeide et al 1996, Takenaka et al 2013). Many of the vegetables used by rural African communities are wild or semi-domesticated species that are native to the region (Ojiewo et al. 2013). However, production for the market is often oriented to globally important vegetable species that have been introduced from outside the continent (e.g. Osei-Kwarteng et al. 2012, Tchientche Kamga et al. 2016). Demand for indigenous African vegetables is increasing in many parts of Africa as a result of promotion and awareness raising efforts, among other trends (Cernansky 2015). In Mali, demand for leaves of West African sorrel (*Corchorus* sp.) has increased in recent years and there is indication that the full potential for marketing this native vegetable has not yet been realized and could bring significant revenue to producers (Pasquini et al. 2009). The vegetables cultivated by communities were documented in the current study to help identify species that can improve nutrition, income and climate resilience through greater use. Many vegetables introduced to Africa have been naturalized over hundreds of years and form part of traditional cuisine, e.g. sweet potato (*Ipomea batatas*) and cassava (*Manihot esculenta*). However, the focus on this work was on native vegetables that originated in Africa and which have largely been neglected by agricultural research and development.

Baseline study

Household survey

The Project is targeting six communities in Ségou and Sikasso regions of Mali (Figure 1, 2). The villages were selected based on having a higher level of cultivation and varietal diversity of the target crops, threat of these plant genetic resources from cash cropping (e.g. cotton), and involvement of women in income generation from the target crops. The six target villages were surveyed in October 2015 along with one additional village in each region to serve as controls. We aimed to survey 50 households in each village to have a balanced sample size. In Somo, a slightly higher number of farmers was surveyed (N=60) because of the large size of the village and willing participation of the farmers. The sampling of households within villages was done randomly with the technical assistance of local resource farmers but was dependent on engagement of the respondents. Details on the surveyed villages and sample sizes are reported in Table 1. The total sample size was 414 households, including 210 in Ségou region and 204 in Sikasso region.

Table 1. Villages targeted for the baseline study in Mali and number of households surveyed

Region	Village	Abbrev	Group	Population	# households in community	# households surveyed
Ségou	Boumboro	Bom	Treatment	312	46	50
	Bolimasso	Bol	Treatment	478	104	50
	Somo	Som	Treatment	2520	535	60
	Bountenisso	Bun	Control	908	199	50
Sikasso	Siramana	Sir	Treatment	2127	302	50
	Finkoloni	Fin	Treatment	1980	279	54
	N'Gountjina	NGu	Treatment	3372	437	50
	Kaniko	Kan	Control	2210	284	50

Questions in the survey pertained to household assets, the production system (crops and livestock), income sources, management and income from the target crops, consumption of target crops, food and nutrition security, dietary diversity, climate change adaptation practices, information received on climate change, and participation of household members in community institutions (see questionnaire in Padulosi et al. 2016). The survey sought responses from the head man and woman of the household. Some questions were directed to the male respondent, particularly those about landholdings, farm production, and sale of the target crops. Other questions were targeted at the female respondent, especially those concerning consumption in the household (e.g. diet, food insecurity, and consumption of the target crops), gender roles in crop management and participation in community institutions. Questions relating to climate change adaptation actions being applied and information received on climate change were directed to both the male and female respondent.

The current document summarizes the main results of the baseline household survey with the aim to guide further investigation and actions in the Project. The analysis focuses on visualizing and identifying key patterns in the data. Comparisons are made between communities and regions for orientation but statistical tests were not performed, so the differences discussed here are not necessarily significant. The analysis was performed in R (Version 3.02 R Foundation for Statistical Computing) and Excel (Microsoft 2013).

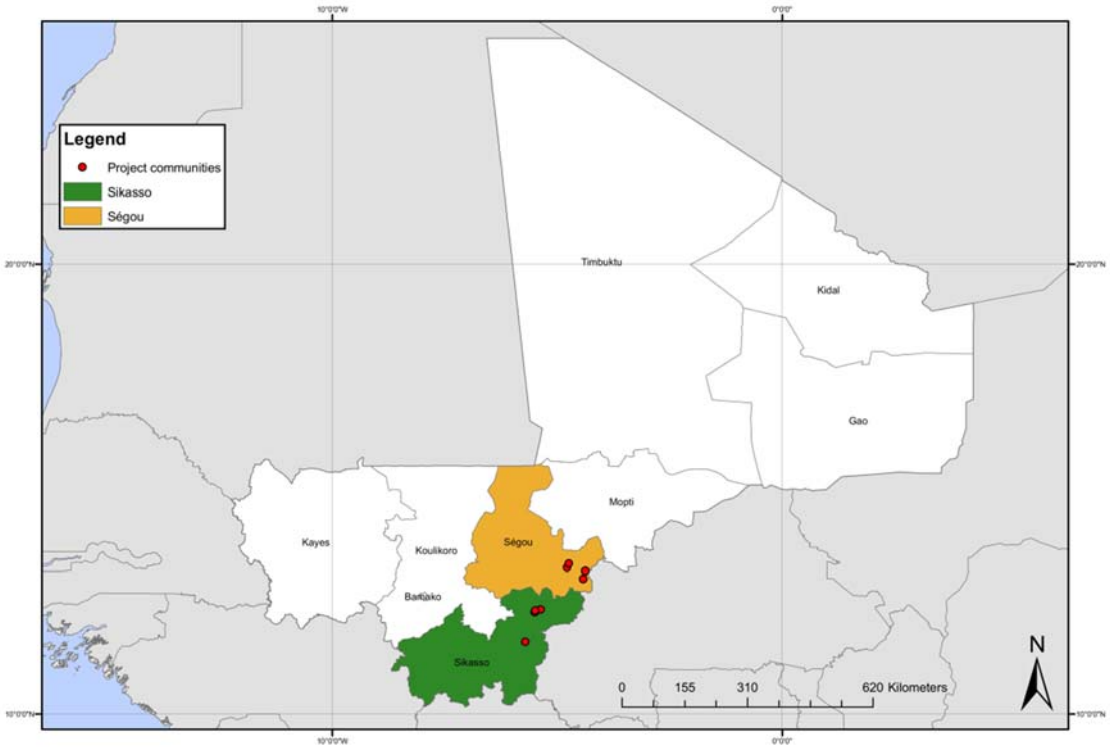

Figure 1. Targeted regions of the IFAD-EU NUS Project in Mali

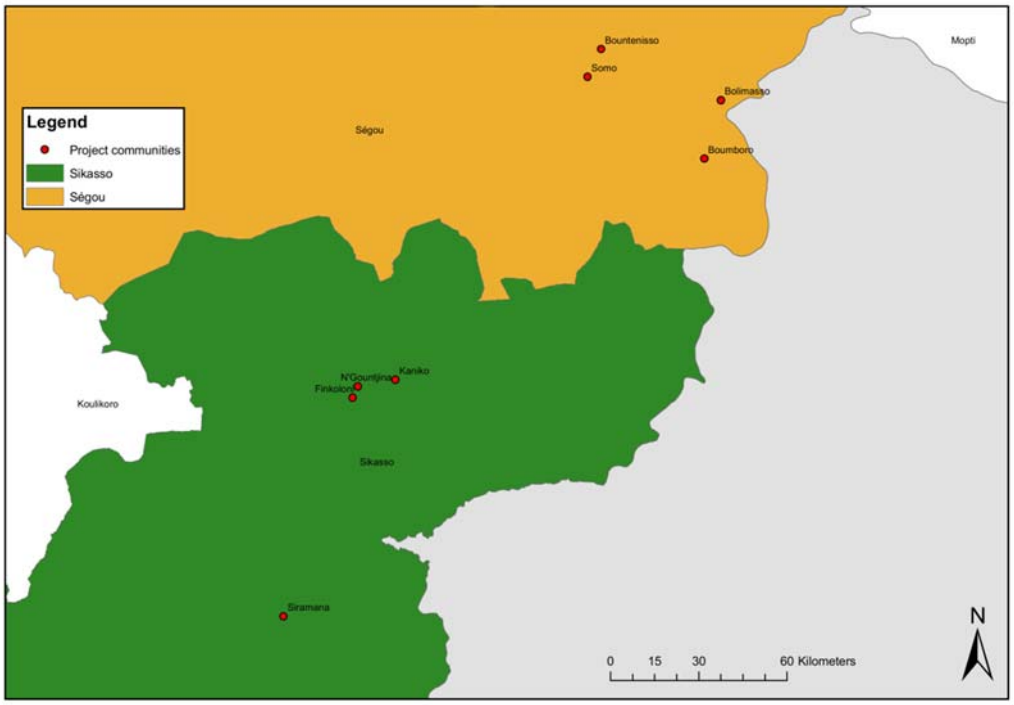

Figure 2. Targeted villages of the IFAD-EU NUS Project in Sikasso and Ségou regions of Mali

It is noted that crop species and varieties were denoted by common name in the surveys so the precise species identification could not be made for every species. Further work is required for some crops to assess the precise species name where several species could be associated to one common name or for which the common name was in local language the scientific name of the species was unknown to the investigators. More work is also needed to control for synonyms in variety names between households and communities. This is ongoing work in the Project.

Focus group discussions

Focus groups were performed in the six project villages and two control villages in Ségou in October 2015 and in Sikasso in January 2016. The aim of the discussions was to collect orienting information about the communities to guide decisions in the Project and support interpretation of the household survey. The questions were focused on the crop and livelihood systems of the study communities, observations of climate change, soil degradation and changes in pest and disease, as well as mapping the institutions that currently exist in the communities (Padulosi et al 2016). All the community members were invited to participate in the discussions, for which a total of 576 farmers participated—61% women (Table 2). The main highlights of these discussions—particularly where they relate to the findings of the household survey—are shared throughout this document in blue boxes. All other results shared in the document are from the household surveys.

A notable methodology applied in the focus groups was five cell analysis. This rapid rural appraisal method collects an inventory of crop species or varieties grown by a community and the relative number of households growing each crop in which relative area. The crop species or varieties fall in four cells: 1) grown by many households in large areas, 2) grown by many households in small areas, 3) grown by few households in large areas, and 4) grown by few households in small areas. A fifth cell documents the species or varieties lost by the community. This fifth cell is an adaptation of the four cell analysis method (Rana et al 2005), which provides further insight on the conservation risk of crop resources in the community. Five cell analysis was performed at the crop species level and at the variety level for fonio and Bambara groundnut during the focus groups. During the exercise, the participants also reflected on the gendered management for the crops and varieties, noting whether it is mostly men, women or both genders responsible for each crops' cultivation.

Table 2. Dates and participation details for the baseline focus group discussions

Region	Community	Date of focus group	Number participants	% female
Ségou	Somo	27 October 2015	31	38.7
	Bolimasso	27 October 2015	34	50.0
	Bountenisso	28 October 2015	31	74.2
	Boumboro	26 October 2015	80	67.5
Sikasso	Siramana	21 January 2016	37	56.8
	Kaniko	19 January 2016	66	30.3
	Finkoloni	22 January 2016	165	69.1
	N'Gountjina	20 January 2016	132	68.2
Total			**576**	**60.9**

Respondent and household characteristics

Gender

Eighty-six percent of households surveyed met the sampling targets for interviewing both the head man and woman of the household (Table 3). Eleven percent of the households (N=46) had a male and female respondent but at least one was not the head of household. In 11 of these households, the head woman was interviewed but not the head man. In 35 households, both the man and woman interviewed were not the household heads. The remaining 11 households (3%) had only one respondent. Of these, three were woman-headed households in which only the female head was interviewed. In four cases only the head man was interviewed and in two cases only head woman interviewed. In two cases, a younger male was interviewed who was not the head of household. Some of these households may be considered for exclusion in more advanced analyses. For the current assessment, all households have been retained. In total there were 409 male respondents and 408 female respondents.

Table 3. Type of men and women interviewed

Male	Female	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Head	Head	356	191	165	44	45	48	54	42	43	45	35
Other	Head	11	4	7	2			2	1		3	3
Other	Other	36	11	25	4	4	2	1	8	7	2	8
Head	No respondent	4	2	2				2				2
No respondent	Head	5	2	3		1		1	3			
No respondent	Other	2		2								2
Total men interviewed		**409**	**208**	**201**	**50**	**49**	**50**	**59**	**51**	**50**	**50**	**50**
Total women interviewed		**408**	**208**	**200**	**50**	**50**	**50**	**58**	**54**	**50**	**50**	**46**

Age and education

The age and education of the respondents is shown in Table 4. Male respondents ranged from 18 to 86 years of age, with a mean age of 49. Female respondents ranged from 15 to 70 with a mean age of 41. The level of education with generally low, with at least three quarters of male and female respondents having received no formal education. The mean number years of formal education for female respondents was 0.38 years, as compared to 0.8 years for male respondents. It is noted that traditional education and literacy in local language was not captured by this assessment.

Ethnicity

The households surveyed included a total 15 distinct ethnicities (Table 5). The most common ethnicities were Bobo (39%), Minianka (34%), Dafing (11%), and Senoufo (8%). Three of the villages in Ségou were largely Bobo, whereas one village (Boumboro) was mainly Dafing. In Sikasso, three of the villages were Minanka, while the village of Siramana was largely Senoufo. More minor ethnicities in our sample were Bamanan, Bambara, Bozo, Dogon, Forgeon, Griot, Koule, Malinke, Peulh, and Samogo.

Table 4. Age and years of formal education of the respondents

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Male respondent											
Mean Age	49	48	51	44	42	50	54	54	53	50	46
Min age	18	18	20	18	26	25	33	30	27	20	22
Max age	86	85	86	85	70	80	77	86	80	79	70
Mean education (years)	0.38	0.12	0.63	0.06	0.29	0.00	0.13	0.48	0.50	1.54	0.09
Min education	0	0	0	0	0	0	0	0	0	0	0
Max education	14	14	11	9	14	0	6	8	9	9	11
Female respondent											
Mean age	41	40	41	37	35	42	47	43	40	42	38
Min age	15	15	18	15	17	20	20	20	18	21	20
Max age	70	70	70	70	65	65	70	67	70	63	60
Mean education (years)	0.38	0.12	0.63	0.06	0.29	0.00	0.13	0.48	0.50	1.54	0.09
Min education	0	0	0	0	0	0	0	0	0	0	0
Max education	14	14	9	3	14	0	6	9	9	5	3

Table 5. Ethnicity of respondents in household survey—most were mixed ethnicity households

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Bobo	160	159	1	50		50	59			1	
Minanka	141		141					51	45	44	1
Dafing	47	47			47						
Senoufo	35		35							2	33
Griot	13	3	10	1	1	1				1	9
Peulh	10		10						2		8
Bamanan	9	2	7		1		1	2	3		2
Malinke	5		5								5
Forgeron	4	3	1		2		1		1		
Dogon	3		3					1		1	1
Bambara	2		2							2	
Koule	1		1					1			
Bozo	1	1			1						
Samogo	1	1			1						

Household size and composition

The size of the households ranged from 2 to 61 with a mean of 14 inhabitants (Table 6). Households were generally larger in Sikasso region, where higher mean and maximum family sizes were seen. The households were composed of the head of household and his family (wives, children, and/or grandchildren) and in some cases the siblings of the head of household, their families, and/or their elderly parents. In 82% percent of the households, the heads lived with their young children, while in fewer households (16%) the heads lived with their older children and grandchildren. In a few cases (2%), the heads of household were not living with their own children.

Forty-two percent of the heads of household had multiple wives. Polygynous households were less common in Ségou, where men also had fewer wives on average (mean of two wives versus four in Sikasso). Counting the sisters-in-law and daughters-in-law of the household head, as well as his wives, the mean number of family units in the household was three overall —two in Ségou and four in Sikasso. The ratio of

adult women to men among adults was slightly biased toward women (mean 60%). The mean number of children in the house was seven overall (Table 6). There were slightly more children on average in households in Sikasso.

Table 6. Size and composition of surveyed households

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Mean household size	14	11	17	9	12	12	11	17	17	15	21
Generation of the household (offspring of the head of household)											
# households with head with no children	8	3	5	2	0	0	1	1	1	2	1
# households with head living with children	342	180	162	44	44	42	50	46	38	41	37
# households with head living with children and grandchildren	64	27	37	4	6	8	9	7	11	7	12
# households with parent/s of heads	25	16	9	5	3	5	3	0	2	3	4
Mean # of family units*	3	2	4	1	2	2	2	4	4	4	5
# household heads with multiple wives	175	60	115	3	15	14	28	24	23	29	39
Mean # of wives of head of household	2	2	2	1	2	2	2	2	2	2	2
Mean prop. of adults in the household that are female	0.6	0.5	0.6	0.5	0.6	0.5	0.6	0.6	0.6	0.6	0.6
Mean # of children	7	6	8	5	6	6	5	7	7	8	10

*married women in household - wives, daughters-in-law, sisters-in-law of head of household

Education and labor in the household

Of all the members of the households, very few had achieved any level of formal education (Table 7). The maximum education achieved by anyone in the household was fairly low on average (mean 1.7 years). In Ségou, households had more members with some level of formal education. The maximum number of years of education achieved by anyone in the household was also higher on average in the villages surveyed in Ségou than those surveyed in Sikasso (mean maximum 2.7 years vs 0.7). It is noted that this question did not capture traditional education and literacy in the local language.

A mean of eight household members were available to help with farm labor at any point over year. A higher number of family members were available to help with farm work in Sikasso, reflecting the larger household sizes in this region. The ages of farm helpers ranged from 1 to 86, but most were between the ages of 14 and 50 years of age (mean minimum and maximum ages). Forty-seven percent of households were hiring laborers from outside the household to assist with farm work, which was more common in Sikasso than in Ségou region (Table 7).

Table 7. Education level and labor availability in the surveyed households

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Mean # household members with any education	1	2	0	3	1	7	0	0	0	0	1
Max. education of anyone in household (mean # of years)	1.7	2.7	0.7	3.5	2.4	3.2	1.9	0.5	1.4	0	0.9
Mean # household members available to help on farm at any point of year	8	6	10	5	6	6	6	9	9	9	12
# households hiring workers	196	88	108	16	31	12	29	26	26	26	30

Wealth

The progress out of poverty index (PPI) was used as an indicator of wealth for the surveyed households (Grameen Foundation 2016). The index is based on 10 country-specific questions, which assess household characteristics and assets. For Mali, the questions related to the primary material for the roof and walls of their house, the primary water source, type of latrine, and whether the household had a television, radio, iron, or motorbike (Schreiner 2010). The answers to each question were matched to defined categories with associated scores. The sum of the scores for each question gives the PPI score, which ranges between 0 and 100 and is linked to a standardized set of poverty likelihoods. Lower PPI scores indicate higher probability of poverty.

The mean progress out of poverty index score for the households sampled was 39 (Table 8). The mean poverty likelihood by the national poverty line was 72% (Schreiner 2010). Households in Sikasso were a slightly more likely to fall under the national poverty line than households in Ségou (mean poverty likelihood 74% versus 70%). The village with the lowest poverty likelihood was Somo and the village with the highest poverty likelihood was N'Gountjina (Table 8).

Table 8. Progress out of poverty index (PPI) score and poverty likelihood of surveyed households

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Mean PPI score	39	40	38	40	40	38	42	40	39	34	37
Poverty likelihood (% below national poverty line)											
Mean (%)	72.0	69.8	74.3	70.5	71.9	71.9	65.6	70.0	73.7	79.6	74.4
Min (%)	5.6	5.6	7.2	7.2	21.3	7.2	5.6	7.2	21.3	21.3	24.9
Max (%)	98.4	98.4	98.4	94.2	94.2	98.4	98.4	94.1	94.2	98.4	94.1

Farm characteristics

Land

The landholdings of the surveyed households are summarized in Table 9. The mean landholding size for all the households surveyed was 13.8 Ha. The smallest landholdings were 0.5 Ha and the largest landholdings were 106 Ha. The mean number of parcels held by households was 5.7, with a mean distance of 2 km between the furthest plots. The longest distance between parcels held by a household was 15 km. Households in Sikasso had access to larger areas of land than households in Ségou (mean 20 Ha compared to 8 Ha) but the number of parcels held and the distance between them was similar.

Farmers owned most of their land. Relatively few households were renting land (13%) or cultivating on communal lands (4%) (Table 10). Just six households did not own any land and were cultivating exclusively on rented land (2 in Somo, 2 in Bolimasso, 1 in Boumboro and 1 in N'Gountjina). For four households—all in Somo village—it was not indicated whether their land was rented or owned, which could be an error in data collection or could indicate their landholdings fell under a different tenure arrangement than those considered in the questionnaire.

Table 9. Land profile of the surveyed households

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Mean landholdings(Ha)	13.8	8.4	19.5	9.9	6.3	7.4	9.7	19.9	21.8	15.2	21.0
Min. landholdings (Ha)	0.5	0.5	0.5	0.5	2.0	1.4	1.0	1.0	1.25	1.0	0.5
Max. landholdings (Ha)	106.0	52.2	106.0	52.2	19.5	24.3	32.0	61.3	106.0	95.0	88.0
# of parcels held	5.7	5.8	5.7	6.1	5.8	5.8	5.4	6.4	5.8	5.5	5.0
Mean distance between furthest parcels (km)	2.4	2.0	2.8	2.5	1.6	3.0	1.1	3.4	2.7	3.0	2.0
Maximum distance between furthest parcels (km)	15	15	15	8	11	15	8	11	12	15	7

Table 10. Land ownership of the surveyed households

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Land owned (Ha)	14.2	8.2	20.3	10.0	6.2	7.3	9.1	20.1	22.4	16.2	22.7
# renting land	54	38	16	12	11	7	8	2	5	5	4
Mean area rented (Ha)	2.3	1.9	3.0	2.5	1.2	1.7	2.3	1.5	2.1	3.6	4.1
# cultivating on communal lands	15	12	3	1	4	2	5	1	1	1	0
Mean area of communal land cultivated (Ha)	0.6	0.2	1.9	1.5	0.0	0.1	0.2	1.0	2.0	2.8	-
# renting land to others	99	43	56	16	7	8	12	11	16	18	11
Mean area rented (Ha)	3.7	2.2	5.0	2.1	1.2	1.6	3.1	3.7	4.0	3.9	9.2

Land was allocated to different uses is described in Table 11. The largest areas were devoted to rainfed cultivation. Only 8% of households had any area under irrigated cultivation and the irrigated area was relatively small (mean 1 Ha). Irrigated cultivation was more common in Ségou than in Sikasso. In accordance with the larger landholdings in Sikasso region, areas for rainfed and irrigated cultivation, homegardens, pasture and forest were larger on average in this region than in Ségou.

Table 11. Number of households allocating land to different uses and mean area (excl. zeros)

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
# with rainfed cultivation	411	208	203	49	50	50	59	53	50	50	50
Rainfed area (Ha)	10.0	5.9	14.2	6.6	5.4	5.7	5.8	12.5	16.7	10.2	17.6
# with irrigated cultivation	35	29	6	4	5	13	7	3	1	1	1
Irrigated area (Ha)	1.0	1.0	1.1	1.2	0.1	0.9	1.7	0.4	0.5	0.5	4.5
# with a garden	141	38	103	10	9	6	13	23	35	29	16
Garden area (Ha)	0.6	0.2	0.8	0.3	0.1	0.1	0.1	0.5	0.6	0.8	1.7
# with a pasture	69	6	63	1			5	26	10	19	8
Pasture area (Ha)	3.5	4.9	3.4	20.0			1.9	2.7	3.8	4.2	2.9
# with area under fallow	213	111	102	23	25	27	36	42	25	19	16
Fallow area (Ha)	4.6	3.7	5.7	5.7	1.7	2.2	4.8	5.4	6.2	4.9	6.7
# with forest on property	60	14	46	3	2		9	15	10	12	9
Area forest	3.4	3.1	3.5	2.9	0.6		3.7	4.1	3.6	3.3	2.4

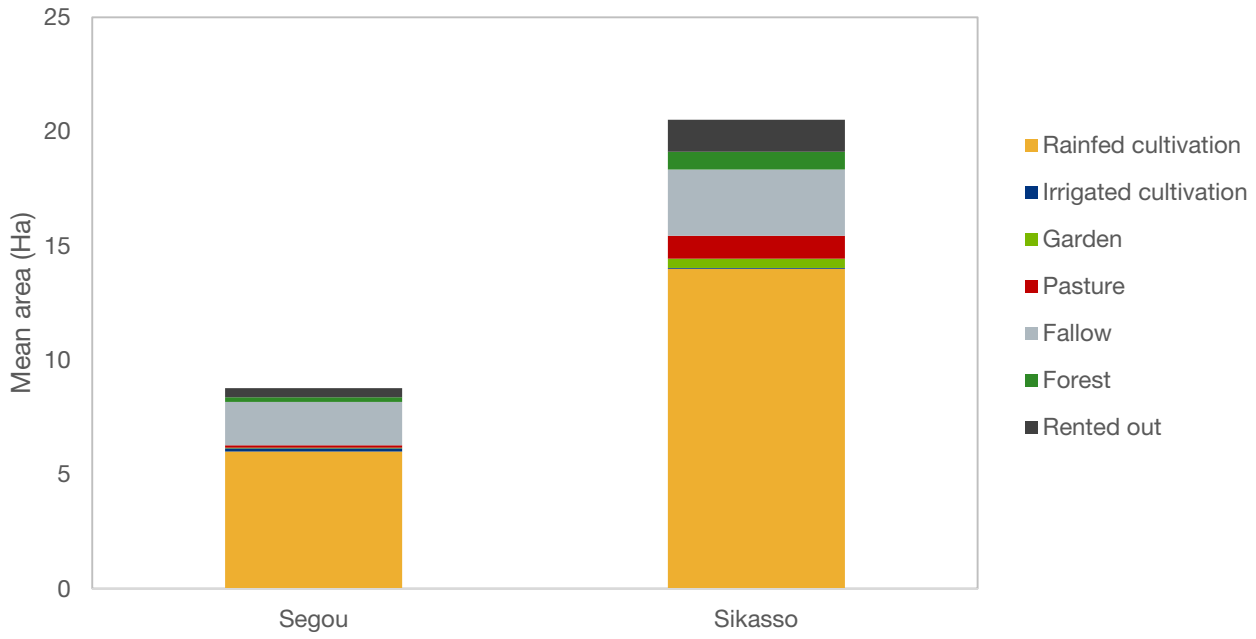

Figure 3. Mean area for different land use types in Ségou and Sikasso (including zeros)

Livestock

Ninety-seven percent of the surveyed households were keeping livestock. The most common type of livestock maintained overall were chickens (*Gallus gallus domesticus*; 87%), cattle (*Bos taurus*; 76%), donkeys (75%), goats (*Capra aegagrus hircus*; 74%), and sheep (*Ovis aries*; 56%) (Table 12). Less common livestock were other types of poultry—guinea fowl (*Numida meleagris*; 21%), ducks (*Anas platyrhynchos domesticus* 10%), pigeons (*Columba livia domestica*; 10%) and turkeys (*Meleagris sp*. 2%)—as well as horses (*Equus ferus caballus*; 20%) and rabbits (*Oryctolagus cuniculus*; 0.2%). Looking closer at cattle, 75% of households were maintaining oxen, 41% cows, 38% calves and 24% bulls. Most of the livestock species and cattle types were more popularly kept in Sikasso than in Ségou with the exception of pigs and horses, which were more common in Ségou, and chickens, which were kept by a similar proportion of households across regions (Figure 4). The total number of livestock species kept across the sites was 12. Households maintained a mean of 4.5 livestock species.

In general, households kept the largest number head of poultry (Table 13). Just one or two head were kept for horses and donkeys. In Sikasso, households kept larger numbers of cattle as compared to goats and sheep. By contrast, in Ségou, herd sizes were similar if not larger for sheep and goats as compared to cattle. Considering cattle types, the largest number head were maintained for cows (mean 9), and fewer head were maintained for other types of cattle (mean 4 for calves, bulls, and oxen). Households in Sikasso maintained higher head counts of most livestock species and cattle types (Table 14,15).

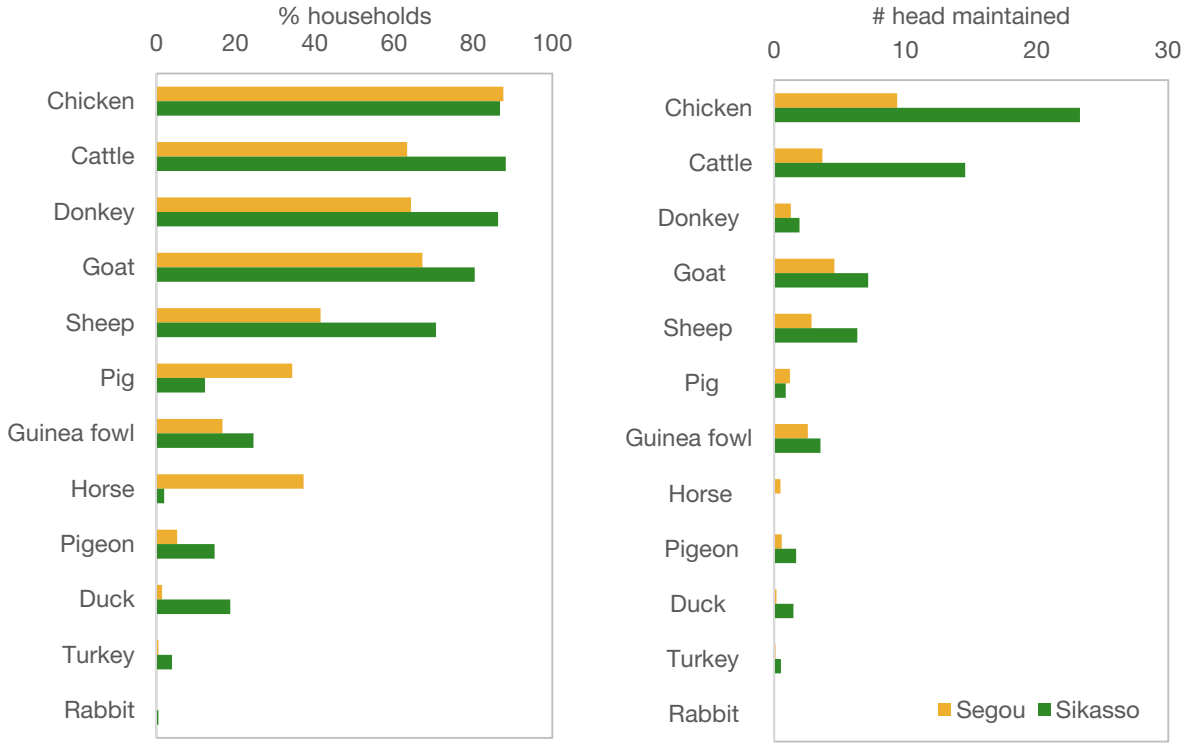

Figure 4. Percent of households maintaining species of livestock and the mean number of head maintained (incl. zeros)

Table 12. Number of households keeping livestock species and livestock richness

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Chicken	361	184	177	42	46	42	10	51	41	43	42
Cows	313	133	180	31	43	25	8	50	44	44	42
Donkey	311	135	176	28	39	31	3	49	43	44	40
Goat	305	141	164	38	42	24	8	47	38	45	34
Sheep	231	87	144	16	39	18	8	42	39	33	30
Pig	97	72	25	34	1	25		8	3	11	3
Guinea fowl	85	35	50	5	17	2	7	15	11	8	16
Horse	82	78	4	13	16	22	8		3	1	
Pigeon	41	11	30		4	3		11	6	12	1
Duck	41	3	38		1			16	6	11	5
Turkey	9	1	8		1			4		3	1
Rabbit	1		1					1			
Total # species	12	11	12	8	11	9	7	11	10	11	10
Household species richness	4.5	4.2	4.9	4.1	5.0	3.8	5.2	5.4	4.7	5.1	4.3

Table 13. Mean head of livestock maintained by those who kept the species (excl. zeros)

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Chicken	18.9	10.9	27.0	13.5	11.7	6.3	11.9	37.4	20.1	23.9	24.0
Turkey	15.5	20.0	14.9		20.0			14.0		17.3	10.0
Guinea fowl	15.5	16.3	15.0	21.8	17.4	17.5	11.6	13.5	15.5	23.0	11.8
Cows	11.9	5.8	16.5	4.4	6.4	4.7	6.9	13.9	10.5	9.0	33.6
Pigeon	11.8	11.0	12.2		10.3	6.3	15.3	10.8	18.6	11.6	1.0
Rabbit	10		10					10			
Duck	8.6	18.5	8.1		7.0		30.0	8.7	4.2	8.6	9.4
Sheep	8.3	7.0	9.1	4.2	9.6	3.8	7.4	10.9	6.7	7.5	11.2
Goat	8.0	6.9	9.0	7.2	9.5	3.4	5.8	9.5	7.1	7.7	11.9
Pig	4.6	3.5	7.8	4.0	16.0	1.7	5.0	7.0	8.3	7.6	10.5
Donkey	2.1	2.0	2.3	1.5	2.0	2.1	2.3	1.8	2.5	1.9	3.0
Horse	1.3	1.3	1.5	1.4	1.3	1.3	1.2		1.5		

Table 14. Number of households keeping cattle types

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Oxen	305	131	174	30	42	25	34	49	42	42	41
Cows	170	50	120	7	21	10	12	35	27	28	30
Calves	156	42	114	7	18	5	12	32	27	26	29
Bulls	99	23	76	8	7	1	7	22	16	18	20

Table 15. Mean head of different cattle maintained by those who kept the cattle type (excl. zeros)

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Cow	8.5	4.4	10.3	2.4	4.2	3.9	6.3	8.8	5.9	5.0	20.9
Calf	4.3	2.6	4.9	2.6	2.3	2.0	3.2	3.7	3.4	3.0	9.2
Bull	4.0	2.3	4.5	2.5	2.4	4.0	1.7	4.2	3.9	2.6	7.2
Oxen	4.0	2.9	4.8	2.7	3.1	2.6	3.3	3.6	3.6	3.2	9.1

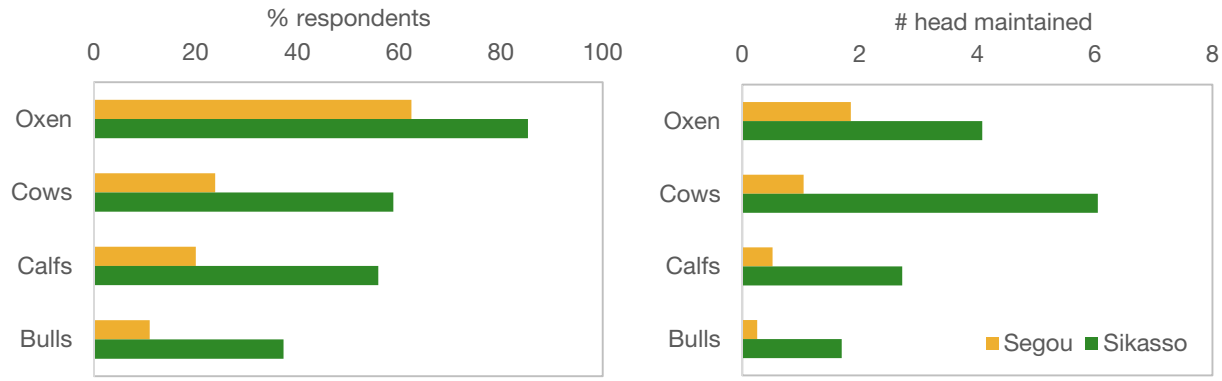

Figure 5. Percent of households maintaining cattle types and the mean head maintained (incl. zeros)

Crops

A total of 39 species were cultivated by the surveyed communities, including five cereals, four legumes, 24 species of vegetables, four fruits, one species of oilseed, and one fiber crop (Table 16). Three of the vegetable species documented in Ségou region could not be identified to scientific name: *bunu untio, dawani,* and *diamadia*. Two households were noted to grow vegetables but it was not specified which species and one household was noted to have an orchard but the species grown were not specified. Overall, households maintained a mean 6.5 crop species, including 3.1 cereal crops, 1.6 legume species, 1.2 vegetables, and less than one fiber crop, oilseed, and fruit species (Table 18).

The most popularly cultivated crops overall were pearl millet (*Panicum milliaceum*; 88%), sorghum (81%), peanut (77%), and maize (68%) (Table 17). Peanuts were grow by proportionally more farmers in Ségou, while maize was grown by proportionally more farmers in Sikasso (Figure 6). Less commonly cultivated cereals were fonio (43%) and rice (33%), both of which were more common in Ségou. Bambara groundnut (47%) was the second most common legume after peanut, while the third most common legume was cowpea (31%). Sesame (*Sesamum indicum*) was grown by a considerable number of households (18%), particularly in Ségou region (Figure 6). Among the vegetables cultivated, tomato (*Solanum lycopersicum*) was the most common (25%), followed by okra (*Abelmoschus esculentus*; 18%), chili pepper (*Capsicum* sp.; 16%), onion (*Allium cepa*; 14%), eggplant (*Solanum melongena*; 11%), and cucumber (*Cucumis sativus*; 10%). These vegetables were more commonly grown in Sikasso than in Ségou (Figure 6). Cotton (*Gossypium* sp.) was only grown in Sikasso, where it was cultivated by 70% of households and in large areas (mean 5.3 Ha).

Households assigned large areas to cereals (mean 6.7 Ha)—especially to pearl millet (mean 2.9 Ha), sorghum (mean 2.4 Ha), and maize (mean 2.2 Ha) (Tables 16, 17). Larger areas were allocated to cereals in Sikasso in accordance with the larger landholdings in this region (mean 9.3 Ha of cereals in Sikasso versus 4.2 Ha in Ségou). Households grew a mean 1.1 Ha of peanut overall, which was similar across regions (Table 17). Some crops were grown by few households but in large areas, in particular sweet potato, yam (*Dioscorea* sp.), pumpkin (*Cucurbita pepo, C. maxima* and *C. moschata*), roselle (*Hibiscus sabdariffa*) and banana (*Musa* sp.) occupied a mean 1 to 2 hectares of growers' landholdings.

Table 16. Number of households growing crop species and crop species richness

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Cereals	**414**	**210**	**204**	**50**	**50**	**50**	**44**	**54**	**50**	**50**	**50**
Panicum miliaceum	363	194	169	50	50	50	57	51	50	36	32
Sorghum bicolor	336	164	172	33	40	34	27	54	46	46	26
Zea mays	283	89	194	18	22	22	23	50	47	48	49
Digitaria exilis	178	156	22	45	44	44	38	9		11	2
Oryza sativa	135	88	47	7	5	38	44	4	4	16	23
Legumes	**350**	**199**	**151**	**47**	**49**	**48**	**55**	**51**	**44**	**31**	**25**
Arachis hypogaea	319	190	129	43	49	45	53	47	35	27	20
Vigna subterranea	196	111	85	40	33	18	2	42	22	13	8
Vigna unguiculata	128	78	50	29	19	15	15	15	20	8	7
Glycine max	5		5					1	2	2	
Vegetables	**211**	**76**	**135**	**16**	**17**	**20**	**23**	**35**	**35**	**34**	**31**
Solanum lycopersicum	102	25	77	7	13		5	24	20	22	11
Abelmoschus sp.	75	26	49	6	2	8	1	12	11	19	7
Capsicum sp.	68	16	52	5	4	3	4	14	12	22	4
Allium cepa	56	38	18	8	11	6	13	4	11	3	
Solanum melongena	45	13	32	3	3	5	2	8	3	11	10
Cucumis sativus	43	2	41			1	1	11	15	15	
Brassica oloracea	27	7	20	3	2		2	1	15	3	1
Ipomoea batatas	25	9	16	4	3	1	1			1	15
Capsicum annuum	21		21					2	5	12	2
Solanum aethiopicum	13	5	8		1	2	2		1	1	6
Lactuca sativa	9	7	2	1	4		2		1	1	
Hibiscus sabdariffa	7	7		2		5					
Phaseolus vulgaris	3	2	1				2			1	
Dioscorea sp.	3		3								3
Corchorus sp.	3		3							1	2
Daucus carota subsp. sativus	2	2			1		1				
Beta vulgaris subsp. vulgaris	1	1			1						
Cucurbita sp.	1		1							1	
Spinacia oleracea	1	1				1					
Manihot esculenta	1	1					1				
Solanum tuberosum	1		1								1
Dawani	2	2		2							
Diamadia	1	1					1				
Bunu untio	1	1		1							
Unspecified vegetables	2	1	1		1			1			
Fruit	**18**	**3**	**15**		**1**	**1**	**1**	**4**	**5**	**4**	**2**
Musa sp.	7		7						5	1	1
Cucumis melo	6		6					3		3	
Citrullus lanatus	4	3	1		1	1	1	1			
Carica papaya	2		2						1		1
Orchard	1		1								1
Oilseed	**73**	**64**	**9**	**12**	**13**	**14**	**25**	**4**		**4**	**1**
Sesamum indicum	73	64	9	12	13	14	25	4		4	1
Fibre	**143**		**143**					**33**	**33**	**34**	**43**
Gossypium sp.	143		143					33	33	34	43
Total # species	**39**	**29**	**31**	**20**	**21**	**19**	**24**	**21**	**21**	**27**	**23**
Household species richness	**6.5**	**6.2**	**6.8**	**6.4**	**6.4**	**6.3**	**5.8**	**7.2**	**7.2**	**7.2**	**5.5**

Table 17. Mean area (hectares) allocated to crop by growers (excl. zeros)

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Cereal	**6.7**	**4.2**	**9.3**	**4.6**	**3.5**	**4.5**	**4.1**	**9.7**	**11.8**	**7.6**	**8.2**
Panicum miliaceum	2.9	1.9	4.1	2.2	1.9	1.9	1.5	4.9	5.9	3.0	1.3
Sorghum bicolor	2.4	1.5	3.4	1.4	1.0	1.0	2.2	3.7	3.6	3.8	1.3
Zea mays	2.2	0.4	3.0	0.3	0.3	0.5	0.6	1.4	2.8	1.6	6.1
Digitaria exilis	0.8	0.9	0.5	1.4	0.7	0.7	0.4	0.3		0.7	1.0
Oryza sativa	1.1	1.1	1.2	1.0	0.4	1.4	1.0	0.9	1.3	0.9	1.4
Legume	**1.5**	**1.6**	**1.4**	**1.9**	**1.6**	**1.2**	**1.4**	**1.5**	**1.6**	**1.4**	**0.9**
Arachis hypogaea	1.1	1.2	1.0	1.4	1.2	0.9	1.3	0.9	1.2	1.0	0.8
Vigna subterranea	0.4	0.3	0.5	0.4	0.3	0.3	0.3	0.5	0.5	0.4	0.5
Vigna unguiculata	0.8	0.7	0.9	0.6	0.7	0.8	0.6	0.9	0.9	1.0	0.6
Glycine max	0.8		0.8					1.0		0.8	
Vegetables	**0.9**	**0.6**	**1.1**	**0.5**	**0.1**	**0.3**	**1.3**	**0.5**	**0.7**	**0.6**	**2.7**
Ipomoea batatas	2.5	0.1	3.8	0.1	0.1	0.1	0.2			0.1	4
Dioscorea sp.	2.5		2.5								2.5
Cucurbita sp.	2.0		2.0							2.0	
Hibiscus sabdariffa	1.1	1.1		2.3		0.7					
Solanum tuberosum	0.6		0.6								0.6
Bunu untio	0.5	0.5		0.5							
Corchorus sp.	0.5		0.5							0.1	0.6
Diamadia	0.5	0.5					0.5				
Allium cepa	0.4	0.4	0.3	0.1	0.1	0.1	1.0	0.3	0.3	0.2	
Solanum aethiopicum	0.3	0.1	0.4		0.1	0.2	<0.1		0.2	0.3	0.5
Phaseolus vulgaris	0.3	0.3					0.3				
Solanum lycopersicum	0.3	0.6	0.2	0.1	<0.1		2.5	0.2	0.2	0.1	0.3
Brassica oloracea	0.2	<0.1	0.3	<0.1	<0.1		0.1	0.1	0.3	0.1	0.5
Cucumis sativus	0.2	0.5	0.2			0.3	0.8	0.2	0.3	0.1	
Solanum melongena	0.2	0.1	0.2	<0.1	<0.1	0.1	0.1	0.2	0.2	0.2	0.3
Dawani	0.2	0.2		0.2							
Abelmoschus sp.	0.2	0.1	0.2	0.1	0.1	0.1	0.2	0.2	0.3	0.2	0.4
Capsicum sp.	0.2	<0.1	0.2	<0.1	<0.1	0.1	<0.1	0.2	0.3	0.2	0.2
Capsicum annuum	0.2		0.2					0.2	0.2	0.1	0.3
Daucus carota subsp. sativus	<0.1	<0.1			<0.1		0.1				
Spinacia oleracea	<0.1	<0.1				<0.1					
Beta vulgaris subsp. vulgaris	<0.1	<0.1			<0.1						
Lactuca sativa	<0.1	<0.1	0.1	0.1	<0.1		0.1		0.1	0.1	
Manihot esculenta	<0.1	<0.1					<0.1				
Fruit	**0.7**	**0.3**	**0.8**		**0.3**		**0.3**	**0.6**	**0.5**	**1.4**	**0.5**
Musa sp.	1.1		1.1						0.5	5.0	0.2
Cucumis melo.	0.3		0.3					0.5		0.2	
Carica papaya	0.3		0.3						0.2		0.2
Citrullus lanatus	0.5	0.3	1.0		0.3		0.3	1.0			
Oilseed	**0.6**	**0.6**	**0.6**	**0.4**	**0.9**	**0.5**	**0.7**	**0.6**		**0.6**	**0.5**
Sesamum indicum	0.6	0.6	0.6	0.4	0.9	0.5	0.7	0.6		0.6	0.5
Fibre	**5.3**		**5.3**					**2.9**	**5.3**	**2.6**	**9.2**
Gossypium sp.	5.3		5.3					2.9	5.3	2.6	9.2

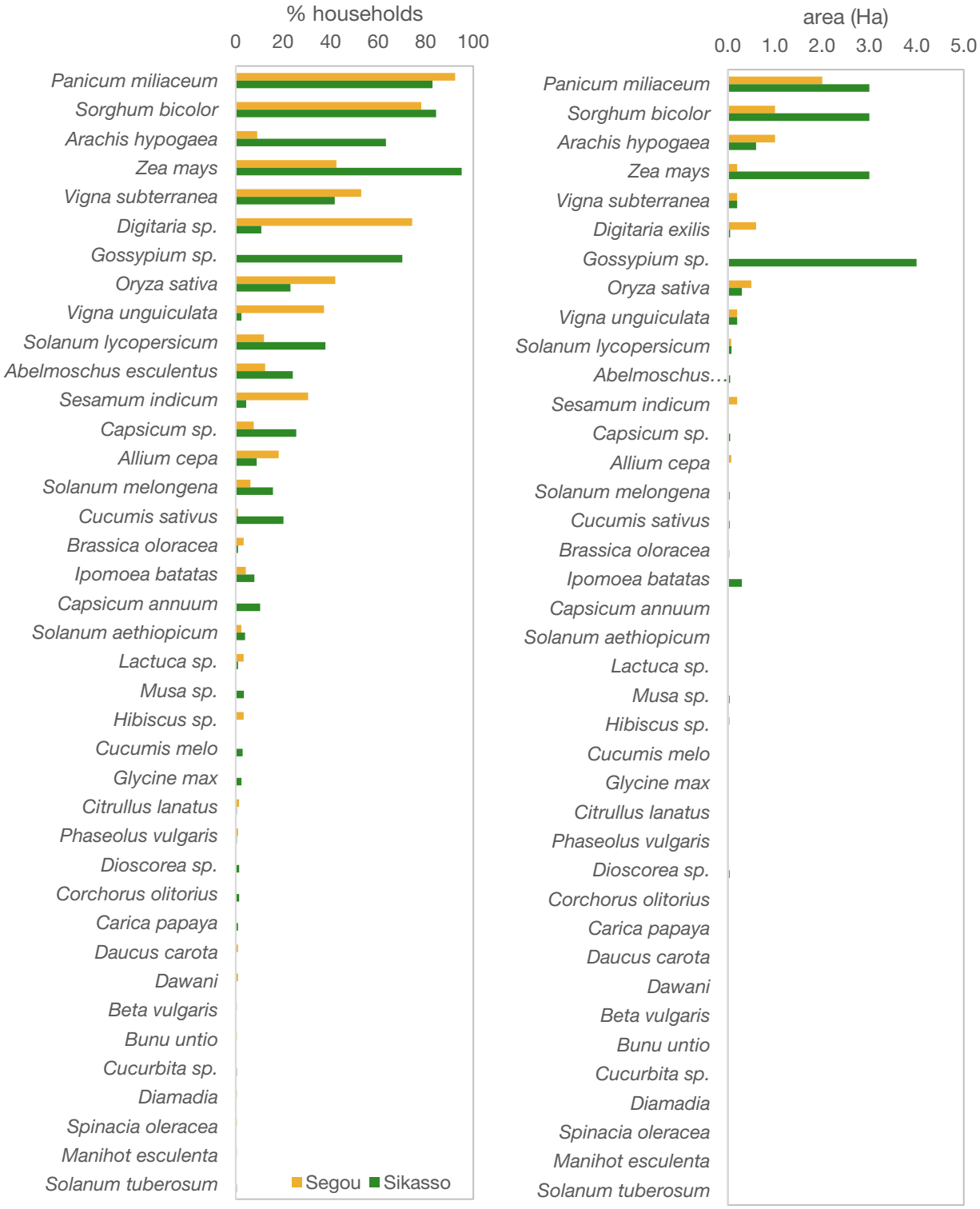

Figure 6. Percent of households cultivating different crops and the mean area cultivated (incl. zeros)

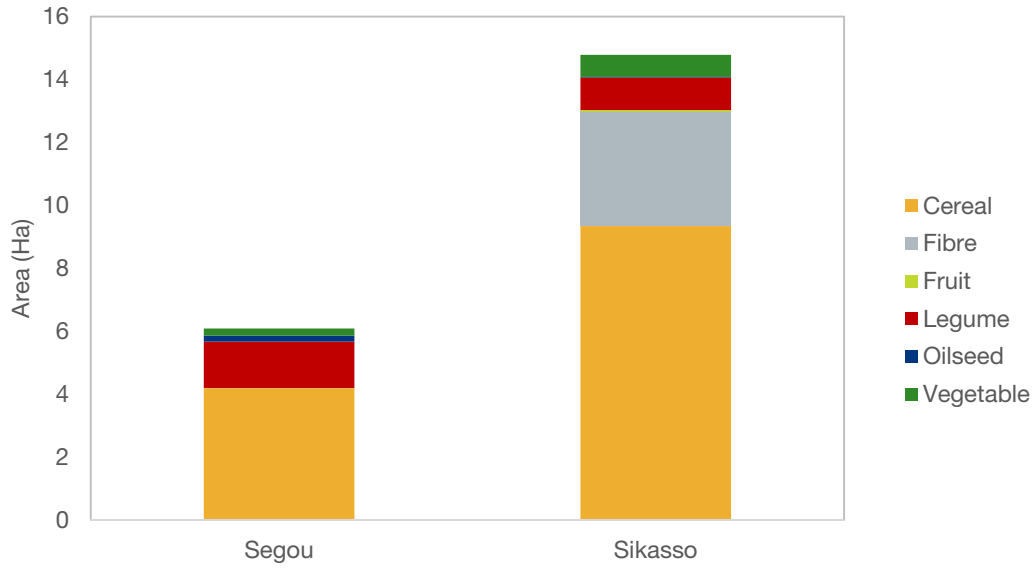

Figure 7. Mean area grown of different crop types (incl. zeros)

Table 18. Mean number of species of different crop types kept at the household level (incl. zeros)

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Cereals	3.1	3.3	3.0	3.1	3.2	3.8	3.1	3.1	2.9	3.1	2.6
Legumes	1.6	1.8	1.3	2.2	2.0	1.6	1.5	1.9	1.6	1.0	0.7
Vegetables	1.2	0.8	1.7	0.8	0.9	0.6	0.8	1.4	1.9	2.3	1.2
Fiber	0.4	<0.1	0.7	<0.1		0.1		0.6	0.7	0.7	0.9
Oilseed	0.2	0.3	<0.1	0.2	0.3	0.3	0.4	0.1	<0.1	0.1	<0.1
Fruit	<0.1		0.1		<0.1		<0.1	0.1	0.1	0.1	0.1

Crop-level five cell analyses performed during the focus groups documented two species that were not captured in the household survey: taro (*Colocasia esculenta*) in N'Gountjina and Somo and bottlegourd (*Lagenaria siceraria*) in Finkoloni. The five cell analyses also documented some crops in communities where they were not captured in the household survey. Most of the extra crops noted in the five cell analyses were grown by few households in small areas. Cassava was documented in N'Gountjina and Bountenisso in addition to Somo. Potato (*Solanum tuberosum*) was additionally documented in Finkoloni, N'Gountjina, Kaniko, Somo, and Bountenisso. Roselle was noted in Bountenisso, Somo and Finkoloni. Yam was documented in the other three villages in Sikasso in addition to Siramana. Carrot (*Daucus carota subsp. sativus*) was additionaly seen in N'Gountjina and Kaniko; green bean (*Phaseolus vulgaris*) in Kaniko; pumpkin in Finkoloni and Somo; African eggplant (*Solanum aethiopicum*) in Finkoloni; melon (*Cucumis melo*) in Somo and Bountenisso; beet (*Beta vulgaris* subsp. *vulgaris*) in Somo; lettuce (*Lactuca sativa)* in Bountenisso; and soy (*Glycine max*) in Siramana. Onion, tomato, and sesame were revealed to be grown in all the communities as shallot (*Allium cepa var. aggregatum*) was noted in Siramana, sesame in Finkoloni, and tomato in Bountenisso. Fonio was said to be extremely rare in Kaniko (1% of households growing it in a small area).

Household Income

The survey assessed the diversity of sources from which households drew their income. The livelihood sources included crops, crop products, livestock, livestock products, other natural resources (e.g. collection of wild plants and wood), labor and skilled job positions, credit and remittances, among others. These different sources of income are described in detail below and summarized for which were the most common and which were considered to be the most important to the household income (top 3-5 sources).

Crops for income

Most of the crops grown by the different communities were providing a source of income for at least some households (Table 19). Peanut and cotton were the most common cash crops. Peanut was providing income to many households in both Ségou (81%) and Sikasso (50%). Cotton was providing income to a majority of households (67%) in Sikasso but was not cultivated in Ségou. Often peanut and cotton were cited among households' top income sources (Table 20).

Cereals—particularly millet, sorghum and maize— were providing an income source for many households, especially in Sikasso region. These crops were commonly cited among households' top income sources. However, relative the number of households cultivating them, it could be seen that the cereals were more often used for household consumption and were more rarely providing a source of income compared to other crop types (Figures 9, 10). Sesame was an income source for almost all that were growing the crop and was a top income source for a notable number of households, particularly in Ségou region. Among the vegetables, tomato, chili, onion, okra, eggplant, and cucumber were providing a source of income to many households. These vegetables, while common income sources, were rarely cited among the top income sources for the households. By contrast, the few households cultivating fruits all reported that they were a source of income for the household and, in some cases, a top income source.

Some households (6%) reported preparing processed crop products as a source of household income. Most commonly, households were preparing dried vegetable products, including dried onion, chili, okra, and tomato (Table 21). Nine households reported preparing dried and roasted Bambara groundnuts for sale.

Cotton field in Sikasso, Mali. Credit G. Meldrum/ Bioversity International

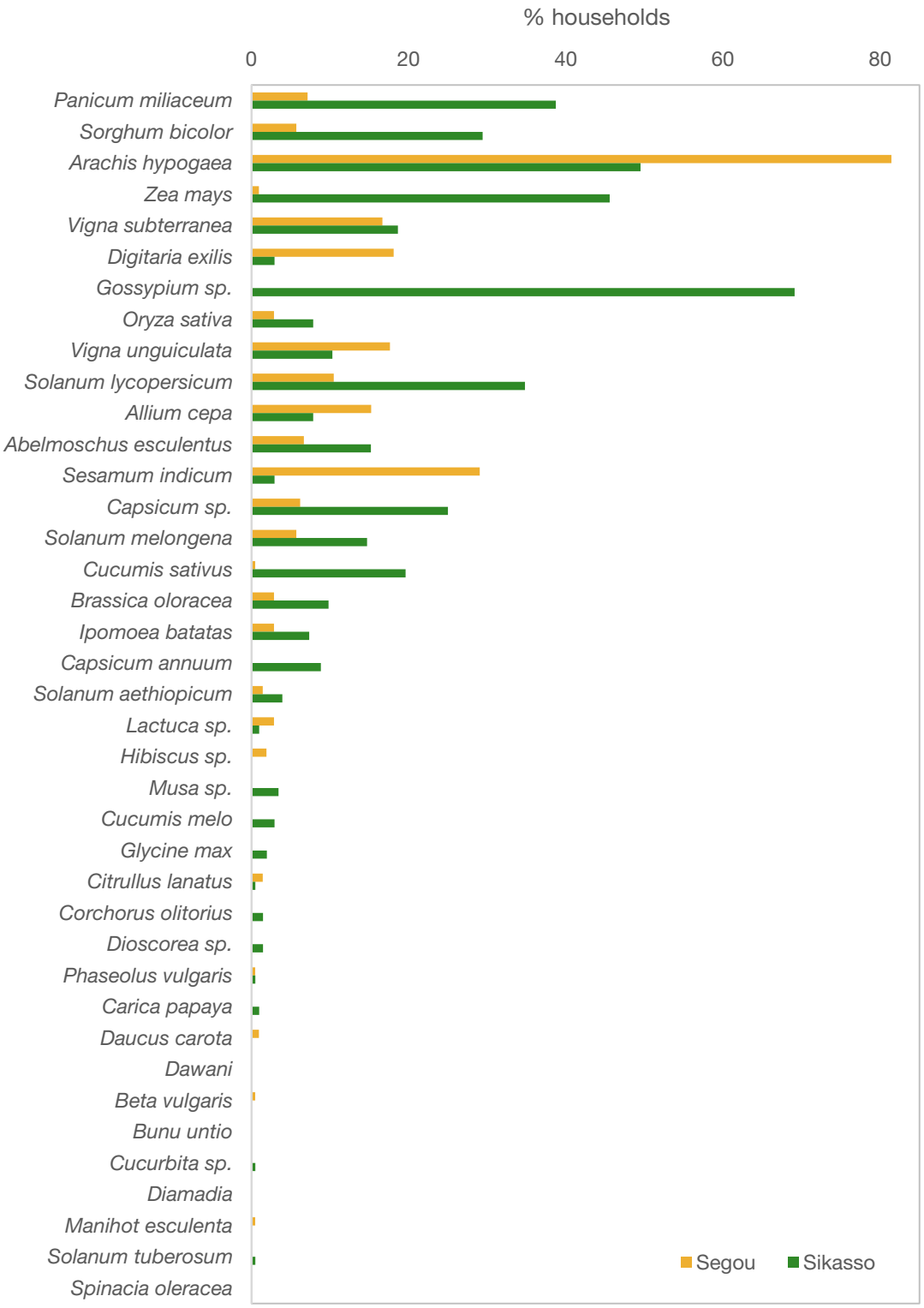

Figure 8. Percent of households reporting crops as a source of income

Table 19. Number of households earning income from different crop species

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Cereal	**187**	**50**	**137**	**14**	**25**	**8**	**3**	**46**	**42**	**18**	**29**
Zea mays	95	2	93		2			29	26	13	25
Panicum miliaceum	94	15	79	4	7	3	1	35	37	6	1
Sorghum bicolor	72	12	60	3	8	1		29	20	7	4
Digitaria exilis	48	38	10	14	18	4	2	4		6	
Oryza sativa	22	6	16		1	5			2	3	11
Legume	**291**	**173**	**118**	**37**	**49**	**40**	**47**	**45**	**37**	**20**	**16**
Arachis hypogaea	272	171	101	36	49	39	47	42	31	16	12
Vigna subterranea	73	35	38	2	26	4	3	22	8	6	2
Vigna unguiculata	58	37	21	17	10	3	7	7	8	2	4
Glycine max	4		4					1	2	1	
Vegetables	**179**	**54**	**125**	**13**	**16**	**13**	**12**	**30**	**34**	**32**	**29**
Solanum lycopersicum	93	22	71	6	12		4	21	20	21	9
Capsicum sp.	64	13	51	5	1	3	4	14	12	21	4
Allium cepa	48	32	16	7	10	6	9	4	9	3	
Abelmoschus sp.	45	14	31	5	2	4	3	6	5	14	6
Solanum melongena	42	12	30	3	3	4	2	7	3	11	9
Cucumis sativus	41	1	40			1		11	15	14	
Brassica oloracea	26	6	20	3	1		2	1	15	3	1
Ipomoea batatas	21	6	15	3	2	1				1	14
Capsicum annuum	18		18					2	5	10	1
Solanum aethiopicum	11	3	8		1	1	1		1	1	6
Lactuca sp.	8	6	2	1	4		1		1	1	
Hibiscus sabdariffa	4	4		1		3					
Dioscorea sp.	3		3								3
Corchorus sp.	3		3							1	2
Daucus carota subsp. sativus	2	2			1		1				
Phaseolus vulgaris	2	1	1				1			1	
Unspecifed vegetables	2	1	1		1			1			
Beta vulgaris subsp. vulgaris	1	1			1						
Cucurbita sp.	1		1							1	
Manihot esculenta	1	1					1				
Solanum tuberosum	1		1								1
Spinacia oleracea	0										
Bunu untio	0										
Dawani	0										
Diamadia	0										
Fruit	**18**	**3**	**15**		**1**	**1**	**1**	**4**	**5**	**4**	**2**
Cucumis melo	6		6					3		3	
Citrullus lanatus	4	3	1		1	1	1	1			
Carica papaya	2		2						1		1
Orchard	1		1								1
Musa sp.	7		7						5	1	1
Oilseed	**67**	**61**	**6**	**10**	**13**	**14**	**24**	**3**		**3**	
Sesamum indicum	67	61	6	10	13	14	24	3		3	
Fiber	**141**		**141**					**32**	**33**	**33**	**43**
Gossypium sp.	141		141					32	33	33	43
Total number citing crops as a livelihood source	**377**	**183**	**194**	**39**	**50**	**43**	**51**	**53**	**50**	**44**	**47**

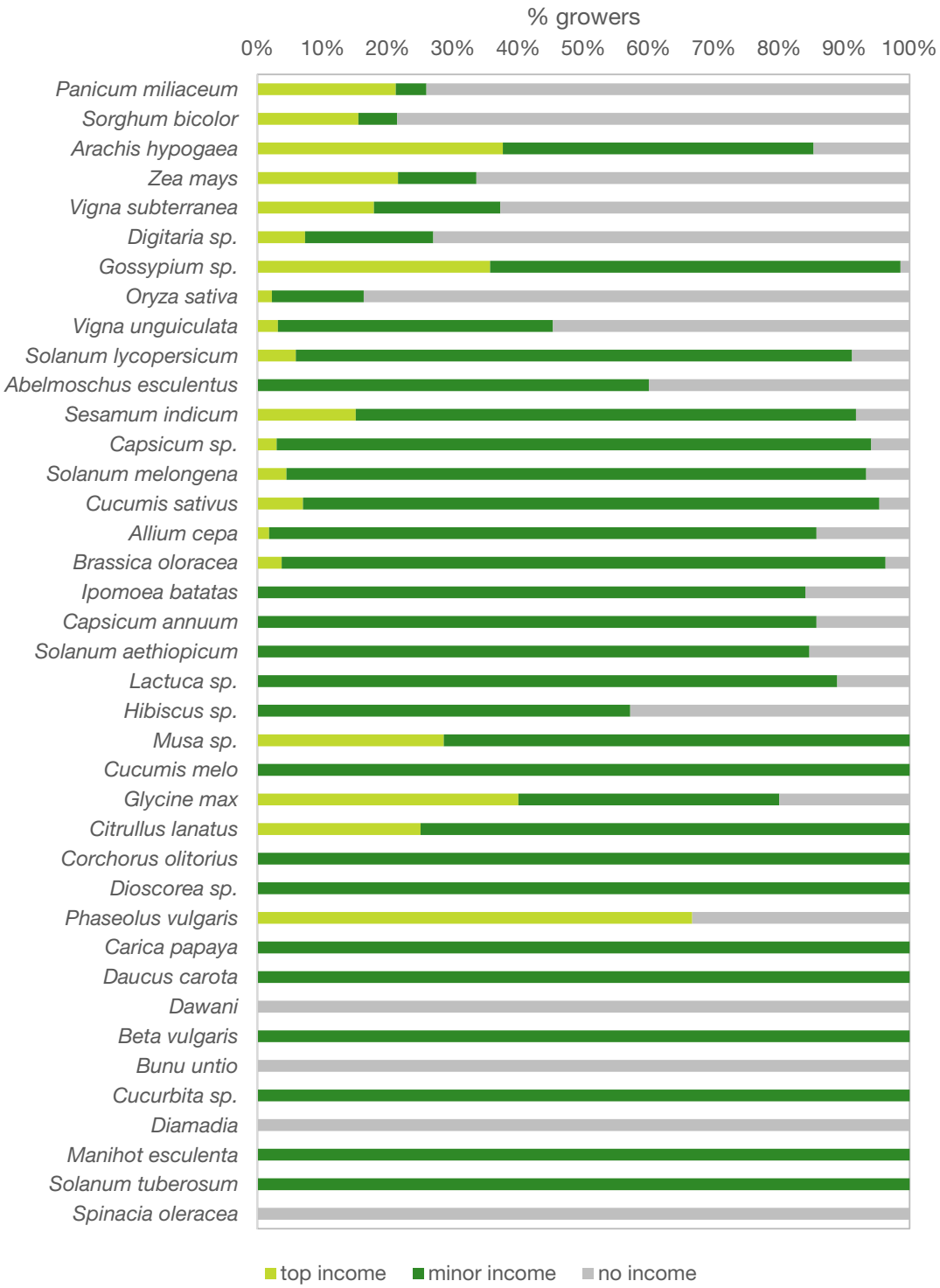

Figure 9. Percent of growers reporting crops as a source of income and among the top income sources for the household

Table 20. Number of households reporting crops in their top 3-5 income sources

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Cereals	**111**	**11**	**100**	**2**	**7**	**2**		**43**	**42**	**15**	
Panicum miliaceum	77	3	74		1	2		33	36	5	
Zea mays	61		61					27	24	10	
Sorghum bicolor	52	2	50		1	1		28	18	4	
Digitaria exilis	13	10	3	2	7	1		1		2	
Oryza sativa	3		3						1	2	
Legumes	**133**	**68**	**65**	**9**	**27**	**24**	**8**	**35**	**23**	**7**	
Arachis hypogaea	120	66	54	9	26	23	8	29	19	6	
Vigna subterranea	35	14	21		12	2		16	5		
Vigna unguiculata	4	2	2	1	1			1	1		
Glycine max	2		2						2		
Vegetables	**46**	**11**	**35**	**4**	**1**	**5**	**1**	**11**	**15**	**9**	
Solanum lycopersicum	6		6					3	3		
Cucumis sativus	3		3						3		
Phaseolus vulgaris	2	1	1				1			1	
Capsicum sp.	2		2					2			
Solanum melongena	2	1	1			1		1			
Allium cepa	1	1				1					
Brassica oloracea	1		1						1		
Fruit	**3**	**1**	**2**				**1**		**2**		
Musa sp.	2		2						2		
Citrullus lanatus	1	1					1				
Oilseed	**11**	**9**	**2**		**4**	**4**	**1**	**1**		**1**	
Sesamum indicum	11	9	2		4	4	1	1		1	
Fibre	**51**		**51**					**20**	**21**	**10**	
Gossypium sp.	51		51					20	21	10	
Total number citing crops as a top livelihood source	**365**	**164**	**201**	**30**	**45**	**39**	**50**	**53**	**50**	**49**	**49**

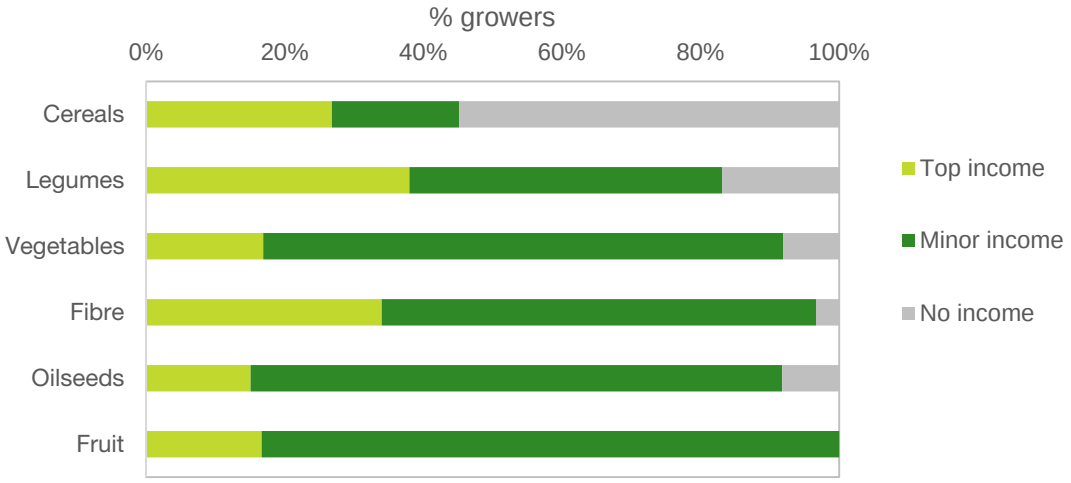

Figure 10. The proportion of grower of different crop types that were earning income and considering a crop type as a top income source for the household

Table 21. Number of households for which processed crop products provide a source of income

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Dried onion	4	4				3					
Dried chili pepper	7	2	5			2		1		3	1
Dried okra	7	1	6			1		4			2
Dried tomato	1		1					1			
Processed Bambara groundnut	9	4	5		4			5			
Other processed crop product	3	2	1		1	1				1	
Total number citing crop products as a livelihood source	**25**	**10**	**15**	**0**	**4**	**5**	**1**	**9**	**0**	**4**	**2**

Livestock for income

Many livestock species were providing a source of household income (Table 22). Poultry were the most common livestock providing income, which included most commonly chickens (70%), but also guinea fowl (18%), and to a lesser degree pigeons (7%), ducks (5%), and turkeys (1%). Goats and sheep were also fairly common income sources reported by 51% and 36% of households respectively. Interestingly, although cattle were kept by many households, they were more rarely providing income to the households. This is likely because the cattle kept were most commonly work animals (oxen) and the sale of milk was more important for income generation than sale of the livestock itself (see details on milk sales below). Other work animals —donkeys and horses—were also rarely cited as income sources, although there were some households that rented animals for income (see below).

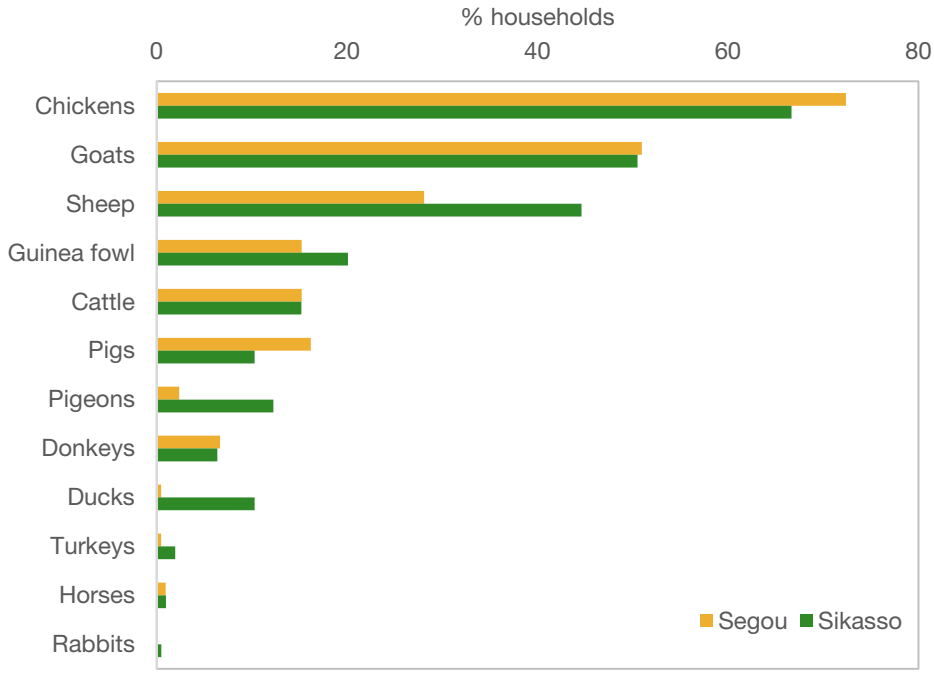

Figure 11. Percent of households for which livestock were providing a source of income

Table 22. Number of households for which specific livestock species provide a source of income

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Chicken	288	152	136	31	41	35	45	36	34	33	33
Goat	210	107	103	24	39	18	26	30	21	29	23
Sheep	150	59	91	9	32	9	9	25	23	22	21
Guinea Fowl	73	32	41	5	16	1	10	12	10	5	14
Cattle	63	32	31	5	15	3	9	7	10	4	10
Pig	55	34	21	17		10	7	7	1	10	3
Pigeons	30	5	25		2	1	2	9	5	10	1
Donkey	27	14	13	1	7	5	1	4		3	6
Duck	22	1	21				1	8	1	8	4
Turkey	5	1	4		1			2		1	1
Horse	4	2	2	2					1	1	
Rabbit	1		1					1			
Total number citing poultry as a livelihood source	**299**	**155**	**144**	**31**	**43**	**35**	**46**	**38**	**35**	**36**	**35**
Total number citing livestock as a livelihood source	**344**	**172**	**172**	**33**	**48**	**40**	**51**	**47**	**43**	**42**	**40**

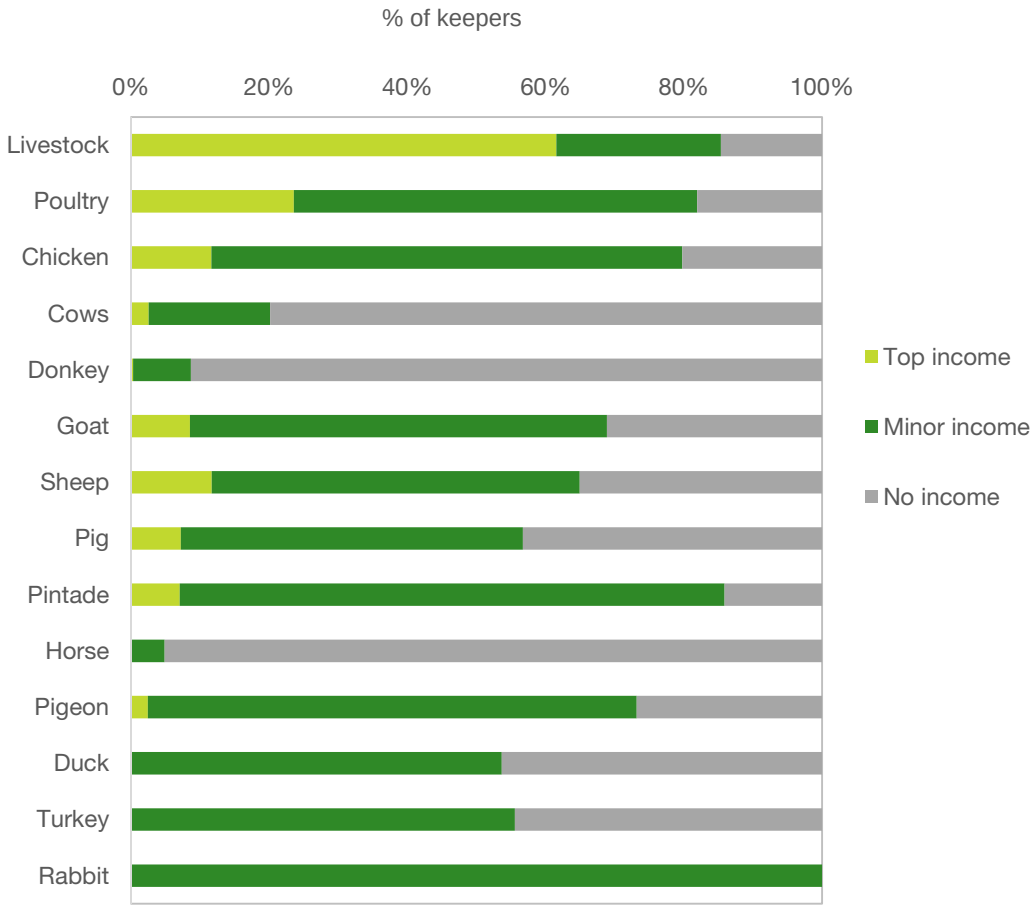

Figure 12. The percent of households keeping livestock that were earning income and considering the species or livestock type as a top income source for the household

Table 23. Number of households for which livestock species were in top 3-5 income sources

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Chicken	42	30	12	3	14	11	2	7	3	2	
Sheep	27	12	15		10	2		11	3	1	
Goat	26	18	8	2	11	4	1	6	1	1	
Cattle	8	1	7		1			4	3		
Pig	7	7		1		6					
Guinea Fowl	6	4	2		4			1		1	
Donkey	1	1			1						
Pigeon	1		1							1	
Total number citing poultry as a top livelihood source	**86**	**57**	**29**	**5**	**24**	**19**	**9**	**16**	**10**	**3**	
Total number citing livestock as a top livelihood source	**248**	**134**	**114**	**26**	**40**	**27**	**41**	**34**	**26**	**26**	**28**

Table 24. Number of households for which livestock products provide a source of income

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Dairy	*57*	*2*	*55*		*1*	*1*		*13*	*10*	*11*	*21*
Cow milk	56	2	54		1	1		13	9	11	21
Goat or sheep milk	4		4					2	1		1
Butter	7		7					2	2	3	
Yoghurt	1		1							1	
Meat	*48*	*23*	*25*	*3*	*9*	*3*	*8*	*10*	*4*	*10*	*1*
Goat or sheep meat	26	9	17		6		3	7	4	5	1
Poultry meat	21	13	8		7	2	4	3	2	3	
Cattle meat	13	4	9		2		2	3	2	3	1
Pig meat	12	5	7	3		1	1	3		4	
Guinea fowl meat	6	4	2		3		1	2			
Eggs	28	11	17	3	5	1	2	5	5	3	4
Honey	18	8	10	5	2	1			4	3	3
Wool	9	3	6		2	1		1	2	2	1
Total number citing animal products as livelihood source	**131**	**42**	**89**	**11**	**15**	**6**	**10**	**28**	**17**	**20**	**24**

Table 25. Number of households for which livestock products were in top 3-5 income sources

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Milk	4	1	3			1		2			1
Meat	6	2	4	1			1	1	2	1	
Wool	1	1				1					
Honey	9	4	5	3		1			2	2	1
# households citing animal products as top income source	**18**	**8**	**10**	**4**		**3**	**1**	**2**	**3**	**3**	**2**

In additon to selling the livestock itself, 32% of households reported selling animal products (Table 24). Cow milk was a fairly common source of income, especially in Sikasso where it was reported by 26% of households. Meat was also fairly common income source for 12% of households overall. In Sikasso sales were more common for goat or sheep meat, while in Ségou sale of poultry meat was more common. Eggs were reported by 7% of households as an income source, honey by 4% and wool by 2%. Those

households that produced honey often cited it as one of their top income sources (Table 25). Other animal products were less commonly cited as top income sources (Figure 13).

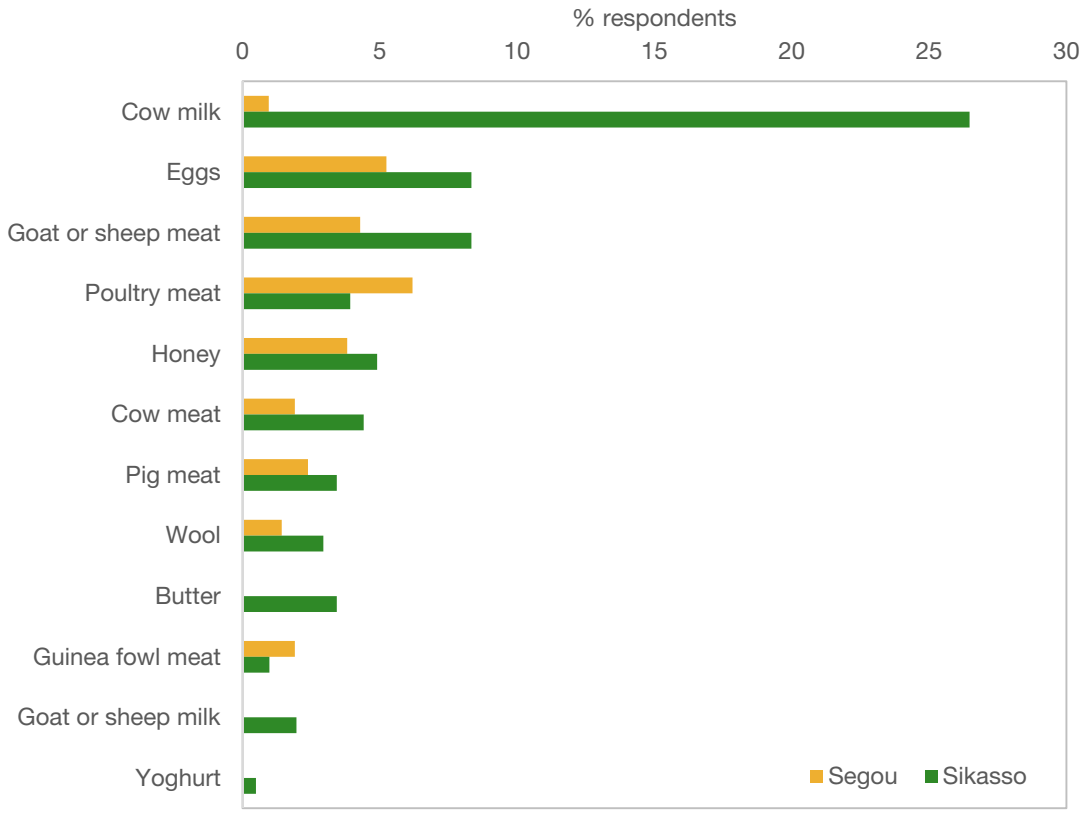

Figure 13. Percent of households reporting livestock products as income sources

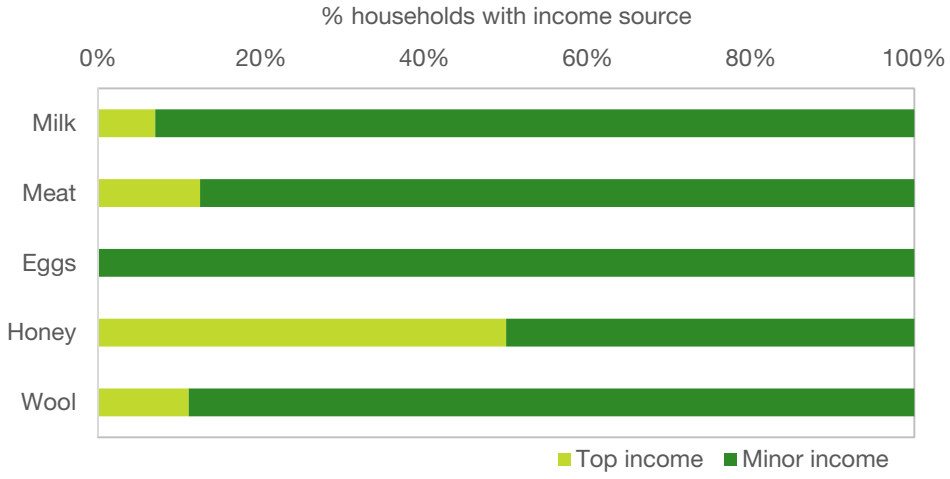

Figure 14. Percent of households reporting livestock products as income sources and top income sources

Other natural resource-based livelihood sources

Aside from crops and livestock, other natural resources were also being exploited by the households as a source of income (Table 26). In particular, forestry and wild plant gathering were common income sources. Wood was gathered by many households and sold for heating (19%), charcoal (7%), or lumber (7%). Some households specifically mentioned gathering, preparing and selling shea butter (*Vitellaria paradoxa*), soumbala (fermented seeds of *Parkia biglobosa,* African locust bean), and traditional medicines. A few households mentioned forage and straw as sources of income. Forage may have been gathered from wild areas or produced on their land. Sales of manure or compost were also fairly common (7% of households overall). Fish was a source of income for 3% of households—in most cases they were fished from natural populations, but in one case they were farmed fish. Fish were a common income source in Ségou, whereas forestry and wild plant gathering were more common income sources in Sikasso (Figure 15).

Forestry was a common income source, but was only listed among the top income sources for a third of those that were engaged in this activity. Wild plant gathering and sales of compost or manure were also common income sources but they were never considered in the top 3-5 income sources for the households interviewed. Instead, shea, soumbala, traditional medicines, forage, fish, and alcohol, which were less common, were considered among the top 3-5 income sources by the households that were selling them.

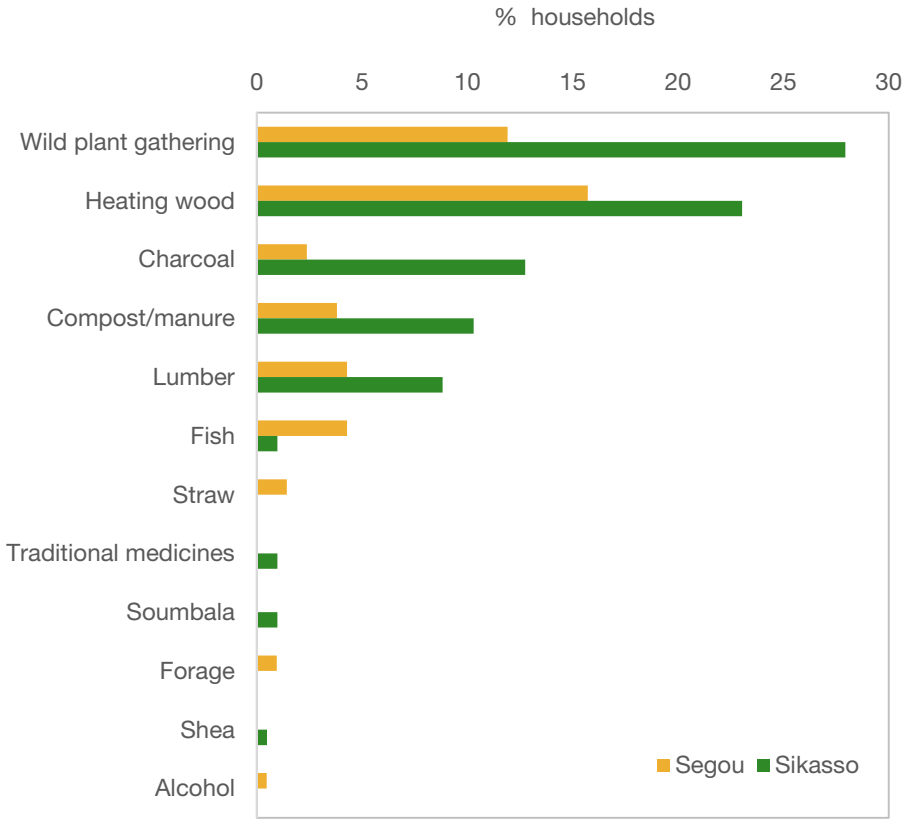

Figure 15. Percent of households reporting livelihood sources

Table 26. Number of households reporting livelihood sources

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Forestry	*106*	*41*	*65*	*10*	*3*	*14*	*14*	*28*	*18*	*15*	*4*
Heating wood	80	33	47	8		12	13	25	12	10	
Charcoal	31	5	26		2	1	2	3	9	11	3
Lumber	27	9	18	5	1	1	2	8	5	4	1
Wild plant gathering	*82*	*25*	*57*	*7*	*9*	*4*	*5*	*18*	*14*	*18*	*7*
Traditional medicines	2		2						1	1	
Soumbala	2		2					1		1	
Shea	1		1						1		
Compost/manure	29	8	21		2	1	5	10	8		3
Straw	3	3		2			1				
Forage	2	2				1	1				
Fish*	11	9	2	1		5	3				2
Alcohol	1	1		1							
# households with income from other natural resources	**182**	**74**	**108**	**16**	**14**	**22**	**22**	**39**	**32**	**25**	**12**

*some cases fished other raised, not well captured in survey

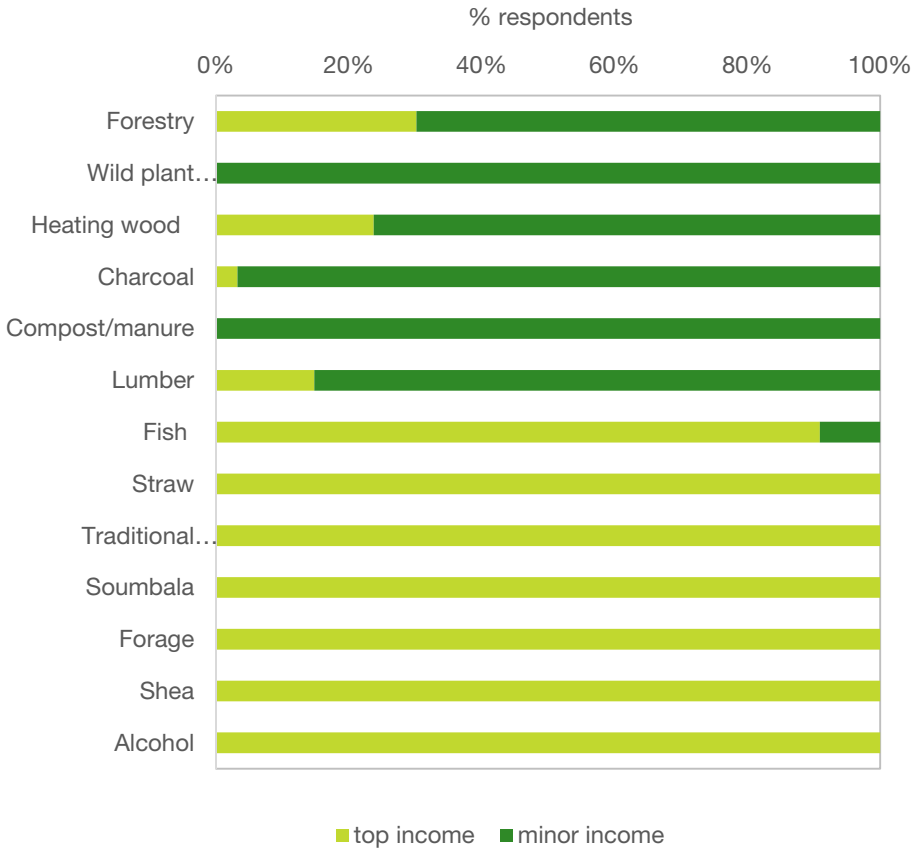

Figure 16. Percent of households reporting livelihood sources as top income sources

Table 27. Number of households reporting resources among top 5 income sources for the household

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Forestry	*32*	*26*	*6*	*9*		*10*	*7*	*4*	*1*	*1*	
Heating wood	19	19		4		10	5				
Lumber	4	4		3			1				
Charcoal	1	1					1				
Traditional medicine	2		2						1	1	
Shea	1		1					1			
Forage	2	2				1	1				
Straw	3	3		2			1				
Alcohol	1	1		1							
Fish	10	8	2			5	3				2
# Households citing other natural resource top income sources	**49**	**37**	**12**	**11**	**0**	**15**	**11**	**5**	**2**	**3**	**2**

Labor, service and other income sources

Employment of household members on other farms provided an income source for 30% of households overall, but this was rarely considered a top income source (Tables 28, 29). More households had some members engaging in other types of labor or service work for remuneration (65%) and these jobs were often considered a top income source for the household (Figure 18). Other sources of income for the surveyed households were credit (26%), remittances (26%), renting equipment or farm animals (13%), payment by projects run by the government or other organizations (11%), and renting land (3%). Most commonly these latter sources were not considered as top income sources for the household.

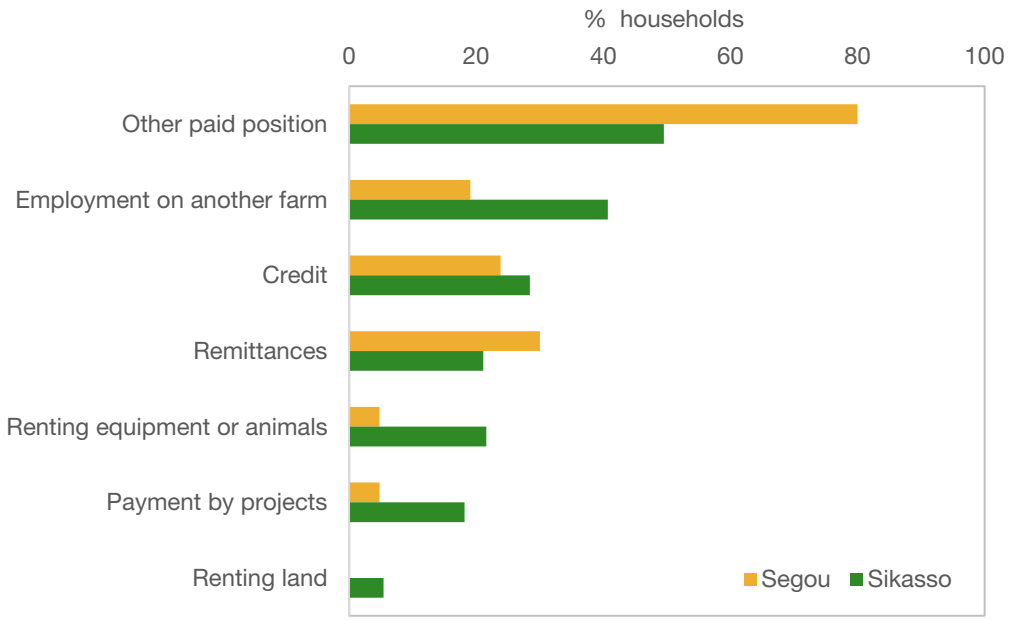

Figure 17. Percent of households reporting livelihood sources as income sources

Table 28. Number of households reporting livelihood sources as income sources

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Employment on another farm	123	40	83	20	10	4	6	14	22	24	23
Other paid position	269	168	101	41	49	41	37	22	21	34	24
Credit	108	50	58	13	9	11	17	7	18	15	18
Remittances	106	63	43	16	4	17	26	16	10	13	4
Renting equipment/work animals	54	10	44	5	5			6	14	8	16
Payment by projects	47	10	37	3	1	1	5	6	7	13	11
Renting land	11		10					2	3	3	3
# households with income from other sources	**365**	**190**	**175**	**47**	**49**	**45**	**49**	**41**	**45**	**45**	**44**

Table 29. Detail on other paid positions

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Small business	65	33	32	9	16	3	5	2	9	13	8
Laborer	13	11	2	4	2	1	4	0	0	1	1
Masonry	12	10	2	4	1	1	4	0	0	2	0
Service position	10	5	5	1	0	0	4	0	2	3	0
Mechanic	8	6	2	1	2	2	1	0	1	0	1
Other craft	8	5	3	0	1	0	4	0	0	1	2
Migration	8	8	0	5	0	3	0	0	0	0	0
Brick making	6	6	0	3	0	2	1	0	0	0	0
Other trade	6	2	4	1	0	0	1	0	1	0	3
Rope weaving	6	6	0	0	2	4	0	0	0	0	0
Blacksmith	5	4	1	0	2	1	1	0	1	0	0
Chair making	5	4	1	3	0	0	1	0	1	0	0
Mat weaving	5	5	0	0	0	0	5	0	0	0	0
Couture	5	3	2	2	0	1	0	1	1	0	0
Cobbler	4	3	1	1	0	0	2	0	0	0	1
Digging wells	3	3	0	0	0	2	1	0	0	0	0
Net making	2	2	0	0	0	1	1	0	0	0	0

Table 30. Percent of households reporting livelihood sources as top income sources

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Employment on another farm	8	8		5	2	1					
Other paid position	155	104	51	31	26	21	26	3	15	19	14
Renting equipment/work animals	5	3	2	1	2				2		
Renting land	1		1					1			
Remittances	13	12	1	1	1	3	7				1
Payment by projects	1	1		1							
# households with other top income sources	**166**	**115**	**51**	**34**	**27**	**24**	**30**	**3**	**15**	**19**	**14**

Employment on other farms was relatively more common in Sikasso than in Ségou (Figure 17), likely because of the larger landholdings and the large areas devoted to cash cropping of cotton in this region. Instead, other paid positions were more common sources of income in Ségou than in Sikasso. The paid

jobs included labor (e.g. brick-making, well-digging), trades (masonry, mechanic, blacksmith, etc.), crafts (weaving ropes, mats and nets, chair-making, couture, tailor, cobbler), and services (e.g. traditional therapy, teaching, government, social mediation, chauffeur, health work), as well as running small business (e.g. trading vehicles or vehicle parts, selling equipment, trading dogs) (Table 29).

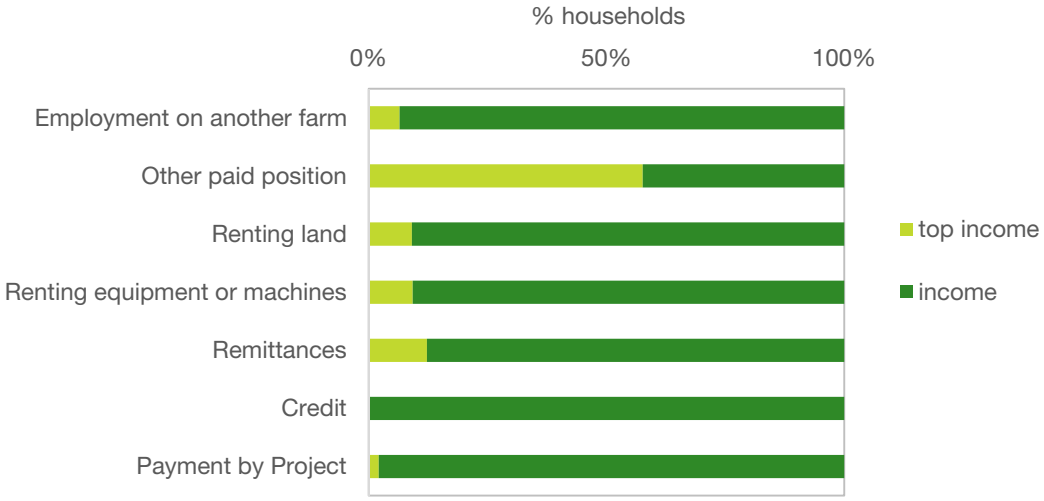

Figure 18. Percent of households with livelihood source reporting as top income source

Types and numbers of livelihood sources

The households surveyed had a total of 87 unique sources of income, considering all the specific crops, livestock, crop and animal products, other natural resources, farm labor, other employment, and other sources (Table 31). Overall, individual households had a mean of 8.6 income sources. Households in Sikasso had more sources of income on average than households in Ségou (10 vs 7).

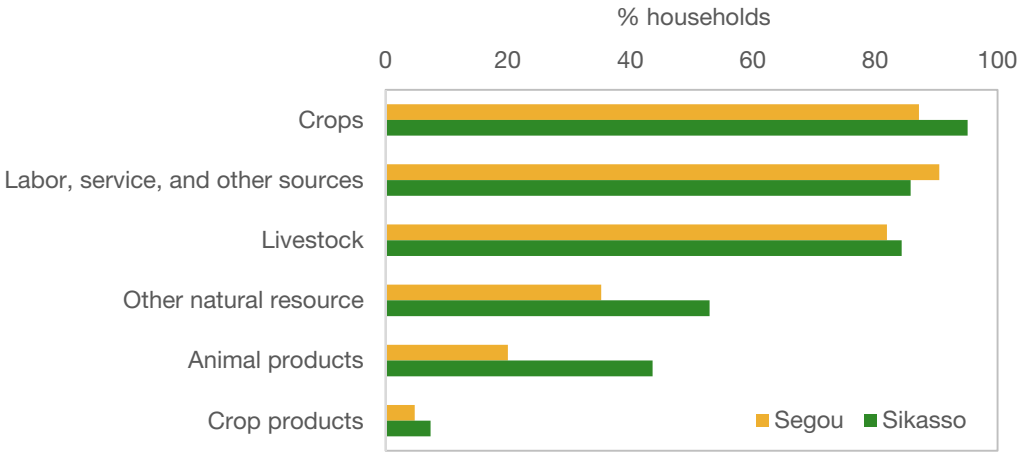

Figure 19. Number of households gaining an income from different types of livelihood sources

Ninety-one percent of households were gaining an income from crops and 83% were gaining income from livestock (Table 32). Eighty-eight percent were gaining income from labor, services or other sources not based in natural resources. Exploitation of natural resources aside from crops and livestock (e.g. forestry, wild plant gathering) was an income source for 44% of households. Animal products (32%) and crop products (5%) were more rare sources of income. Animal products and other natural resources were more common sources of income in Sikasso than Ségou (Figure 18).

Households had a mean of 3.4 cash crops and 2.2 animal species that generated income (Table 32). In addition, households had a mean 1.7 sources of income from labor, service or other non-natural resource based opportunities and less than one income source from other natural resources, animal products or crop products.

Table 31. Richness of livelihood sources

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Total # livelihood sources in region	86	66	78	38	50	47	47	59	53	63	53
Mean # livelihood sources at household level	8.6	6.9	10.3	6.9	9.0	5.9	6.1	11.2	10.8	10.5	8.6

Table 32. Mean number of income sources within different types of livelihood sources (incl. zero)

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Crops	3.4	2.4	4.4	2.4	3.5	1.9	1.9	5.1	5.2	4.0	3.2
Crop products	0.1	0.1	0.1	<0.1	0.1	0.1	<0.1	0.2	<0.1	0.1	0.1
Livestock	2.2	2.1	2.4	1.9	3.1	1.6	2.5	2.6	2.1	2.5	2.3
Animal products	0.5	0.3	0.7	0.2	0.6	0.1	1.0	0.8	0.6	0.8	0.6
Other natural resource	0.7	0.4	0.9	0.5	0.3	0.5	0.5	1.2	1.0	0.9	0.3
Labor, service, and other	1.7	1.6	1.9	2.0	1.6	1.5	1.4	1.4	1.9	2.2	2.0

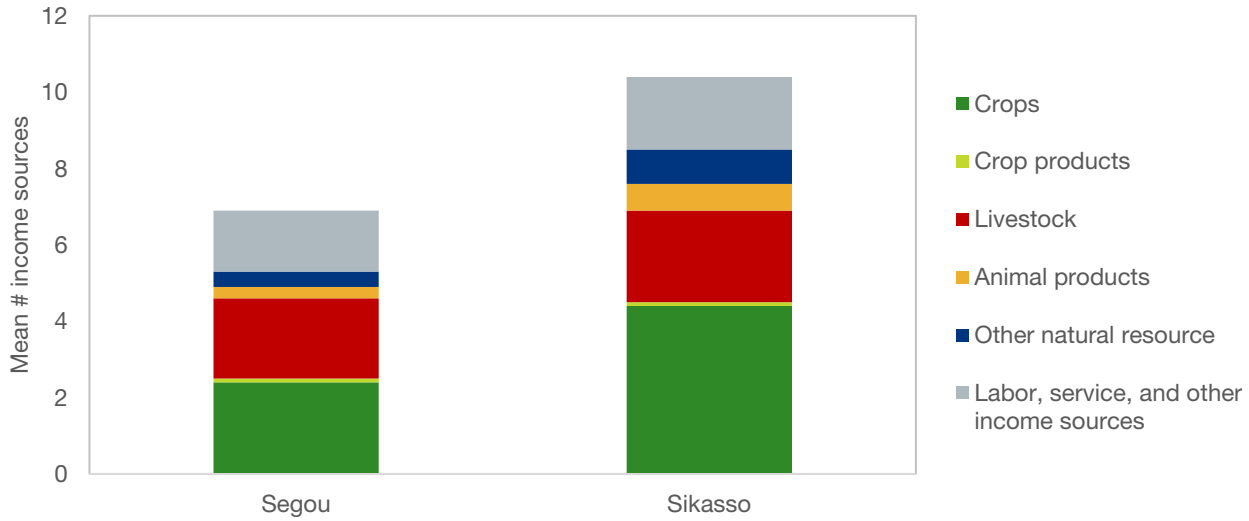

Figure 20. Mean number of livelihood sources of different types at household level (incl. zero)

Most common and top income sources

Overall, the most common livelihood sources were poultry, peanut, and paid positions aside from working on other farms (Table 33). Goats also were a notably popular income source. The common income sources were slightly different in Ségou than in Sikasso. The importance of cotton in Sikasso (as second most common income source) was a remarkable difference between regions.

The most popular income sources were not necessarily the highest earning income sources. Peanut and other paid employment were frequently listed among the top income sources but poultry was interestingly not so frequently listed among top income sources relative the popularity of poultry farming (Table 34). It is noted that the question on top income sources was open and in some cases the farmers responded with more general categories (such as livestock or crops) instead of listing specific species. This could be a factor in why poultry was less often showing up as a top income source.

Table 33. Most popular livelihood source ranked by number of households citing income sources

Rank	Overall	Ségou	Sikasso
1	Poultry (72%)	Peanut (81%)	Poultry (71%)
2	Peanut (66%)	Other paid employment (76%)	Cotton (69%)
3	Other paid employment (63%)	Poultry (74%)	Goats (50%)
4	Goats (51%)	Goats (51%)	Other paid employment (50%)
5	Sheep (36%)	Remittances (30%)	Peanut (50%)
6	Cotton (34%)	Sesame (29%)	Maize (46%)
7	Work on another farm (30%)	Sheep (28%)	Sheep (45%)
8	Credit (26%)	Credit (24%)	Work on another farm (41 %)
9	Remittances (26%)	Work on another farm (19%)	Millet (39%)
10	Maize (23%)	Fonio (18%)	Tomato (35%)
11	Millet (23%)	Cowpea (18%)	Sorghum (29%)
12	Tomato (22%)	Bambara groundnut (17%)	Credit (28%)
13	Wild plant collection (20%)	Pigs (16%)	Wild plant collection (28%)
14	Heating wood (19%)	Heating wood (16%)	Cow milk (26%)
15	Bambara groundnut (18%)	Onion (15%)	Chili (25%)

Table 34. Most common top income sources ranked by number of households listing them in top 3-5 income sources for the household

Rank	Overall	Ségou	Sikasso
1	Other paid employment (37%)	Other paid employment (50%)	Millet (36%)
2	Peanut (29%)	Peanut (31%)	Maize (30%)
3	Poultry (21%)	Poultry (27%)	Peanut (26%)
4	Millet (19%)	Small business (16%)	Other paid employment (25%)
5	Small business (16%)	Heating wood (9%)	Cotton (25%)
6	Maize (15%)	Goats (9%)	Sorghum (25%)
7	Sorghum (13%)	Bambara groundnut (7%)	Vegetables (17%)
8	Cotton (12%)	Remittances (6%)	Small business (16%)
9	Vegetables (11%)	Sheep (5%)	Poultry (14%)
10	Bambara groundnut (8%)	Vegetables (5%)	Bambara groundnut (10%)

Cultivation and sale of the target crops

The project is focused on research and development of the value chains of fonio, Bambara groundnut and native vegetables. A more detailed assessment was made of the current levels of cultivation and commercialization of these crops, considering the diversity of varieties of these crops, as well as the management practices and gender roles associated with these species.

Fonio

Cultivation of fonio

Overall 43% of the households surveyed were growing fonio (Table 35). Many more households were growing fonio in Ségou (74%) than in Sikasso (11%) and in larger areas. In Ségou, growers devoted a mean 0.9 Ha to fonio, representing about 15% of their rainfed cropland. In Sikasso, growers devoted less area to fonio—on average half a hectare, representing just 5% of their rainfed cropland. Among the villages in Ségou, fonio was cultivated by the grand majority (88%-90%) of households in Bolimasso, Boumboro and Bountenisso. Much fewer (38%) households grew fonio in Somo and in smaller areas. In Sikasso, fonio was grown by some households in Finkoloni and N'Gountjina, very rarely in Siramana, and by no household surveyed in Kaniko.

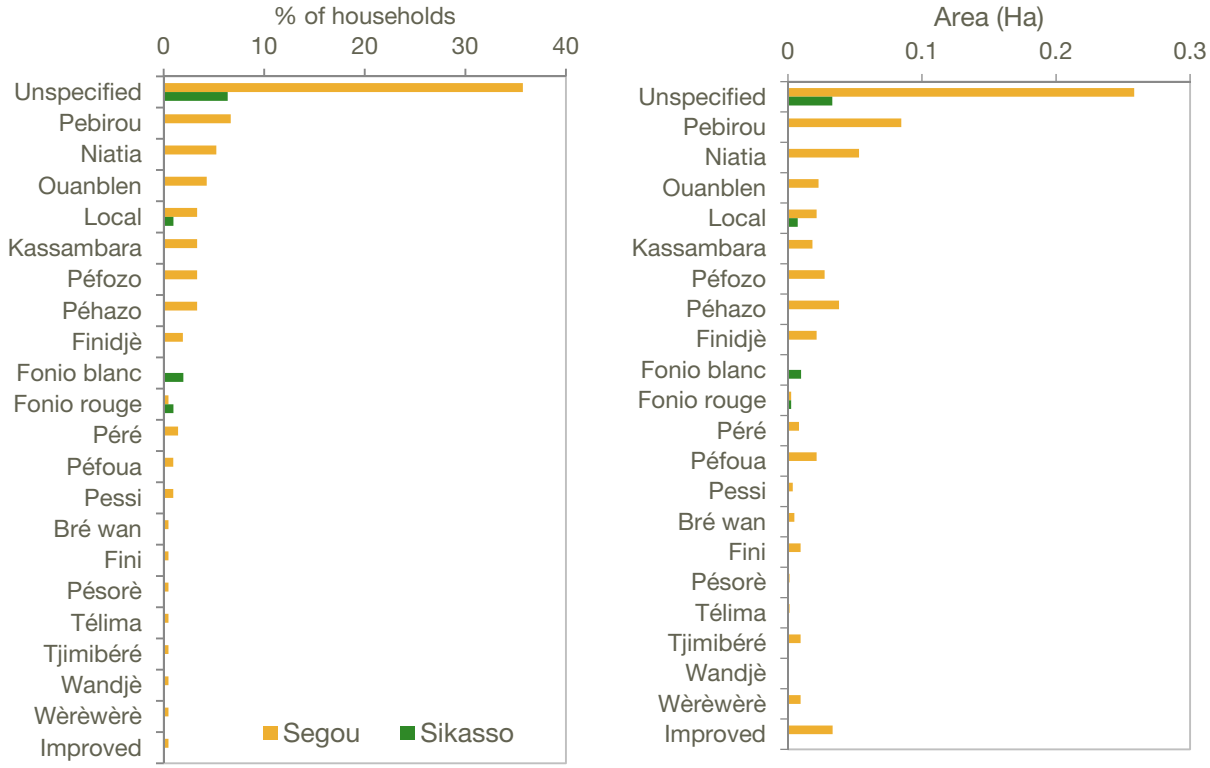

Figure 21. Percent of households growing varieties of fonio and the mean area (incl. zeros) cultivated under each variety by all the surveyed households

Table 35. Number of households cultivating fonio and area allocated to the crop

Variable	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
# of households growing fonio	178	156	22	45	44	44	23	9	0	11	2
% of households growing fonio	43.0	74.3	10.8	90.0	88.0	88.0	38.3	16.7	0.0	22.0	4.0
Mean area devoted to fonio by growers (Ha)	0.8	0.9	0.5	1.4	0.7	0.7	0.4	0.3	0.0	0.7	1.0
Mean % of rainfed land devoted to fonio by growers	13.6	14.8	4.9	20.4	13.2	13.6	9.4	3.3	0.0	6.6	3.1

Table 36. Number of households growing fonio varieties and variety richness

Variety	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Bré wan	1	1				1					
Fini	1	1		1							
Finidjè	4	4		1	3						
Fonio blanc	4		4							4	
Fonio rouge	3	1	2	1				2			
Kassambara	7	7		1	6						
Niatia	11	11		7			4				
Ouanblen	9	9			6	1	2				
Pebirou	14	14		14							
Péfoua	2	2		2							
Péfozo	7	7		3			4				
Péhazo	7	7		6			1				
Péré	3	3		3							
Pésorè	1	1					1				
Pessi	2	2					2				
Télima	1	1					1				
Tjimibéré	1	1		1							
Wandjè	1	1			1						
Wèrèwèrè	1	1			1						
Improved*	1	1		1							
Local*	9	7	2	2		1	4			1	1
Unspecified*	88	75	13	4	29	41	1	7		5	1
Total # varieties in region	19	18	2	11	6	2	7	1	0	1	0
Mean # varieties at household level	1.05	1.00	1.05	1.09	1.07	1.00	1.05	1.00	0.00	1.00	1.00

** Not counted in regional variety richness*

A total of 19 specific varieties of fonio were named across the villages. Most of these varieties were only found in Ségou region (Figure 1). The only named varieties in Sikasso were red fonio (*fonio rouge*) and white fonio (*fonio blanc*), the latter which was uniquely mentioned in this region. Often the farmers did not specify the name of the variety they grew, either referring to it as a local variety or an improved variety, or in many cases they did not know the name. The unknown varieties may be the local landrace. This common result may also indicate a lack of awareness about varietal differences in fonio. Across the villages, households typically only cultivated one variety of fonio and occasionally two varieties (Table 36). The community level richness was more variable, with the highest number of fonio varieties found in Bolimasso and Somo.

The crop-level five cell analysis revealed that fonio was grown in all the villages, however in Kaniko and Siramana there was only a very low level of cultivation (1% of households). Most of the communities reported growing fonio in small areas with the exception of Siramana, where the few households cultivating fonio grew it in relatively large areas.

The five cell analysis for fonio documented additional varieties that were not mentioned in the household surveys. In Somo, CVF477, *fini coumbaba*, *fini soumalen*, *fini telima*, and *banco kounkoutré* were noted to be grown by many families in large areas. *Banco kounkoutré* was also noted to be grown in Boumboro, along with the *pétri* variety by few families in small areas. The *pithioi* variety was documented in Finkoloni and the *wabinè* variety in N'Gountjina, in both cases grown by few families. The *piaraa* variety was documented as a lost variety in Siramana village.

Management of fonio

The work carried out for managing fonio included preparing the soil, sowing the seed, weeding, pest management, and harvesting (Table 37). In the survey, the respondents noted the family members who were engaged in each activity for managing fonio. The household members listed were more commonly men than women. There was a higher involvement of women in the cultivation activities for fonio in Sikasso, but the gender ratio was still biased toward men (Figure 22).

Table 37. The number of households carrying out different stages of fonio management and the mean proportion of household members involved in the work that were female

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Prepare earth	168 (0.1)	156 (0.1)	12 (0.2)	45 (0.1)	43 (0.1)	44 (0.1)	24 (0.1)	8 (0.2)	0	3 (0.2)	1 (0.6)
Sowing	168 (0.2)	156 (0.2)	12 (0.4)	45 (0.2)	43 (0.1)	44 (0.2)	24 (0.3)	8 (0.4)	0	3 (0.4)	1 (0.5)
Weeding	155 (0.2)	144 (0.2)	11 (0.4)	42 (0.2)	38 (0.1)	40 (0.2)	24 (0.3)	8 (0.4)	0	2 (0.4)	1 (0.5)
Pest management	114 (0.1)	103 (0.1)	11 (0.4)	30 (0)	32 (0.2)	27 (0.1)	14 (0)	7 (0.4)	0	3 (0.4)	1 (0.5)
Harvesting	165 (0.3)	153 (0.3)	12 (0.4)	45 (0.3)	43 (0.3)	44 (0.2)	21 (0.3)	8 (0.4)	0	3 (0.3)	1 (0.5)

The focus groups revealed that fonio is more of a women's' crop in Ségou, especially in Bountenisso and Somo villages. In Bolimasso and Boumboro, fonio was said to be managed by both men and women. By contrast in Sikasso, fonio was noted to be managed by men in Kaniko and N'Gountjina and by both genders in Finkoloni and Siramana. Considering other cereals, in most of the communities, sorghum, millet and maize were men's' crops. The only exception was in Siramana, where maize and sorghum were said to be managed by women. Rice was managed by both genders in most communities, except in Kaniko and N'Gountjina, where men were the primary gender involved in managing rice, as for other cereals.

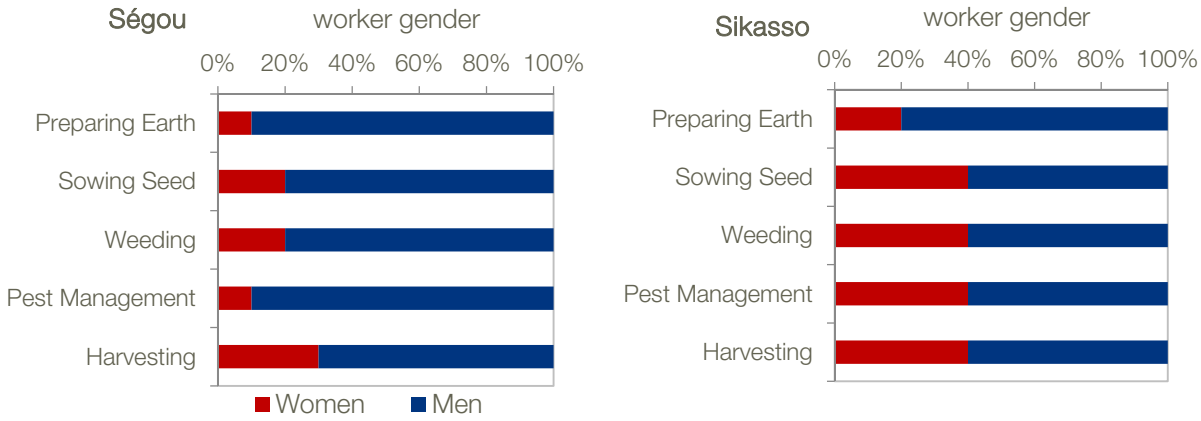

Figure 22. Gender ratio in different stages of fonio management

The sources of fonio seed reported in the survey are listed in Table 38. The most common seed sources were farmers' own production, the local diversity field and the market. Diversity fields are communal fields that support the conservation and dissemination of crop and varietal diversity which have been established in Bolimasso, Boumboro and Somo through other initiatives of IER and Bioversity International. Exchange with other farmers in the village was also reported by numerous farmers including exchanges with relatives and non-relatives.

Table 38. Seed sources for fonio

Seed Source	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Own production	85	77	8	25	20	30	2	3		4	1
Seed Exchange											
Relative	15	14	1	7	3	2	2	1			
Other villagers	13	12	1	1	7	4		1			
Market or another Community											
Market	21	12	9	5		3	4	4		5	
Bountenisso	4	4				3	1				
Women in the market	1		1							1	
Market in San	1	1				1					
Diensso	1	1				1					
Fingasso	1	1					1				
Yasso	1	1					1				
Seed Store	1	1			1						
NGO/CBO/Research organization											
Diversity field	26	26		7	11		8				
Researchers	4	4			3		1				
IER	3	3		1	2						
Union des Agriculteurs du Cercle de Tominian (UACT)	1	1		1							

Most farmers that were cultivating fonio did so without the use of any inputs. Seven percent of households, mostly in Ségou region, reported using organic manure for fonio. Three percent were using urea or different types of chemical fertilizer (*complexe céréales, engrais complexe, engrais chimique*). Just a few reported using herbicide for fonio cultivation. Fonio was not grown by any household under irrigation.

Table 39. Inputs used in fonio cultivation

Inputs	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
# households using inputs for fonio	43	41	2	10	15	9	7	1		1	
% of fonio producers using inputs	24.2	26.3	9.1	22.2	34.1	20.5	30.4	11.1		9.1	
Organic manure	31	30	1	10	8	6	6			1	
Chemical fertilizer	11	11			8	3					
Urea	5	3	2		2		1	1		1	
Herbicide	3	3			2	1					

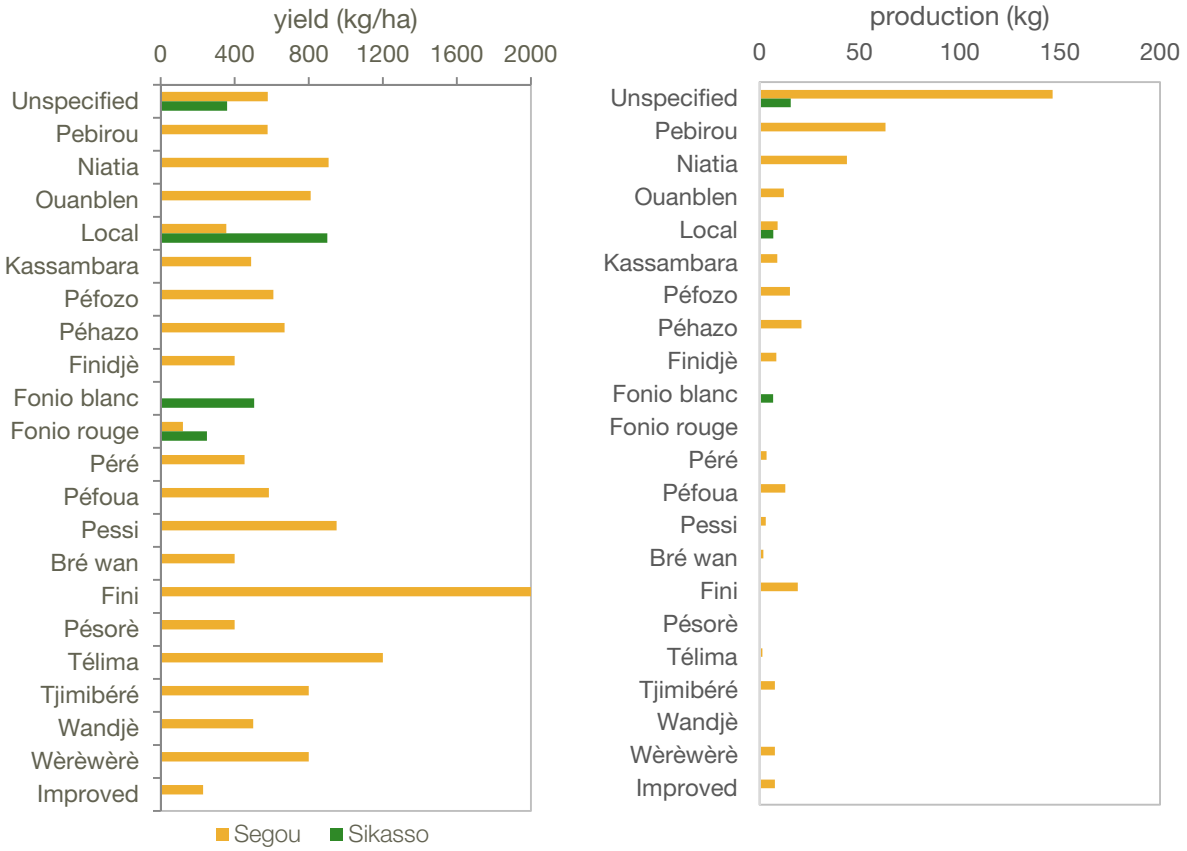

Figure 23. Mean yield of different varieties of fonio as recalled by farmers and the mean production (incl. zeros) of the variety by the surveyed households

Table 40. Mean yield and production of fonio

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Mean Yield (kg/ha)	582.8	603.1	431.3	650.4	528	563.5	757.9	366.7	-	432.6	1000
Mean Production (kg)	517.5	546.2	303.7	1024.6	354.8	381.9	277	97.2	-	419.9	1000

Overall, the mean yield of fonio achieved by the households surveyed was 582.8 kg/ha. Yields were higher on average in Ségou, yet the highest yields were reported in Siramana village in Sikasso. The other villages in Sikasso, by contrast, had below-average yields. The yields of the different varieties were quite variable (Figure 23). The *fini* variety stood out for having very high yield, while the red variety (*fonio rouge*) and 'improved' variety were lower-yielding. It is noted that these three values were each reported by only one farmer and the precision of the yield data overall is limited by the recall capacity of the farmers for the area they planted and the amount they harvested. The yields of the fonio varieties did not correspond well to their popularity.

Sale of fonio

Over a quarter of fonio producers were selling part of their harvest. Commercial production of fonio was more common in Ségou than in Sikasso. Among the different villages, fonio sales were most common in Boumboro and Bolimasso. Commercial producers sold on average 38% of their production. In Sikasso, the proportion of the harvest that was sold was much higher (three quarters), where a much lower proportion of production was sold in Ségou (a quarter). The mean volume traded was 247 kg. Higher volumes were sold on average in Sikasso than in Ségou. It is noted that the volumes sold in the different communities varied greatly. Finkoloni and Boumboro had the lowest trade volumes of fonio and N'Gountjina and Bolimasso had the highest trade volumes (Table 41).

Table 41. Number of households selling fonio and volumes traded

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
# of households selling fonio	48	38	10	14	18	4	2	4		6	
% of fonio growers selling production	27.0	24.4	45.5	31.1	40.9	9.1	8.7	44.4		54.5	
Mean % of production sold by commercial producers	37.8	27.3	76.1	21.9	31.9	26.3		76.3		76.0	
Mean volume sold by commercial producers (kg)	246.6	221.0	340.7	336.1	137.8	179.4		93.5		538.5	
CFA/Ha among commercial producers	127,413	122,874	144,056	155,006	96,079	125,625		113,000		168,900	

Just as commercial transactions for fonio were more common in Ségou than in Sikasso a wider diversity of buyers was reported in Ségou (Table 42). In Sikasso, fonio was only sold in the local market. In Ségou, farmers sold their production directly to consumers in their village, to mobile traders, at the local market, and in more distant markets. In Bolimasso, one farmer reported selling fonio to the local diversity field. All sales were made in a raw form; no households reported selling processed fonio.

While there were fewer sale transactions for fonio in Sikasso, the price achieved was notably higher in this region than in Ségou (mean 295 CFA/kg vs 188 CFA/kg). The highest price was achieved in the market in N'Gountjina, where fonio sold for a mean 310 CFA/kg. The lowest price was reported for a sale to a retailer in Boumboro for 75 CFA/kg. There was no clear pattern of some buyers offering higher prices than others. The mean income earned from commercial production of fonio was 254,261 CFA/Ha.

While some households were making income from fonio, most—especially in Sikasso—considered fonio to have a negligible contribution to their household income (Figure 24). In Ségou, slightly more households considered fonio to have at least a minor contribution to their income. Among the villages, Bolimasso and Boumboro stood out for having more households for which fonio contributed at least minimally to their income (Table 11). The fonio varieties involved in commercial transactions are shown in Table 12. Some varieties were sold more often than others. For instance, all those who reported growing white fonio (*fonio blanc*) were selling some of their production (Figure 25).

Table 42. Details on sales of fonio in Sikasso and Ségou, number of households reporting selling to buyer type and mean price obtained (CFA/kg).

Buyer	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Raw											
Mobile traders	7 (204)	7 (204)	0	1 (250)	2 (190)	4 (200)	0	0	0	0	0
Market	20 (237)	11 (193)	9 (294)	8 (184)	3 (220)	0	0	4 (275)	0	5 (310)	0
Retailers	1 (75)	1 (75)	0	0	1 (75)	0	0	0	0	0	0
Diversity field	1 (150)	1 (150)	0	1 (150)	0	0	0	0	0	0	0
Local sales	9 (184)	9 (184)	0	1 (150)	5 (188)	0	0	0	0	0	0

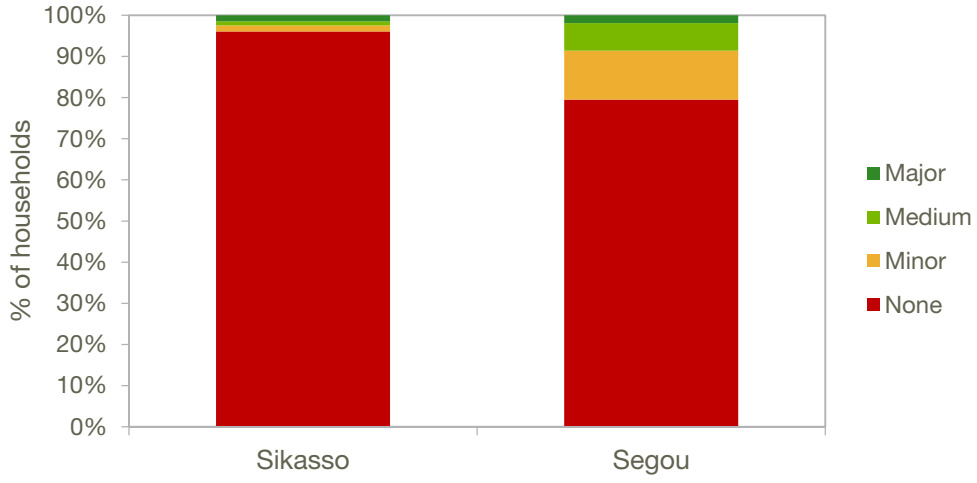

Figure 24. Importance of fonio to household income

Table 43. Number of households reporting importance of fonio to household income

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
None	363	167	196	35	33	46	53	51	50	46	49
Minor	28	25	3	9	10	3	3	3			
Medium	16	14	2	5	5	1	3			1	1
Major	7	4	3	1	2		1			3	
In top 3-5 income sources	13	10	3	2	7	1	0	1	0	2	0

Table 44. Number of households reporting selling specific varieties of fonio.

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Finidjè	3	3		1	2						
Fonio blanc	4		4							4	
Fonio rouge	1		1					1			
Kassambara	3	3			3						
Niatia	3	3		3							
Pebirou	3	3		3							
Péfozo	2	2		2							
Péhazo	2	2		2							
Tjimibéré	1	1		1							
Wandjè	1	1			1						
Wèrèwèrè	1	1			1						
Improved	1	1		1							
Local	1	1					1				

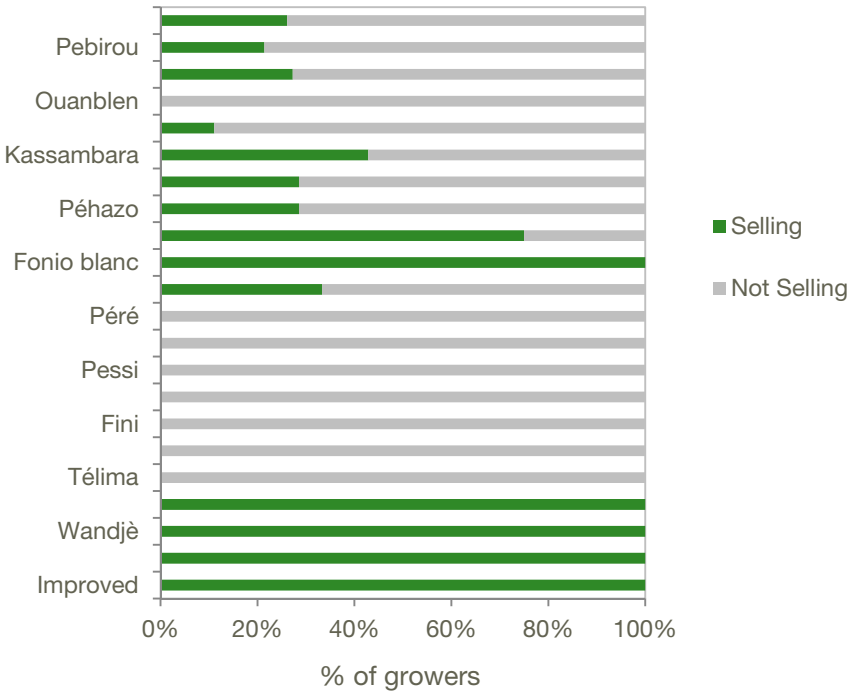

Figure 25. Percent of growers selling specific varieties of fonio

Bambara groundnut

Cultivation of Bambara groundnut

Overall, just under half of the households surveyed were cultivating Bambara groundnut (Table 13). There was a more even cultivation of Bambara groundnut between Ségou (53%) and Sikasso (42%) as compared to fonio. Among the villages in Ségou, Bambara groundnut was cultivated by the majority of households in Bolimasso (80%) and Boumboro (66%) and by fewer households in Bountenisso (36%) and Somo (33%). In Sikasso region, Bambara groundnut was grown by the most households in Finkoloni (78%), by fewer in Kaniko (44%) and N'Gountjina (26%), and more rarely in Siramana (16%).

The amount of land devoted to Bambara groundnut was slightly higher on average in Sikasso than in Ségou. In Sikasso, growers dedicated on average 0.5 Ha to Bambara groundnut, corresponding to around 5% of their rainfed land. In Ségou, a smaller mean area (0.3 Ha) was dedicated to Bambara groundnut but it represented a similar proportion of their rainfed farmland (6%).

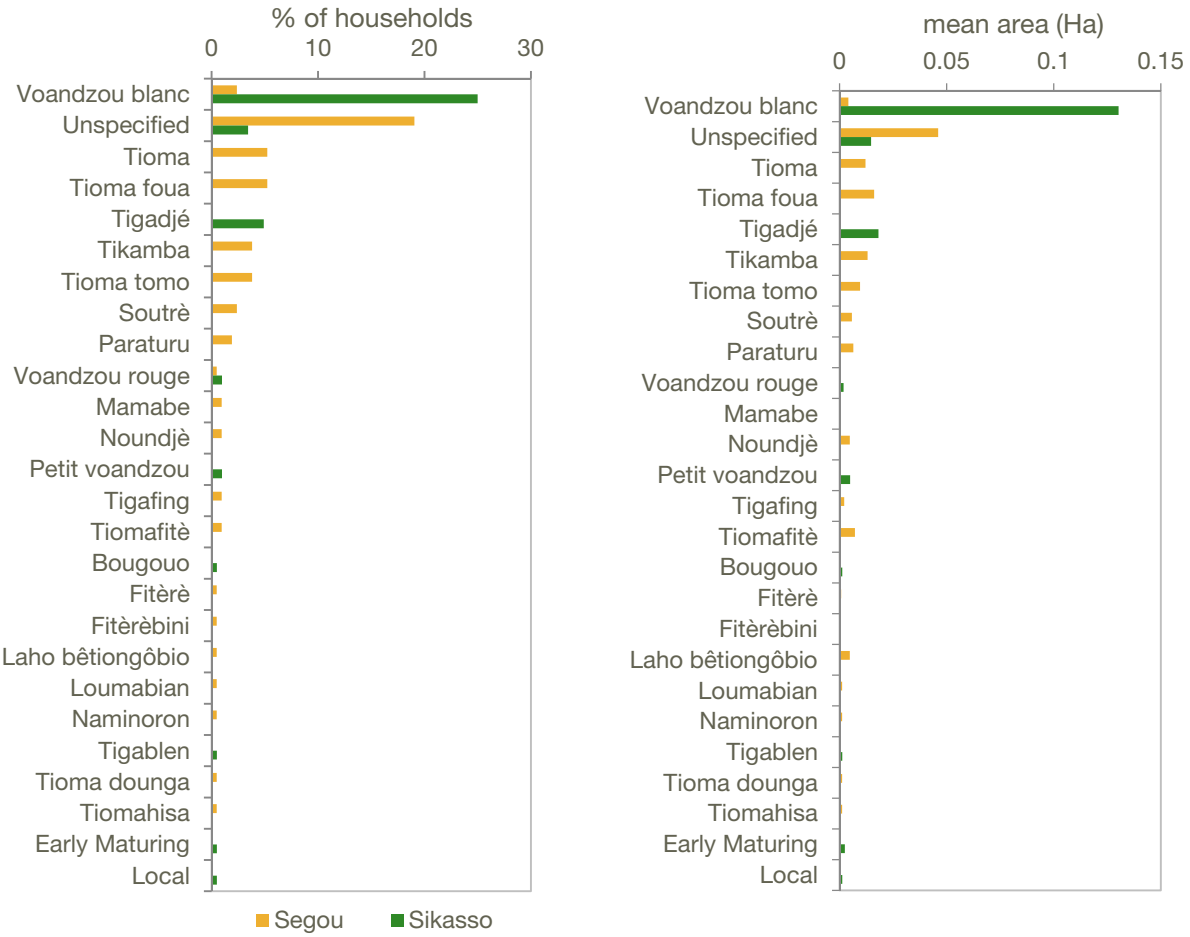

Figure 26. Percent of households growing varieties of Bambara groundnut and the mean area (incl. zeroes)

Table 45. Number of households cultivating Bambara groundnut and area allocated to the crop

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
# of households growing Bambara groundnut	196	111	85	40	33	18	20	42	22	13	8
% of households growing Bambara groundnut	47.3	52.9	41.7	80.0	66.0	36.0	33.3	77.8	44.0	26.0	16.0
Mean area devoted to Bambara groundnut by growers (Ha)	0.4	0.3	0.5	0.4	0.3	0.3	0.3	0.5	0.5	0.4	0.5
Mean %of rainfed land devoted to Bambara groundnut by growers	5.5	6.2	4.5	6.7	5.8	3.8	7.9	5.2	3.3	4.5	4.0

Table 46. Number of households growing Bambara groundnut varieties and variety richness

Variety	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Bougouo	1		1						1		
Fitèrè	1	1					1				
Fitèrèbini	1	1					1				
Laho bêtiongôbio	1	1		1							
Loumabian	1	1					1				
Mamabe	2	2				2					
Naminoron	1	1			1						
Noundjè	2	2		2							
Paraturu	4	4			4						
Petit voandzou	2		2					1	1		
Soutrè	5	5		1			4				
Tigablen	1		1					1			
Tigadjé	10		10					10			
Tigafing	2	2			2						
Tikamba	8	8			8						
Tioma	11	11		9			2				
Tioma dounga	1	1					1				
Tioma foua	11	11		7		1	3				
Tioma tomo	8	8		7			1				
Tiomafitè	2	2		2							
Tiomahisa	1	1		1							
Voandzou blanc	56	5	51	3			2	23	18	4	6
Voandzou rouge	3	1	2				1	1			1
Early Maturing*	1		1								1
Local*	1		1								1
Unspecified*	47	40	7		22	17	1	5	2		
Total # varieties in region	23	19	6	9	4	2	10	5	3	1	2
Mean # varieties at household level	1.05	1.07	1.01	1.00	1.12	1.11	1.06	1.00	1.00	1.00	1.13

** Not counted in regional variety richness*

A total of 23 specific varieties of Bambara groundnut were grown across the villages. As seen for fonio, most of the varieties were only found in Ségou region (Figure 1). The named varieties in Sikasso were white (*voandzou blanc*), red (*voandzou rouge*), little (*petit voandzou*), *tigadgé*, *tigablen*, and *bougouau*. The latter four varieties were only noted in Sikasso. The white variety (*voandzou blanc*) was by far the most popular in

Sikasso. In Ségou, farmers most commonly did not specify the name of their Bambara groundnut variety. The unspecified varieties may be local landraces. This result can also indicate a low awareness of variety differences in Bambara groundnut. Similar to the results for fonio, households typically cultivated only one variety of Bambara groundnut and occasionally two varieties. Also as seen for fonio, the highest variety richness of Bambara groundnut was found in Bolimasso and Somo villages (Table 14).

The crop-level five cell analysis revealed that Bambara groundnut was grown in all the eight communities. Few households cultivated Bambara groundnut in N'Gountjina (2%) and Siramana (5%) and Kaniko (15%), while in the other villages between 60-75% of households were estimated to cultivate the crop. In most of the communities, Bambara groundnut was considered by the farmers to be grown in small areas. The exception was Finkoloni and Siramana where it was said to be grown in relatively large areas.

The five cell analysis for Bambara groundnut varieties documented additional varieties that were not mentioned in the household surveys. Most of the extra varieties were noted in Sikasso region: *Diemani* in Siramana, Finkoloni and N'Gountjina; *blemani* in Siramana and Finkoloni; *coumaba* in N'Gountjina and Finkoloni, *nounfini* and *yoroba* in Finkoloni; *boufigué*, *bougnu*, *tioma soutre*, and *tioma tiene* in Kaniko; *naindje* and *nounblen* in N'Gountjina; and *wolotigani* in Siramana. A few additional varieties were also noted in Ségou: *Tioma bio*, *tioma dawane*, and *tioma hesa* in in Bolimasso, *tioma mouan* in Bountenesso; *moan bléma*, *tioma poi*, *tioma santre*, and *tioma tiobo* in Boumboro.

Management of Bambara groundnut

The work carried out for managing Bambara groundnut included preparing the soil, sowing the seed, weeding, pest management, and harvesting. In contrast to fonio, it seemed there was a higher involvement of women in the management of Bambara groundnut but still the household members involved in the cultivation activities were more commonly men than women. In Sikasso, and Siramana village in particular, there was notably higher involvement of women in cultivation activities for Bambara groundnut.

Table 47. Number of households carrying out different stages of fonio management and the proportion of female members involved in the work.

Role	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Preparing the soil	197 (0.2)	112 (0.1)	85 (0.3)	41 (0.1)	33 (0.1)	18 (0.1)	20 (0)	42 (0.3)	22 (0.2)	13 (0.1)	8 (0.7)
Sowing the seed	195 (0.3)	111 (0.3)	84 (0.4)	40 (0.3)	33 (0.3)	18 (0.2)	20 (0.4)	42 (0.4)	21 (0.3)	13 (0.3)	8 (0.7)
Weeding	189 (0.3)	107 (0.2)	82 (0.3)	40 (0.2)	31 (0.2)	16 (0.2)	20 (0.2)	41 (0.3)	22 (0.3)	11 (0.2)	8 (0.8)
Pest management	146 (0.2)	67 (0.1)	79 (0.3)	23 (0.1)	23 (0.2)	9 (0.1)	12 (0.1)	40 (0.2)	21 (0.3)	11 (0.2)	7 (0.6)
Harvesting	193 (0.4)	109 (0.4)	84 (0.4)	40 (0.4)	33 (0.4)	18 (0.3)	18 (0.3)	42 (0.3)	22 (0.3)	13 (0.2)	7 (0.9)

Figure 27. The gender ratio of workers in the cultivation stages of fonio

Similar to the results for fonio, the focus groups revealed that Bambara groundnut is more of a women's' crop in Ségou—especially in Bountenisso and Somo. In Bolimasso and Boumboro, it was said to be managed by both men and women. In Sikasso by contrast, fonio was said to be managed by men in Kaniko and N'Gountjina and by both genders in Finkoloni and Siramana. Considering the gendered management of other legumes, it was found that peanut was managed by both men and women in most of the communities. The exception was N'Gountjina, where peanut was said to be managed mainly by men. Cowpea was also managed in most communities by both genders, with the exception of N'Gountjina and Kaniko where it was more of a male-managed crop. Soy was said to be a male-managed crop in Finkoloni and N'Gountjina and managed by both genders in Siramana.

The sources of Bambara groundnut seed are listed in Table 48. The most common seed sources were farmers' own production and the market. Exchange with other farmers in the village was also reported by numerous farmers, including exchanges with relatives and non-relatives. The diversity field was a less common source of seed for Bambara groundnut than it was for fonio.

Table 48. Seed sources for Bambara groundnut

Seed Source	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Own production	84	40	44	13	15	9	3	27	13	2	2
Seed exchange											
Other villager	15	14		3	8	2	1	1			
Relative	9	8		4	3	1		1			
Farmer in another village	1	1					1				
Market or another community											
Market	65	37	16	13	8	6	10	12	9	2	5
Konkuy	1	1			1						
Tiotio	1	1			1						
Kotobé	1	1				1					
Mandiakuy	1	1				1					
NGO/CBO/research organization											
Diversity field	3	3					3				
NGO	2		2								2

Most farmers that were cultivating Bambara groundnut did so without the use of any inputs. Eight percent of households—mostly in Ségou region—reported using organic manure. Three percent of households were using urea and 2% were using chemical fertilizers—*complexe cereals*, *engrais chimique*, Diammonium phosphate (DAP). A few households reported using compost in cultivation of Bambara groundnut. No household was growing Bambara groundnut under irrigation.

Overall, the mean yield of Bambara groundnut achieved by the households surveyed was 553 kg/ha. As was seen for fonio, yields were higher on average in Ségou. Whereas highest yields for fonio were reported in Siramana, the lowest yields of Bambara groundnut were reported in this village. The highest Bambara groundnut yields were in Somo village. The yields of the different varieties were quite variable (Figure 28). The *fitéré* and red (*voandzou rouge*) varieties stood out for having high yields, while the *tioma tomo*, *tioma foua* and *tioma fité* varieties were lower yielding. The accuracy of the yield data overall was limited to the recall capacity of the farmers for the area planted and mass harvested. Some varieties were also grown by very few farmers, which limits the reliability of these estimates. The yields of the fonio varieties did not correspond well to their popularity.

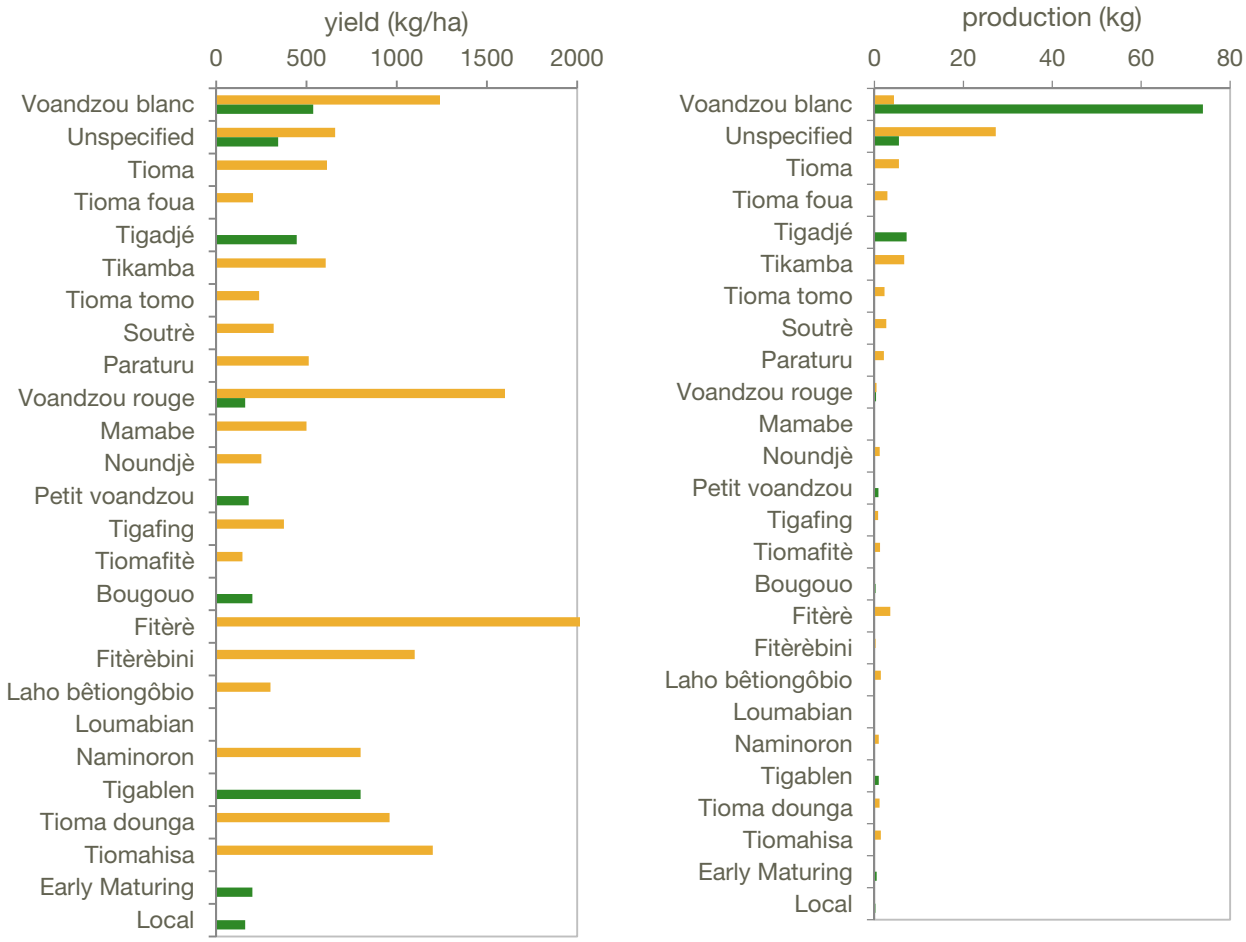

Figure 28. Mean yields of Bambara groundnut varieties and household production (kg)

Table 49. Inputs used in Bambara groundnut cultivation

Inputs	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
# households using inputs for Bambara groundnut	45	15	20	11	9	-	5	6	8	3	3
% of Bambara groundnut producers using inputs	23.0	22.5	23.5	27.5	27.3		25.0	14.3	36.4	23.1	37.5
Organic manure	32	21	11	11	5		5	3	5	3	
Urea	11	3	8		3			1	4		3
Chemical fertilizer	9	6	3		6				2		1
Compost	3	0	3					3			

Table 50. Mean yield and household production of Bambara groundnut

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Mean Yield (kg/ha)	552.7	603.9	483.7	413.6	607.9	655.1	911.2	533.7	451.7	690	212.5
Production (kg)	183.3	138	244.3	101.5	149.7	166.3	156.2	223	340.6	97.5	161.3

Sale of Bambara groundnut

Thirty seven percent of Bambara groundnut producers were selling part of their harvest (Table 51). Sale of Bambara groundnut was slightly more common among producers in Sikasso than in Ségou region. Among the villages, commercialization of Bambara groundnut was most common in Boumboro and Finkoloni. Farmers were selling a mean 58% of their production, which was similar across regions. The mean volume sold was 171.1 kg. Mean traded volumes of Bambara groundnut were nearly double in Sikasso compared to Ségou.

Table 51. Number of households selling Bambara groundnut and the relative percentage of growers that were producing commercially

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
# of households selling Bambara groundnut	73	35	38	2	26	4	3	22	8	6	2
% of Bambara groundnut growers selling production	37.2	31.5	44.7	5.0	78.8	22.2	15.0	52.4	36.4	46.2	25.0
Mean % of Bambara groundnut production sold by commercial producers	58.1	61.1	55.2		62.0	53.3		57.6	50.3		50.0
Mean volume sold by commercial producers (kg)	171.1	116.1	226.1		109.6	170.0		178.1	346.0		262.5
CFA/Ha among commercial producers	157,999	140,551	175,446		133,517	199,167		143,816	284,286		95,000

Most sales of Bambara groundnut were made in a raw form but some sales were made of a processed form, including dehulled and roasted. A distinction between sales of wet-raw and dry-raw Bambara

groundnut was made in a few cases but in most records, this distinction was not specified. In Table 52, records of selling wet-raw Bambara groundnut were grouped with other records of selling 'raw' Bambara groundnut, while the dry-raw records were grouped separately. It is noted that this is an area of variability that would likely affect the price achieved.

Table 52. Details on sales of Bambara groundnut in Sikasso and Ségou, number of households reporting selling to buyer type and mean price obtained (CFA)

Buyer	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Raw											
Mobile traders	2 (225)	2 (225)	0	0	0	2 (225)	0	0	0	0	0
Local market	24 (279)	4 (275)	20 (279)	0	3 (200)	1 (500)	0	12 (270)	7 (314)	0	1 (150)
Mandiakuy Market	2 (250)	2 (250)	0	0	2 (250)	0	0	0	0	0	0
Retailer	1 (250)	1 (250)	0	0	1 (250)	0	0	0	0	0	0
Wholesaler	1 (125)	1 (125)	0	0	1 (125)	0	0	0	0	0	0
Women Processors	1 (125)	1 (125)	0	0	1 (125)	0	0	0	0	0	0
Local sales	4 (213)	4 (213)	0	0	4 (213)	0	0	0	0	0	0
NGO	1 (200)	0	1 (200)	0	0	0	0	0	0	0	1 (200)
Dried											
Local Market	4 (216)	0	4 (216)	0	0	0	0	4 (216)	0	0	0
De-hulled											
Local sales	2 (225)	2 (225)	0	0	2 (225)	0	0	0	0	0	0
Grilled											
Mobile traders	1 (300)	1 (300)	0	0	1 (300)	0	0	0	0	0	0
Local sales	1 (200)	1 (200)	0	0	1 (200)	0	0	0	0	0	0

In Sikasso region, Bambara groundnut was mainly sold in the local market but there was one record of selling it to an NGO. In Ségou there was a greater diversity of buyers recorded, especially in Boumboro village, where commercial transactions were reported for Bambara groundnut at the local market, a more distant market, retailers, wholesalers, local sales, mobile vendors, and a women's processing group. It was notably only in this village where sales of processed Bambara groundnut were reported, which could relate to the activities of this women's group. In the other villages in Ségou region, a lower diversity of buyers was reported, mainly the local market and mobile vendors. The highest price for Bambara groundnut was

achieved in the market in Kaniko (mean 314 CFA/kg). The lowest prices were reported in Boumboro for sales to a local wholesaler and the women's processing group (125 CFA/kg). There was not an obvious difference in the price of Bambara groundnut between regions.

The mean per hectare income from Bambara groundnut was 157,999 CFA/Ha. Although some households were making an income from Bambara groundnut, most considered it to have a negligible contribution to their income—especially in Ségou (Figure 29). In Sikasso, slightly more households considered Bambara groundnut to have a minor to major contribution to their income. Boumboro and Finkoloni villages stood out in having more households considering Bambara groundnut at least a minor part of their income.

Table 53. Number of households reporting importance of Bambara groundnut to household income

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
None	333	155	178	49	26	47	56	26	43	38	48
Minor	34	18	16		10	2	4	14	1	3	
Medium	30	17	13	1	11	1		8	2	5	2
Major	17	14	3		3			6	4	4	
Top 3-5 income sources	35	14	21		12	2		16	5		

Table 54. Number of households reporting selling specific varieties of Bambara groundnut

Variety	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Fitèrè	1	1					1				
Naminoron	1	1			1						
Paraturu	4	4			4						
Petit voandzou	2		2					1	1		
Tigadjé	4		4					4			
Tigafing	2	2			2						
Tikamba	6	6			6						
Tiomahisa	1	1		1							
Voandzou blanc	21		21					12	6	1	2
Unspecified	23	21	2		17	4		2			

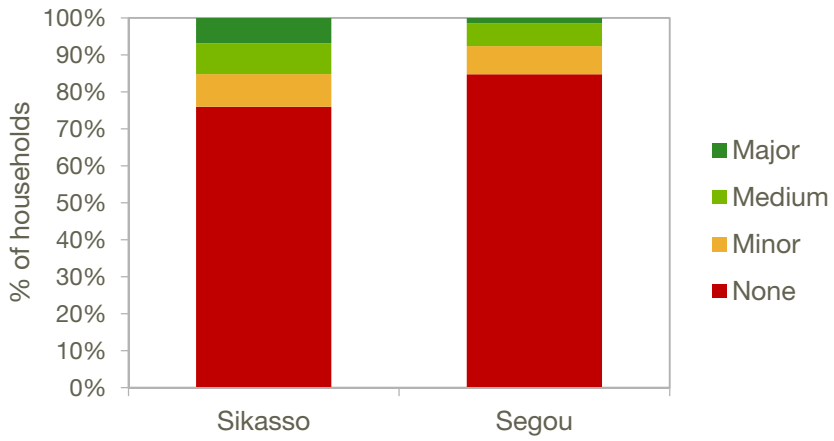

Figure 29. Importance of Bambara groundnut for household income

The Bambara groundnut varieties that were involved in commercial transactions are shown in Table 54. Some varieties were sold more often than others (Figure 30). For example the tioma and tioma foua varieties were grown by several farmers but were not sold. The tikamaba and parature varieties by contrast were sold by all their producers.

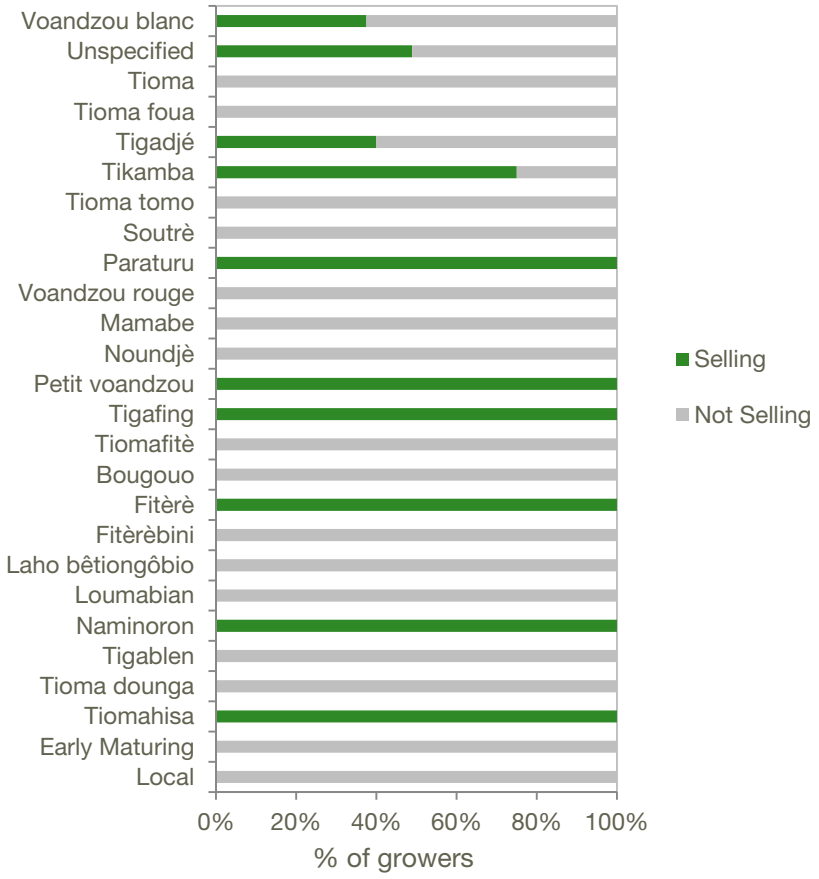

Figure 30. Percent of growers selling varieties of Bambara groundnut relative the percent of households growing the varieties

Vegetables

Cultivation of vegetables

Half of the households surveyed reported cultivating some vegetable species. Vegetables were more commonly cultivated in Sikasso (63%) than Ségou (36%) and in larger areas (Table 56). Larger areas were assigned to vegetable cultivation compared to fonio and Bambara groundnut, especially in Sikasso region. A notably large mean area was assigned to vegetable production by households in Siramana and Somo villages.

Table 55. Number of households cultivating vegetables and mean area

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
# of households growing vegetables	206	71	135	15	17	16	23	35	35	34	31
% of households growing vegetables	51.0	36.2	66.2	32.0	34.0	40.0	38.3	64.8	70.0	68.0	62.0
Mean area devoted to vegetables by growers (Ha)	0.9	0.6	1.1	0.5	0.1	0.3	1.3	0.5	0.7	0.6	2.7
Mean number of vegetable species cultivated	1.2	0.8	1.7	0.8	0.9	0.6	0.8	1.4	1.9	2.3	1.2

A total of 24 vegetable species were cultivated across the study communities (Table 16), while individual households cultivated a mean 1.2 vegetable species (Table 55). Most of the vegetable species were more commonly cultivated by households in Sikasso than in Ségou (Figure 6). The most common vegetable species was tomato. Other common vegetables were okra, chili, onion, eggplant, and cucumber. These most popular vegetables were grown in relatively small areas. By contrast, sweet potato, yam, and pumpkin were grown by fewer households but in relatively large areas. Of the 24 vegetable species recorded, only five were from possible local origins: okra, West African sorrel, African eggplant, roselle, and yam (Table 56). The three unidentified species in Ségou (*bunu untio, dawani* and *diamadia*) could also likely be native to the region. Even for the species that have West African origins, the actual varieties used may not necessarily have originated in the region.

Most of the varieties grown were local or with names unknown to the producers. A subspecies of onion—shallot—was commonly grown in Ségou region. Other named onion varieties were *koumada* (N=2), *diabacoumaba* (N=2), and *forotocoumaba* (N=1). For tomato, five households reported growing the *migoni* variety, and single households were growing the *kassambara*, *tomatikoumaba*, and *gros grain* varieties. More varieties were named for okra, including *gouanteli*, *gouandjan*, *gouansourou*, long, *court*, *noir*, and *petit grain*. Named varieties of eggplant were *chocolat* and *blanche;* of cabbage were *corporuche* and *choux vert*, and of cucumber were *noir*, *petit*, and *teguere misini*. Three households reported growing a white sweet potato variety.

Additional vegetables used in the communities were documented in the focus group discussions. In particular, taro was noted in the five cell analysis in N'Gountjina and Somo and bottlegourd was noted in the five cell analysis in Finkoloni. Taro is of South-Southeast Asian and Pacific origin (Khoury et al. 2016), while bottlegourd is of African origin (Decker-Walters et al 2001). Wild species collected in periods of climate stress were also discussed in the focus groups, which brought up a number of species not captured in the production-oriented household survey. The species mentioned included fruits and leaves of baobab (*Adansonia sp.)*, wild yam (*Dioscorea* sp.), *néré* (*Parkia biglobosa),* shea, and *tongué* (*Leptadania hastate*). Several wild roots were collected with the local names *bafa*, *baga*, *balôlô* (all three similar to potato), *niana kokou* (like wild yam), and *soukoubali* (similar to onion). A variety of other specieis were mentioned with local names *blen, corchoms, lèèma, dataruim, dnké, nenufare, pèhou, rinsin sauvage, saban, sira, sounsoun, tabakouba,* and *tomons*.

Table 56. Species names, common names and geographic origins of vegetables grown by the surveyed communities (Source: Khoury et al 2016 unless otherwise specified)

Scientific name	Common names	Origin*
Abelmoschus sp.	Okra, lady finger, gombo	E & W Africa; S Asia*
Allium cepa	Onion, oignon, echalotte^	W & C Asia
Abelmoschus escuelentus	Okra, lady finger, bhindi	E & W Africa; S Asia*
Beta vulgaris subsp. vulgaris	Beet, betterave	N, SE & SW Europe; S&SE Mediteranean
Brassica oleracea	Cabbage, choux	SE & SW Europe; S & SE Mediteranean; E Asia
Capsicum sp.	Chili, piment	Tropical S America; C America & Mexico; Carribean
Capsicum annuum	Bell pepper, poivron	Tropical S America; C America & Mexico, Carribean
Corchorus sp.	West African sorrel, kokorice	Africa, S Asia**
Cucumis sativus	Cucumber, concombre	S, SE & E Asia
Cucurbita sp.	Squash, courge	N America; C America & Mexico; Tropical S America
Daucus carota subsp. sativus	Carot, carotte	SE & SW Europe; S & E Mediteranean; W & C Asia
Dioscorea sp.	Yam, igname	W Africa; S & SE Asia; Tropical S America
Hibiscus sabdariffa	Roselle, dah	Africa; S Asia***
Ipomoea batatas	Sweet potato, patate douce	C America & Mexico; Tropical S America
Lactuca sp.	Lettuce, laitue	SE, SW & N Europe; S & SE Mediteranean; W&C Asia
Manihot esculenta	Cassava, manioc	C America & Mexico; Tropical S America
Phaseolus vulgaris	Common bean, haricot	C America & Mexico
Solanum aethiopicum	African eggplant, jaxatu	Tropical Africa
Solanum lycopersicum	Tomato, tomate	Andean S America
Solanum melongena	Eggplant, aubergine	S, SE & E Asia
Solanum tuberosum	Potato, pomme de terre	Andean S America
Spinacia oleracea	Spinach, epinard	W Asia
Unknown	Bunu untio	
Unknown	Dawani	
Unknown	Diamadia	

* Kumar et al 2010
** Benor et al 2012, Kundu et al 2013
*** Satya et al 2013
^ Subspecies *Allium cepa var. aggregatum*

Management of vegetables

The work carried out for managing of vegetables included preparing the soil, sowing the seed, weeding, pest management, irrigation and harvesting (Table 27). In the survey, the respondents noted the family members who were engaged in each activity for managing vegetables. The household members listed were more commonly men than women. In Ségou, there was a relatively higher involvement of women in the cultivation activities for vegetables, especially compared to results for fonio and Bambara groundnut (Figure 4).

The focus groups revealed that cucumber, pumpkin, bottlegourd, cassava, onion, potato, chili, taro and tomato were managed by both genders across the eight communities. There were only a few exceptions where crops were said to be managed more by one gender. Okra and African eggplant were noted to be managed by women in Finkoloni. Yam was noted to be managed by men in Finkoloni, Kaniko, and N'Gountjina.

Table 57. The number of households carrying out different stages of vegetable management and the mean proportion of household members involved in the work that were female

Role	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Prepare earth	192 (0.3)	61 (0.5)	131 (0.2)	14 (0.4)	17 (0.9)	13 (0.2)	17 (0.4)	35 (0.2)	38 (0.1)	33 (0.2)	25 (0.4)
Sowing	191 (0.3)	61 (0.5)	130 (0.3)	14 (0.5)	17 (0.9)	13 (0.2)	17 (0.5)	35 (0.3)	37 (0.2)	33 (0.2)	25 (0.4)
Weeding	185 (0.3)	61 (0.5)	124 (0.2)	14 (0.4)	17 (0.8)	13 (0.2)	17 (0.4)	32 (0.3)	36 (0.2)	33 (0.2)	23 (0.3)
Pest management	171 (0.3)	45 (0.5)	126 (0.2)	11 (0.4)	13 (0.8)	9 (0.2)	12 (0.4)	35 (0.2)	36 (0.1)	32 (0.1)	23 (0.3)
Harvesting	189 (0.4)	59 (0.7)	130 (0.2)	14 (0.6)	17 (0.9)	13 (0.4)	15 (0.7)	35 (0.3)	38 (0.1)	32 (0.2)	25 (0.3)

Figure 31. Gender ratio in different stages of vegetable management

In Ségou over a quarter of vegetable producers used irrigation. It was rare to use irrigation for vegetables in Sikasso region (Table 58). Irrigation was most common in Bolimasso but was also reported by several farmers in Boumboro and Somo. Inputs were used by around half of vegetable producers, slightly more often in Sikasso. The inputs used were mostly different types of fertilizer, including organic manure and chemical fertilizers (DAP, *complexe cereals*, etc.) (Table 59). Pesticide and herbicide use were more rarely reported. The most common sources of seed for vegetables were the market and farmers' own production (Table 60).

Table 58. Use of irrigation in vegetable production

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
# of households growing vegetables under irrigation	21	19	2	8	5	1	5	0	1	1	0
% of vegetable producing households using irrigation	10.2	26.8	1.5	53.3	29.4	6.3	21.7	0	2.9	2.9	0

Table 59. Use of inputs in vegetable production

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
# of households using inputs in vegetable production	101	26	75	11	7	1	7	12	21	22	20
% of households using inputs in vegetable production	49.0	36.6	55.6	73.3	41.2	6.3	30.4	34.3	60.0	64.7	64.5
Organic manure	73	26	47	10	6	1	7	7	12	17	10
Urea	40	2	38		1		1	5	12	10	11
Chemical fertilizer	51	5	46	3	2			7	9	16	14
Compost	8	1	7	1				1	4	1	
Pesticide	3	3			2						
Herbicide	1	1		1							

Table 60. Seed sources for vegetables (number of records considering various vegetables)

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Own production	149	13	136	*9*	*2*	*2*		*20*	*32*	*57*	*27*
Seed exchange											
Other villager	12	9	3	1	3	1	4	3			
Relative	15	6	9	1	1	2	2	7	2		
Farmer in another village	1	1				1					
Market or other community											
Market	248	83	165	22	20	13	28	34	57	53	21
Dougabougou	1	1		1							
Fangasso	1	1					1				
Marché de Mandiakuy	1	1			2						
San	2	2			2	3	2				
Sikasso	7	7		1							
Sinsso	1	1					1				
Tara	1	1					1				
N'Gountjina	1		1					1			
NGO/CBO/Research organization											
Diversity field	3	3					3				
Red cross	3	3		3							
NGO	2		2					1	1		
Project	1		1					1			
Gardening project	3	3			3						
Secteur d'Agriculture	2	2		2							
World vision	3	3			3						

Sale of vegetables

70% of vegetable producers were selling part of their harvest (Table 61). Commercial production of vegetables was more common in Sikasso than in Ségou region. The vegetable species that were being produced commercially are shown in Table 32. Almost all the vegetable species were being sold by most of their producers. Compared to fonio and Bambara groundnut many more respondents—especially in Sikasso region— considered vegetables to have at least a minor contribution to their income. About a quarter of households in Sikasso considered vegetables to have a major contribution to their income.

The highest mean price producers achieved for vegetables was for dry chili (1061 CFA/kg). Fresh chili also had a notably high market price (615 CFA/kg). Cassava stood out for its high price of 1000 CFA/kg but it is noted that this was only one record, so is not a reliable benchmark for the market price. Other tuber crops—beets and potatoes—also had above-average prices. By contrast yam had the lowest price per kilogram price recorded, noting this was only for one record so there is possibility that it does not reflect the true market price. Dry onions were another processed vegetable product that brought good prices to producers, especially in Somo village.

Table 61. Number of households selling vegetables

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
# of households selling vegetables	175	50	125	12	16	10	12	30	34	32	29
% of vegetable growers selling production	70.0	51.5	81.7	63.2	51.6	34.5	66.7	63.8	79.1	94.1	100.0

Table 62. Number of households reporting importance of vegetables to household income

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
None	243	162	81	39	35	42	46	25	13	18	25
Minor	52	18	34	3	7	3	5	11	9	4	1
Medium	51	14	37	3	8	2	1	11	1	9	
Major	68	16	52	5		3	8	7		19	
Top 3-5 income sources	46	11	35	4	1	5	1	11	15	9	

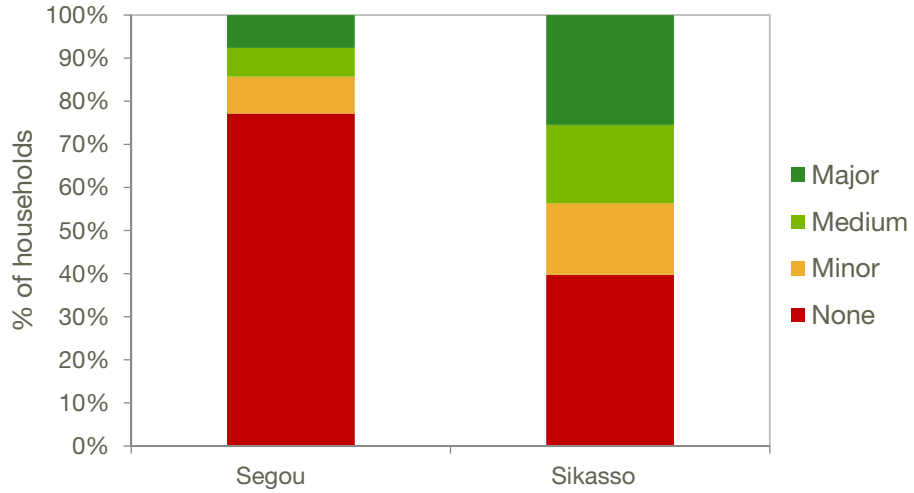

Figure 32. Importance of vegetables to household income

Table 63. Mean prices farmers obtained from sale of vegetables (CFA/Kg). Price for fresh produce unless specified.

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Capsicum sp.	615	372	692	328	400		400	1090	400	707	333
Dry	1061	260	1463			260		150		1100	3500
Manihot esculenta	1000	1000					1000				
Allium cepa	299	283	331	283	283	267	213	200	263	733	
Dry	420	420				255	750				
Beta vulgaris	400	400			400						
Solanum tuberosum	400		400								400
Solanum lycopersicum	315	260	334	283	269		206	288	309	467	192
Dry	250		250					250			
Capsicum annuum	323		323					250	260	298	700
Brassica oloracea	305	293	309	483	100		200	200	233	750	225
Cucurbita sp.	300		300							300	
Abelmoschus sp.	242	249	239	113	250		333	267	205	266	169
Dry	123	260	100			260					300
Solanum aethiopicum	201	300	130		500		200		100	120	138
Daucus carota	200	200					200				
Corchorus olitorius	185		185								185
Cucumis sativus	183		183					175	154	217	
Solanum melongena	155	190	140	208			163	55	125	189	143
Ipomoea batatas	145	200	73	275	100					100	67
Lactuca sp.	131	133	123	100			150		45	200	
Dioscorea sp.	65		65								65

Food security and diet diversity

The food security and diet diversity of the households surveyed was assessed using a variety of indicators with the questions directed to the woman respondent. In order to better understand patterns of food insecurity in the eight villages, the months of adequate household food provisioning indicator (Bilinski and Swindale, 2010) and the Household Food Insecurity Access Scale (HFIAS) (Coates, Swindale & Bilinski 2007) were applied. The Minimum Dietary Diversity for Women (MDD-W) was applied to assess diet quality (FAO and FHI 360, 2016). The description of these indicators and results are presented below.

Food security (access dimension)

Months of adequate household food provisioning

Months of adequate household food provisioning (Bilinski and Swindale, 2010) is a tool used to better understand the patterns of food insecurity throughout the year. Respondents were asked to indicate which months last year they did not have enough food to eat. The highest numbers of households experienced food insecurity from July to September, which coincides with the lean period before harvest (Table 64, Figure 33). In October, after the crops are harvested, the number of households that experienced insufficient food supplies halved. Of the 414 households interviewed, 76% experienced food insecurity for less than three months of the year, 21% for three to six months, 3% for six to nine months, and only 1% for more than nine months of the year (Table 3).

A higher percent of households experienced food insecurity at some point of the year in Ségou than in Sikasso. In total, 73% of households in Ségou experienced inadequate food provisioning in at least one month of the year, while in Sikasso the percentage was lower (59%). In Ségou, food insufficiency was also experienced more consistently over the year, with September being the peak month. The average number of months that a households experienced food insufficiency was 1.9 in Ségou and 1.3 in Sikasso. In Sikasso, the highest rates of food insufficiency were observed in July (22.5%) and in August (41.7%), while in the remaining months, less than 15% of households reported food insufficiency.

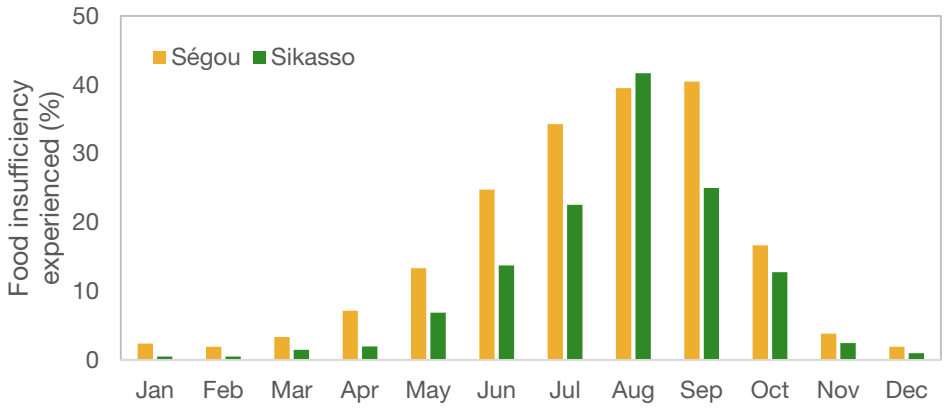

Figure 33. Percent of households that experienced insufficient food supply by month

Table 64. Number of households reporting inadequate food provisioning

Month	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Jan	6	5	1		1		4	1			
Feb	5	4	1				4	1			
Mar	10	7	3				7	3			
Apr	19	15	4	3		3	9	3		1	
May	42	28	14	7	1	9	11	5	5	3	1
Jun	80	52	28	14	4	15	19	11	8	9	
Jul	118	72	46	20	5	20	27	20	9	13	4
Aug	168	83	85	26	11	14	32	33	21	23	8
Sep	136	85	51	21	14	18	32	20	9	17	5
Oct	61	35	26	4	8	5	18	7	2	12	5
Nov	13	8	5		3		5	1		2	2
Dec	6	4	2				4	1			1

Households in Somo village had consistently higher rates of food insufficiency throughout the year compared to the other villages surveyed, with the exception of August when Finkoloni stood out with the highest percentage of vulnerable households (61.1% experiencing food insufficiency). In Somo and Finkoloni, food insufficiency was experienced by some households every month of the year, whereas the other villages had more distinct periods of food sufficiency.

Table 65. Number of households that experienced months of food insufficiency over last year

Food insufficient	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
<3 months	316	154	162	33	46	42	33	37	45	33	47
3-6 months	81	44	37	15	4	7	18	13	5	16	3
6-9 months	7	7	0	0	0	0	7	0	0	0	0
>9 months	3	2	1	0	0	0	2	1	0	0	0

Household Food Insecurity Access Scale (HFIAS)

The Household Food Insecurity Access Scale (HFIAS) is a tool that assess the relative level of household food insecurity (Coates, Swindale & Bilinski 2007). It determines whether the respondent's household has experienced nine conditions of food insecurity in the past four weeks and how often (Table 4). The conditions assessed fall in three domains of food insecurity: i) anxiety and uncertainty about the household food supply; ii) insufficient food quality; and iii) insufficient food intake. A score from one to three is assigned to each condition depending on the frequency of occurrence: 1) rarely (once or twice), 2) sometimes (three to ten times) or 3) often (more than ten times) in the past four weeks. A score of zero is assigned if the condition did not occur. The HFIAS Score is calculated by summing the scores for each of the nine questions, resulting in a continuous variable ranging from 0 to 27. Higher scores indicate more food insecure households.

Based on the conditions they had experienced over the last four weeks, households can be classified under four categories of food insecurity. If a household has not experienced any of the food insecurity conditions, or rarely experienced worry, it is considered *food secure*. A *mildly food insecure* household experienced worry sometimes or often and rarely sacrificed food quality. A *moderately food insecure* household

sacrificed quality sometimes or often and only rarely cut back on the quantity of food, but never experienced any of the three most severe conditions. A *severely food insecure* household often renounced adequate size or number of meals and experienced at least one of the three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating) with any degree of frequency. The number of households falling under these food security categories is known as the HFIA Prevalence.

Conditions and domains of food insecurity

The most common condition of food insecurity experienced by the respondents in the eight villages was worry that their household would not have enough food (40%; Table 66). The second most common condition experienced was to not be able to eat preferred foods (33%), followed by eating smaller meals (30%). Generally, fewer households in Sikasso had experienced the conditions of food insecurity assessed in the nine questions of the HFIAS in the last four weeks (Figure 34). The majority of households surveyed had experienced anxiety and uncertainty about food supply, while a decreasing percentage of households experienced conditions in the domains of insufficient food quality and insufficient food intake (Table 67).

HFIAS Score

The mean HFIAS scores were well below the maximum of 27 across the communities. The mean HFIAS score was lower in Sikasso than in Ségou, indicating higher levels of food security (Table 66). Siramana was the most food secure village with the lowest HFIAS Score, whereas Somo was the least food secure village. It is noted that as the survey took place between the end of October and the beginning of November, so these data do not refer to the period of highest food insufficiency in the year, which was found to be August through September by the months of adequate household food provisioning assessment above.

HFIA Prevalence

Fifty-seven percent of households overall were *food secure*, meaning that these households did not experience any condition of food insecurity, or only worried, in the past four weeks (Table 68). By contrast, 22% of households were *severely food insecure,* meaning they often reduced meal sizes or frequency and experienced at least one of the three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating). A higher percentage of *severely food insecure households* was observed in Ségou region as compared to Sikasso (Figure 35). *Mildly food insecure* (7%) and *moderately food insecure* (14%) households represented the smallest percentage of the sample. The higher number of *severely food insecure* households, compared to *mildly* or *moderately food insecure* households, is explained by the fact that a household automatically falls in this category when it has experienced one of the three most severe conditions with any degree of occurrence.

Boumboro and Siramana had the highest prevalence of *food secure* households, and the lowest prevalence of *mildly, moderately* and *severely* food insecure households. In Finkoloni, households were more evenly distributed amongst the four categories. The village with the highest number of severely food insecure households was Somo, followed by Bountenisso.

Table 66. HFIAS questions and number of households reporting conditions experienced in last four weeks, with mean of frequency of occurrence among those who experienced the condition

Q	Condition	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Anxiety and uncertainty about household food supply												
1	In the past four weeks, did you worry that your household would not have enough food?	164 (1.56)	83 (2.22)	81 (1.73)	18 (2.05)	7 (2.14)	22 (2.28)	36 (2.28)	32 (1.87)	19 (1.26)	26 (1.92)	4 (1.5)
Insufficient quality of food												
2	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	135 (1.28)	79 (2.20)	56 (1.66)	20 (2.15)	7 (1.85)	20 (2.25)	32 (2.28)	23 (1.56)	9 (1.33)	18 (1.83)	6 (2)
3	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	115 (1.06)	69 (1.97)	46 (1.69)	19 (1.68)	4 (1.75)	18 (1.94)	28 (2.21)	18 (1.66)	9 (1.33)	16 (2)	3 (1.33)
4	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	101 (0.93)	57 (1.98)	44 (1.70)	10 (2.3)	5 (2)	19 (1.89)	23 (1.91)	23 (1.91)	10 (2.3)	19 (1.89)	5 (2)
Insufficient food intake												
5	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	124 (1.13)	71 (2.01)	53 (1.54)	15 (2)	4 (2)	21 (2.14)	31 (1.93)	20 (1.65)	8 (1.37)	21 (1.57)	4 (1.25)
6	In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food?	105 (0.97)	62 (2.04)	43 (1.65)	10 (1.9)	5 (1.8)	18 (2.22)	29 (2.03)	18 (1.66)	6 (1.83)	19 (1.58)	0
7	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	59 (0.53)	31 (1.74)	28 (1.71)	4 (1)	2 (1)	9 (1.88)	16 (1.94)	12 (1.41)	4 (2)	12 (1.91)	0
8	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	52 (0.44)	26 (1.65)	26 (1.38)	3 (1.33)	1 (2)	9 (2)	13 (1.46)	13 (1.3)	2 (1)	10 (1.6)	1 (1)
9	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	44 (0.34)	28 (1.68)	16 (1.5)	5 (1.2)	2 (2)	8 (1.87)	13 (1.7)	8 (1.62)	2 (1)	6 (1.5)	0
Mean HFIAS Score		**4.03**	**4.38**	**2.57**	**4.86**	**3.76**	**3.66**	**6.35**	**3.04**	**3.18**	**3.3**	**0.57**

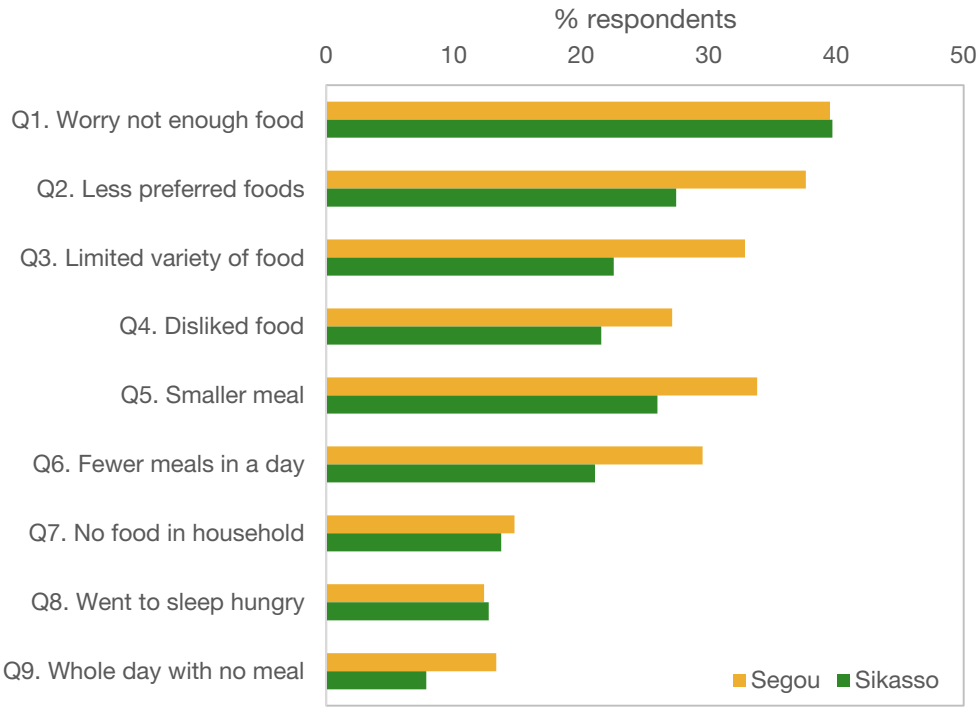

Figure 34. Percent of households experiencing HFIA conditions in past four weeks (questions described in detail in Table 67)

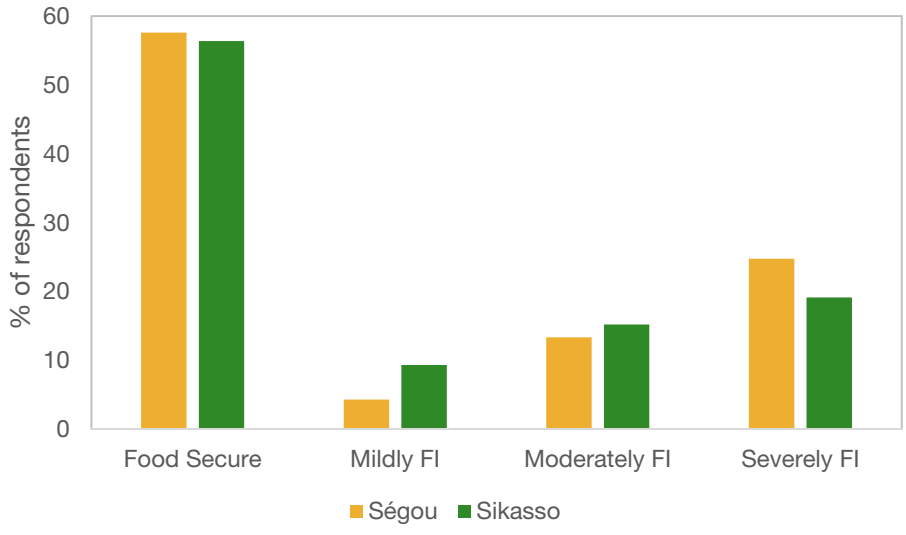

Figure 35. HFIA Prevalence: Percent of households falling under four categories of food insecurity

Table 67. HFIA related domains. Number of households reporting any condition in these domains.

Domain	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Anxiety and uncertainty about household food supply	164	83	81	18	7	22	36	32	19	26	4
Insufficient quality of food	351	205	146	49	16	57	83	64	28	53	14
Insufficient food intake	384	218	166	37	14	65	102	71	22	68	5

Table 68. HFIA Prevalence: Number of households falling under four categories of food insecurity

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Food Secure	236	115	121	29	43	27	22	18	33	23	41
Mildly food insecure	28	19	9	3	2	1	3	6	7	2	4
Moderately food insecure	59	31	28	10	3	4	11	12	5	10	4
Severely food insecure	91	39	52	8	2	18	24	18	5	15	1

Diet Quality

Minimum dietary diversity for Women (MDD-W)

The MDD-W (FAO and FHI 360, 2016) is a dichotomous indicator used is used as a proxy to understand the micronutrient adequacy of the diet of women of reproductive age (between 15 and 49), who are often vulnerable because of their physiological demands. The MDD-W is composed by ten defined and mutually exclusive food groups, briefly described in the list below:

1. **Grains, white roots and tubers and plantains:** Also called “starchy staples”, these foods provide energy and varying amounts of micronutrients and anti-nutrients.
2. **Pulses (bean, peas and lentils):** This group includes members of the plant family *Fabaceae*, but not the peanut. The seeds of *Fabaceae* are harvested at maturity, dried, and then consumed or further processed.
3. **Nuts and seeds:** This group comprises mostly tree nuts, peanuts and certain seeds and “butters” derived from nuts or seed that are consumed in substantial amounts and therefore are important in the diet. Nuts and certain seeds are rich in unsaturated fatty acids, vegetable protein, fiber, minerals, tocopherols, phytosterols and phenolic compounds.
4. **Dairy:** This group provides high quality proteins, as well as potassium, calcium, vitamin B12 and other important micronutrients.
5. **Meat, poultry and fish:** Sometimes referred as “flesh foods”, this group includes all meats, organ meats, bush meats, fresh and dried fish, seafood, reptiles, and amphibians. This group is an important source of high-quality protein, iron, zinc, and vitamin B12.
6. **Eggs:** From any type of bird, they provide proteins, vitamin B12, and other bioavailable micronutrients.

7. **Dark green leafy vegetables:** This groups is composed by all medium-to-dark green leafy vegetables (such as Chinese cabbage (*Brassica rapa)* or green leaves of other food crops) that are rich in Vitamin A, folate, and other important micronutrients.
8. **Vitamin A-rich fruits and vegetables:** This group includes vitamin A-rich fruits, such as ripe mango, and vitamin A-rich vegetables other than leafy greens, such as carrot and pumpkin. These foods are also good sources of vitamin C, folate, and other micronutrients.
9. **Other vegetables:** This group includes vegetables that are not rich in vitamin-A or dark green in color, and legumes when consumed fresh. Vegetables are an important source of fiber, phenols, and flavonoids.
10. **Other fruits:** This group includes most fruits, vitamin A-rich fruits excluded.

The MDD-W indicator is calculated as the number of the above 10 food groups which were consumed in the last 24 hours. In addition to the above ten food groups, data was also collected on optional food categories which were not counted in the MDD-W indicator: Red palm oil, other oils and fats, savory and fried snacks, sweets and sugar-sweetened beverages, insects and other small protein foods, condiments and seasonings, and other beverages and foods.

A woman of reproductive age is considered to have an adequate diet when she consumes foods from at least 5 different food groups in the past 24 hours. MDD-W is a dichotomous indicator, which divides the surveyed population between those women that consumed less than 5 different food groups and those that consumed more than five food groups. The following analysis of dietary diversity was made considering only women of reproductive age, which are between 15 and 49 years old. All the women respondents older than 49 were excluded from the calculations so the sample size was slightly smaller than the total number of households surveyed (N=298) (Table 69).

Table 69. Sample size for the MDD-W analysis which included only women of reproductive age

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
# women of reproductive age	298	150	148	42	40	36	32	37	35	39	37

Number of food groups consumed for women of reproductive age (MDD-W)

The mean number of food groups eaten by women of reproductive age in the recall period of 24 hours was 4.57±1.32 St. Dev. Fifty-two percent of respondents overall had consumed more than 5 food groups in the last 24 hours (Table 70). The largest number of respondents ate items from four or five different food groups (Figure 36). Sixteen percent of respondents had eaten only two or three food groups, and 23% ate six or more food groups. Three women (two from Somo village) had eaten only one food group in the last 24 hours.

The number of food groups consumed was similar but slightly higher on average in Ségou (4.71 ±1.4) as compared to Sikasso (4.43±1.23). In Ségou, 59% of respondents had eaten foods from five or more categories, while fewer in Sikasso had reached this threshold (45.9%). The village of Boumboro stood out for the majority (80%) of respondents having consumed more than five food groups in past 24 hours. On the other hand, the village of N'Gountjina stood out for the majority of women not having reached minimum dietary diversity.

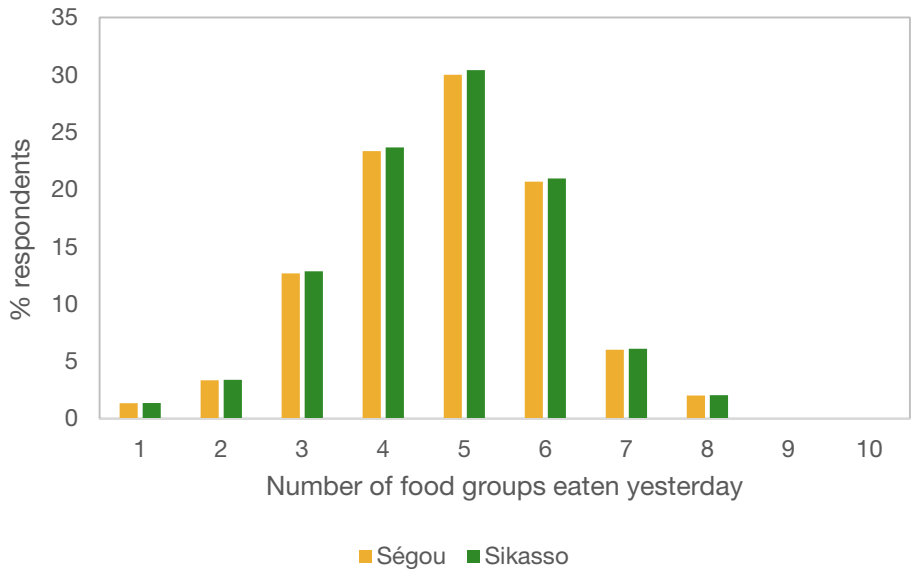

Figure 36. Food group diversity scores

Table 70. Mean MDD-W scores and number of women of reproductive age with a score above and below five

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Mean MDD-W	4.57	4.71	4.43	4.45	5.3	4.78	4.25	4.73	4.63	4.02	4.35
MDD-W <5	142	62	80	22	8	15	17	15	16	27	22
MDD-W ≥5	156	88	68	20	32	21	15	22	19	12	15

Table 71. Number of women of reproductive age consuming each food group

Food group	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Grains, roots & tubers	296	148	148	41	40	35	32	37	35	39	37
Dark green leafy vegetables	208	98	110	26	31	25	16	34	28	28	20
Vitamin A rich fruit and veg	93	57	36	18	13	10	16	13	12	6	5
Other vegetables	204	92	112	27	30	17	18	27	24	30	31
Other fruits	10	3	7	1	1		1	3	3		1
Meat, poultry and fish	255	140	115	36	40	35	29	24	33	28	30
Eggs	9	3	6	0	3	0	0	4		1	1
Nuts and seeds	130	89	41	10	38	33	8	17	8	8	8
Pulses	104	58	46	20	10	13	15	13	11	9	13
Dairy	53	19	34	8	6	4	1	3	8	8	15

Food groups consumed

Almost all the women interviewed (99%) had consumed grains, roots or tubers in the past 24 hours (Table 71). Meat, poultry, and fish was the second most consumed food group (86%), which was mainly due to high consumption of fish and seafood products (Figure 38). High rates of consumption were also observed for dark green leafy vegetables (70%) and other vegetables (68%). All other food groups were consumed by less than 50% of the overall sample. Nuts and seeds were consumed in the last 24 hours by 43% of the women interviewed and pulses by 35%. Vitamin-A rich produce was only consumed by 31% of the women interviewed. It was more common for the women to eat vitamin-A rich vegetables than vitamin-A rich fruits, noting that fruit consumption was generally much lower than vegetable consumption. There was almost negligible consumption of eggs.

Dark green leafy vegetables, and 'other vegetables' were more commonly consumed in Sikasso (Table 71). In Ségou, the consumption of vegetables, including dark leafy ones, was much higher among those respondents who had reached minimum diet diversity. By contrast, in Sikasso, those that had achieved minimum dietary diversity had more often consumed dairy, nuts and seeds, and vitamin A-rich fruits and vegetables.

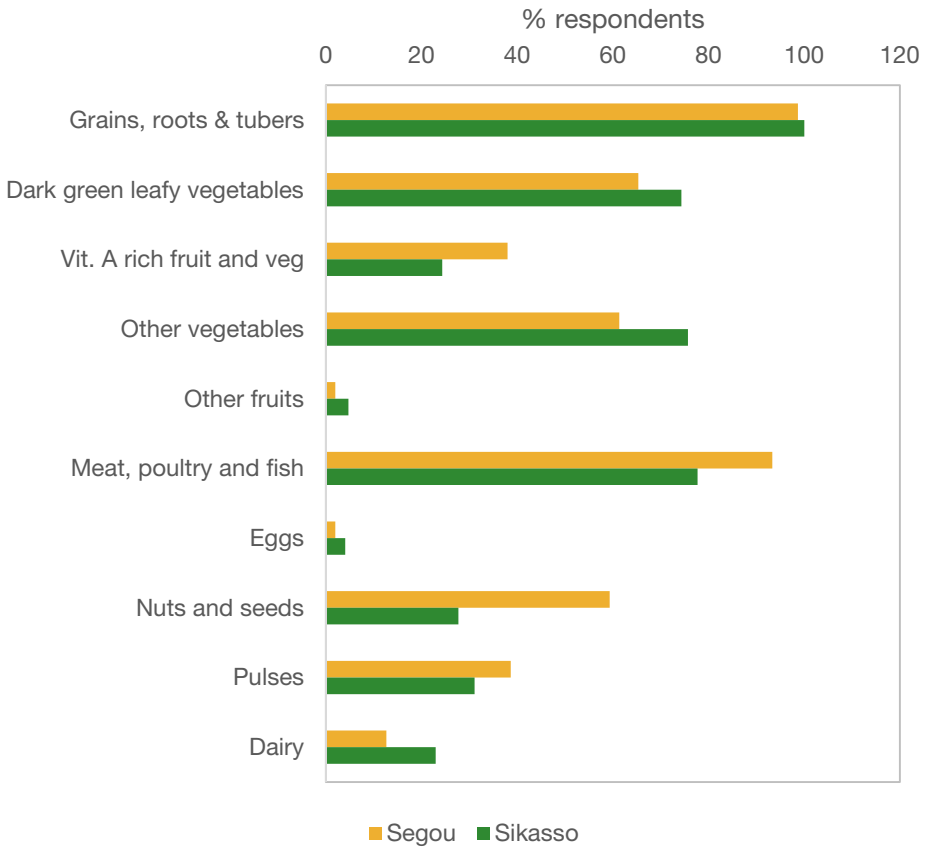

Figure 37. Food groups consumed in past 24 hours by women of reproductive age

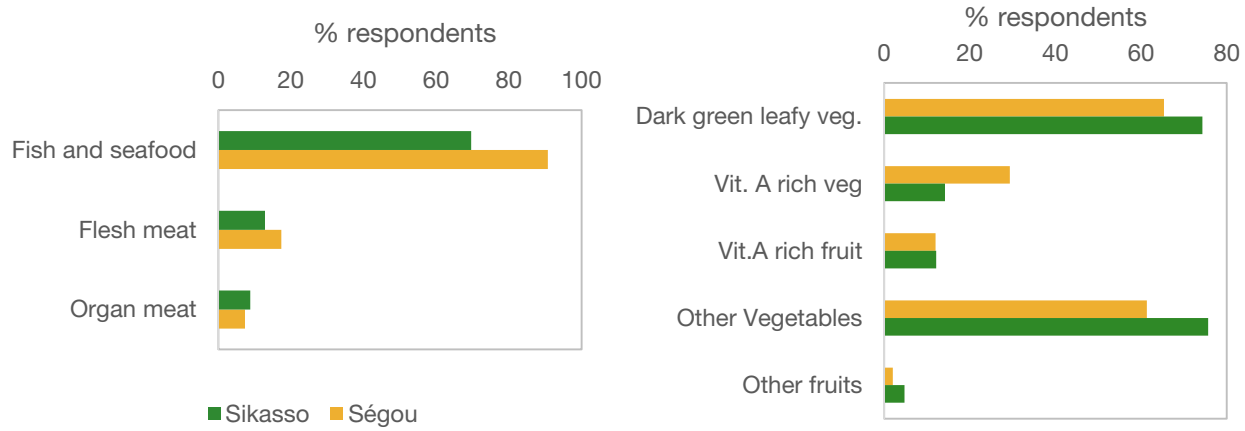

Figure 38. Detail on flesh foods consumption (right) and fruits and vegetables consumption (left) by women of reproductive age in last 24 hours

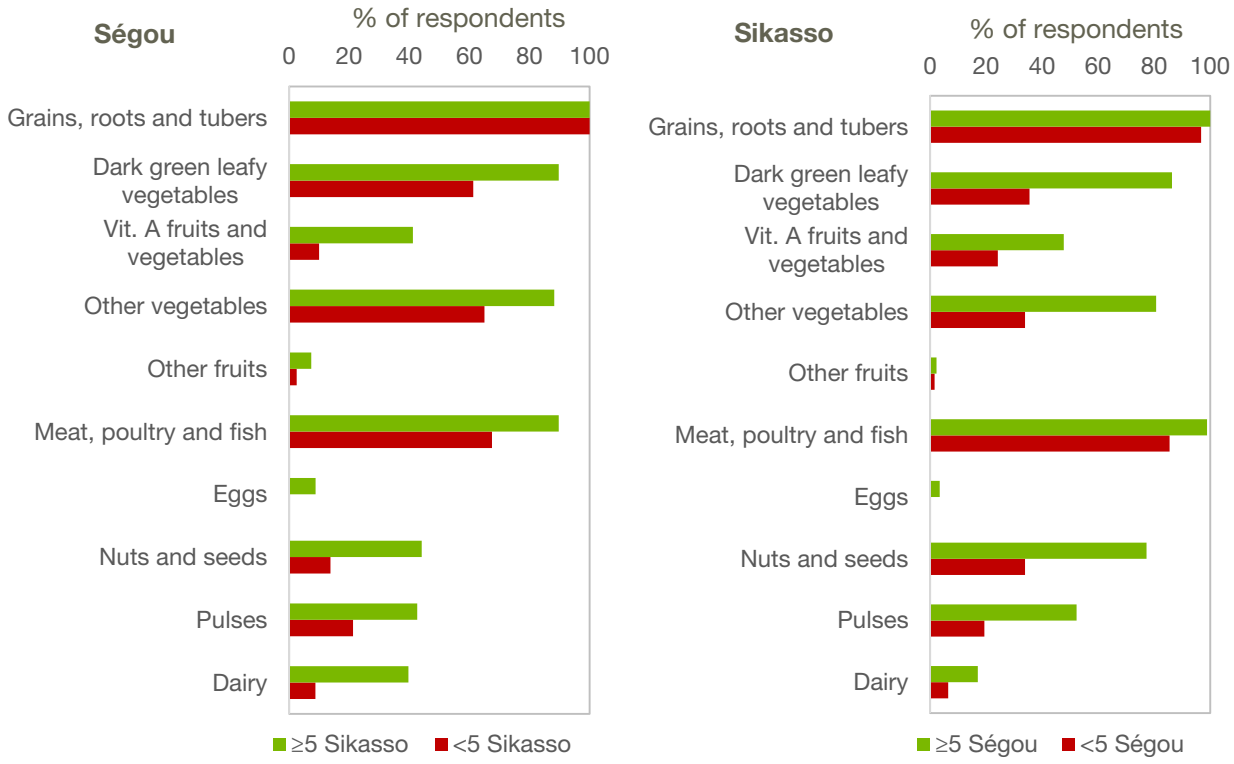

Figure 39. Percent of respondents consuming food groups, for respondents who had reached minimum diet diversity (consumption of at least 5 food groups) and those who had not reached minimum diet diversity

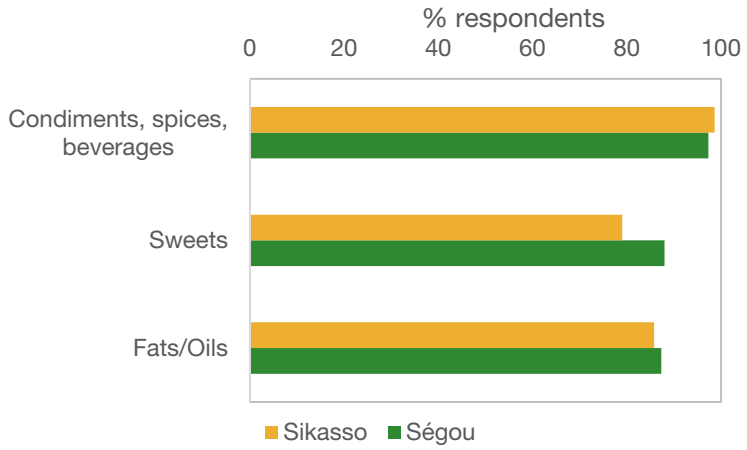

Figure 40. Low nutrient density food groups' consumption

Ninety-eight percent of women had consumed condiments, spices and beverages, 86% had consumed fats/oils and 83% had consumed sweets in the last 24 hours (Figure 40). These low nutrient density foods are not considered in the MDD-W indicator. Fats and oils provide a great quantity of energy but only a limited amount of micronutrients. Sweets are very energy dense but nutrient poor, and condiments, spices and beverages are mostly consumed in small quantities (less than 15g) to provide flavor.

Number of food groups consumed by women of all ages

The ages of the women respondents for the full sample ranged from a minimum of 15 to a maximum of 70 years. The MDD-W was calculated for the whole sample of 414 households, including all ages of respondent as supplementary information. As seen above for women of reproductive age, the sample was evenly distributed between those respondents that had eaten less than five food groups in the last 24 hours, and those that had eaten five or more food groups.

Table 72. Mean MDD-W score and number of women with an MDD-score above and below 5 for full sample of 414 households, including women respondents of ages between 15 and 70 years.

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Mean MDD-W Score	4.55	4.67	4.43	4.52	5.16	4.86	4.25	4.59	4.72	4.1	4.3
# with MDD-W <5	202	93	109	26	12	22	33	24	21	34	30
# with MDD-W ≥5	212	117	95	24	38	28	27	30	29	16	20

Food groups in the production system

A total of eight species were grown across the communities that belonged to the starch-heavy group of *grain, white roots, tubers and plantains*, including pearl millet, sorghum, maize, fonio, rice, potato, yam, and cassava. Three species of *pulses* were grown, namely Bambara groundnut, cowpea, and soya. Peanut and sesame were two species grown in the *nuts and seeds* category. *Dark green leafy vegetables* were provided by four species, namely, spinach and West African sorrel, sweet potato, and cowpea. Cabbage (*Brassica oleracea*) and lettuce could also be dark leafy vegetables, but not all varieties fall under this category, so for the most conservative estimates these crops were categorized as *other vegetables*. Aside from the dark leafy vegetables, o*ther vitamin A-rich fruits and vegetables* grown in these production systems included eight species: carrot, chili, papaya (*Carica papaya*), sweet potato tubers, bell pepper (*Capsicum annum*), pumpkin, melon, and watermelon (*Citrullus lanatus*). There were ten o*ther vegetables* including lettuce and cabbage, as well as eggplant, cucumber, onion, okra, tomato, green bean, African eggplant and beetroots. Bananas were *other fruits* grown, which were not explicitly known to be rich in vitamin-A. Sweet potato was counted as both a dark leafy green and another vitamin-A rich vegetable. Cowpea was counted as both a dark leafy green and a pulse. For the current analysis roselle was not counted since the primary use is for a beverage.

Table 73. Total number of species of crop type grown at community/regional levels

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Other vegetables	10	10	9	6	8	5	9	6	8	9	5
Other vitamin-A rich vegetables and fruits^	8	4	7	2	4	3	4	4	3	5	4
Grain, white roots, tubers, and plantains	8	6	7	5	5	5	6	5	4	5	7
Dark leafy greens*^	4	3	3	2	2	3	2	1	1	3	3
Pulses*	3	2	3	2	2	2	2	3	3	3	2
Nuts and seeds	2	2	2	2	2	2	2	2	1	2	2
Other fruit	1		1						1	1	1

Table 74. Mean number of species of crop type grown at household level (incl zero)

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Grain, white roots, tubers, and plantains	3.1	3.3	3.0	3.1	3.2	3.8	4.0	3.1	2.9	3.1	2.7
Nuts and seeds	0.9	1.2	0.7	1.1	1.2	1.2	1.3	0.9	0.6	0.6	0.4
Other vegetables	0.9	0.6	1.2	0.5	0.8	0.5	0.0	1.2	1.2	1.6	0.9
Pulses*	0.8	0.9	0.7	1.4	1.0	0.7	0.6	1.1	0.9	0.5	0.3
Dark leafy greens*^	0.4	0.4	0.3	0.7	0.4	0.3	0.3	0.3	0.4	0.2	0.5
Other vitamin-A rich vegetables and fruits^	0.3	0.1	0.4	0.1	0.1	0.1	0.0	0.4	0.4	0.8	0.1
Other fruit	<0.1		<0.1						0.1	<0.1	<0.1

The household farms provided better sources of some food groups than others. The largest areas of farmland by far were allocated to the starches, followed by nuts and seeds, due to the large areas of peanut grown (Table 75). The third largest areas, especially in Sikasso, were assigned to non-vitamin A-rich *'other' vegetables* (Figure 41). Smallest areas were assigned to fruits and dark green leafy vegetables, which are two important, nutrient-dense food groups. Overall, households maintained a mean of 3.1 starch crops, 0.9 nut/seed crops, 0.9 other vegetable crops, and less than one pulse, dark green leafy or vitamin-A rich vegetable, and fruit crop.

Table 75. Mean area (Ha) of crop type grown (incl. zero)

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Grain, white roots, tubers, and plantains	6.7	4.2	9.4	4.6	3.5	4.5	4.1	9.7	11.8	7.6	8.4
Nuts and seeds	0.9	1.3	0.6	1.3	1.4	0.9	1.4	0.8	0.8	0.6	0.3
Other vegetables	0.2	0.2	0.3	0.0	0.0	0.0	0.5	0.2	0.4	0.2	0.2
Pulses	0.4	0.4	0.4	0.6	0.5	0.3	0.2	0.7	0.6	0.3	0.2
Other vitamin-A rich vegetables and fruits	0.2	0.0	0.4	0.0	0.0	0.0	0.0	0.10	0.1	0.2	1.2
Dark leafy greens	0.4	0.3	0.5	0.3	0.3	0.3	0.1	0.26	0.3	0.2	1.3
Other fruit	<0.1		<0.1						<0.1	0.1	<0.1

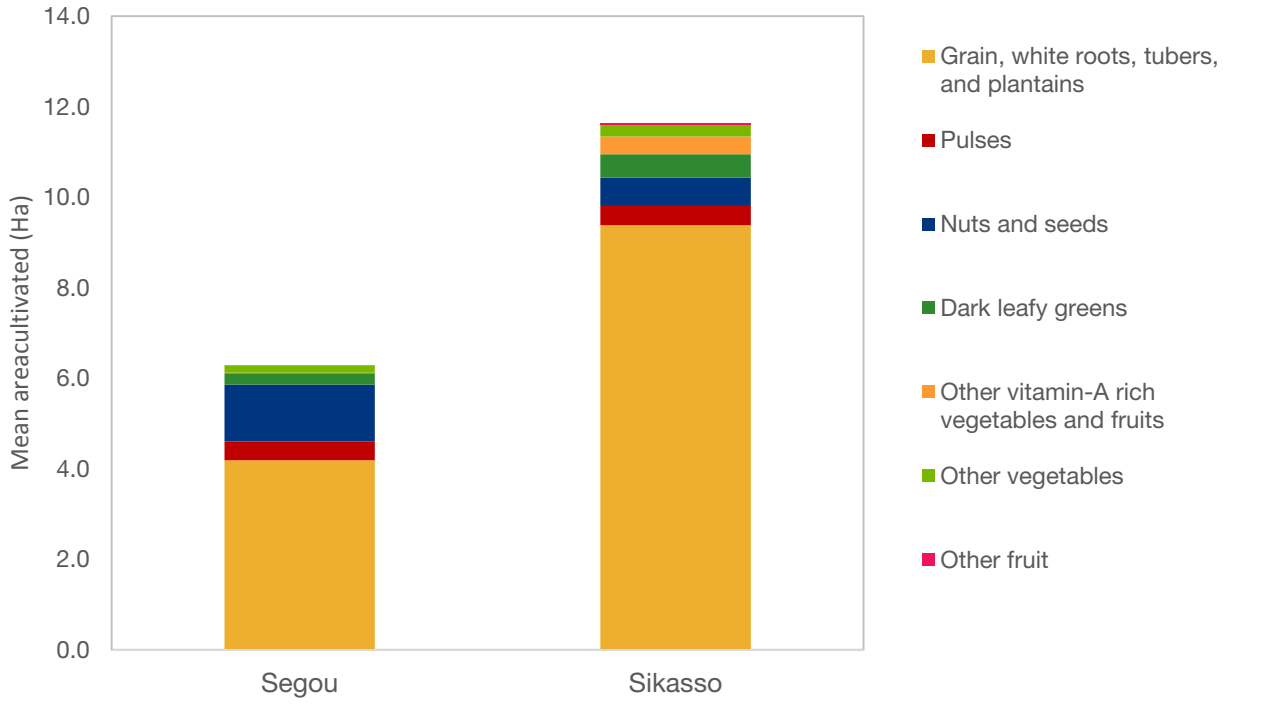

Figure 41. Mean area (Ha) of crop type grown (incl. zero)

Consumption of target crops

The consumption of target crops for the Project, Bambara groundnut, fonio, and vegetables, was assessed asking the female respondent about which months these crops are consumed and how frequently they are consumed in those months. The recipes or preparations the households used for the crops was also documented.

Bambara Groundnut

Bambara groundnut was consumed by 224 out of 414 (54%) sampled households. It was eaten all year round, more commonly in Ségou, with a peak in consumption in October. The total number of households consuming Bambara groundnut at any point over the year was similar between regions but on a monthly basis, it was more commonly consumed in Ségou. The frequency of consumption varied considerably between households. It was most commonly consumed once (27%) or twice per week (31%). It was eaten every day by 10% of households and once per month by 17% of families interviewed. Bambara groundnut was usually consumed baked, boiled or grilled and sometimes in a local traditional dish called *tô*.

Table 76. Number of households consuming Bambara groundnut by month

Month	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Jan	13	11	2	4	4	2	1	1	1	0	0
Feb	4	3	1	1	2	0	0	0	0	0	1
Mar	7	6	1	2	2	1	1	0	0	1	0
Apr	7	6	1	1	3	1	1	0	0	1	0
May	3	0	3	0	0	0	0	1	1	1	0
Jun	24	16	8	7	2	3	4	3	3	0	2
Jul	28	8	20	3	0	4	1	9	7	4	0
Aug	41	27	14	12	8	3	4	5	2	5	2
Sep	41	25	16	8	8	3	6	5	1	5	5
Oct	152	107	45	37	31	20	19	12	9	14	10
Nov	43	27	16	9	5	6	7	7	0	2	7
Dec	29	18	11	11	3	3	1	2	1	3	5

Table 77. Number of households reporting frequency of consumption of Bambara groundnut

Frequency	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Every day	25	17	8	5	0	9	3	2	4	2	0
Every two days	25	7	18	6	1	0	0	5	2	5	6
Twice per week	76	38	38	17	7	5	9	12	10	7	9
Once per week	68	44	24	12	18	7	7	8	4	7	5
Twice per month	25	12	13	6	3	1	2	6	1	4	2
Once every three weeks	11	6	5	3	2	0	1	2	1	1	1
Once per month	42	25	17	5	5	8	7	7	1	5	4

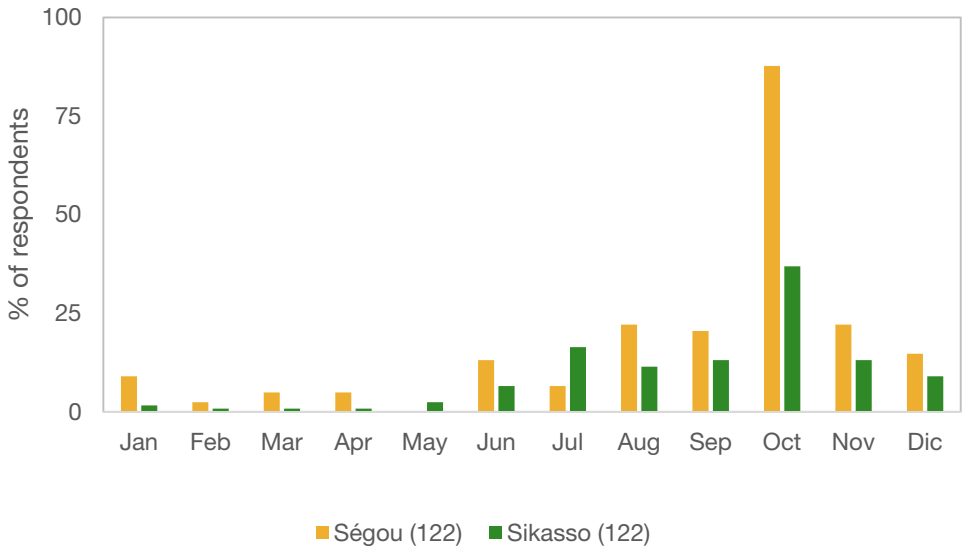

Figure 42. Consumption frequency of Bambara groundnut by month

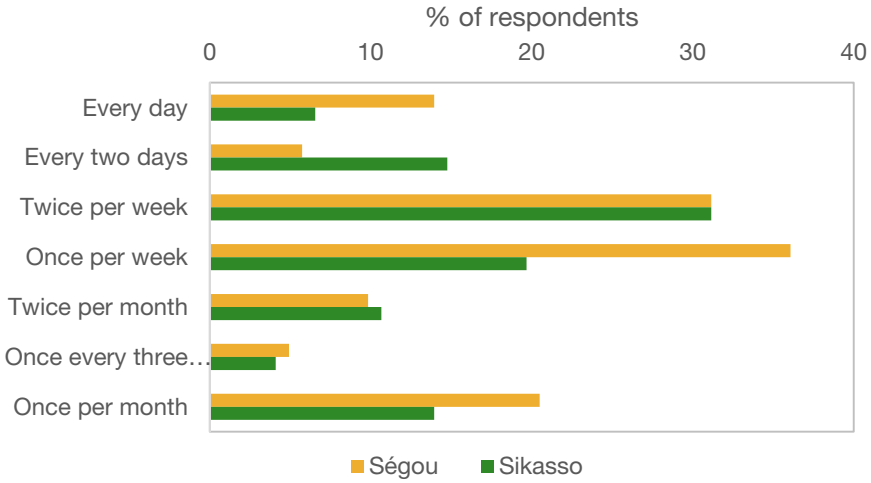

Figure 43. Bambara groundnut frequency of consumption

Fonio

Fonio was consumed by 196 of 414 (47%) households. More than three quarters of the families that consumed fonio were located in Ségou region (N=164), where it was consumed every month of the year by a large portion of the population—up to 61.5% in October. Fonio consumption was highest from August to December, which corresponds with the periods of higher food insecurity as documented earlier in this report. A drop in consumption was noted in November, after the harvest, however consumption increased again in December, before gradually decreasing.

Table 78. Number of households consuming fonio by month

Month	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Jan	27	24	3	5	4	8	7	0	0	1	2
Feb	13	10	3	3	4	3	0	0	0	1	2
Mar	17	16	1	4	9	3	0	1	0	0	0
Apr	15	13	2	2	6	4	1	1	0	1	0
May	8	7	1	3	1	3	0	0	0	1	0
Jun	16	14	2	6	2	5	1	2	0	0	0
Jul	10	8	2	3	1	31	3	1	0	1	0
Aug	49	40	9	14	11	5	10	1	0	3	5
Sep	79	71	8	21	27	14	9	0	0	3	5
Oct	112	101	11	31	22	38	10	4	0	5	2
Nov	26	24	2	9	5	7	3	0	0	2	0
Dec	54	51	3	18	6	21	6	0	0	3	0

Table 79. Number of households reporting frequency of consumption of fonio

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Every day	27	27	0	21	0	6	0	0	0	0	0
Every two days	25	23	2	6	4	11	2	0	0	2	0
Twice per week	55	53	2	11	11	20	11	1	0	1	0
Once per week	57	51	6	16	19	10	6	1	0	3	2
Twice per month	26	20	6	3	8	7	2	2	0	3	1
Once every three weeks	5	4	1	0	1	2	1	1	0	0	0
Once per month	36	21	15	5	6	3	7	4	0	5	6

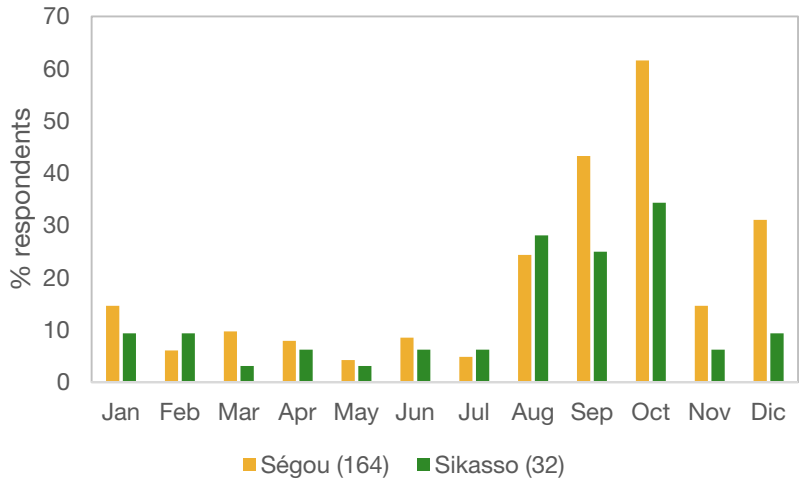

Figure 44. Consumption of Fonio by month

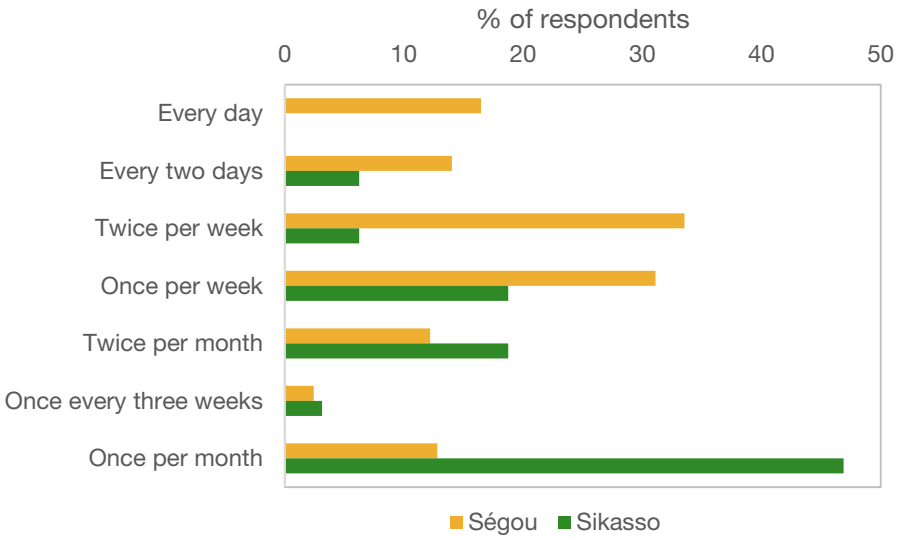

Figure 45. Fonio frequency of consumption

Similar to results for Bambara groundnut, the frequency of consumption varied between households (Figure 14). Consumption of fonio in Sikasso was not very frequent, as 46.9% of households reported consuming it generally once or twice (18.75%) per month. In Ségou, consumption frequency was more variable. The highest share of households (33.54%) consumed it twice per week. Fonio was sometimes boiled, but usually was prepared in local traditional dishes such as *tô*, *kini* and *fôyô*.

Vegetables

223 households out of 414 (54%) reported eating vegetables at any point of the year, of which 64 were located in Ségou and 159 in Sikasso. In Ségou, the consumption of vegetables was more common in January (39%), October (67%) and December (50%). Consumption rates in Sikasso were more similar throughout the year, with the highest percentages in September (26%) and October (30%) (Figure 46).

October was the month with the highest consumption of vegetables. Indeed, according to the data obtained through the 24 hours recall method used for MDD-W, a high percentage of women reported consuming vegetables the day prior to data collection, which happened in October. Vegetable consumption, unlike fonio and Bambara groundnut, occurred mostly on a daily basis or every other day: 89% of the 64 households who reported to have consumed vegetables in Ségou consumed them every day, while in Sikasso 44% of 159 who reported that they consumed vegetables, consumed them every day. Vegetables were consumed in salads, sauces and stews.

Table 80. Number of households consuming vegetables by month

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Jan	51	25	26	1	16	6	2	5	0	3	18
Feb	6	0	6	0	0	0	0	2	2	1	1
Mar	17	16	1	1	8	4	3	0	0	0	1
Apr	5	0	5	0	0	0	0	2	0	3	0
May	30	7	23	0	4	3	0	11	6	4	2
Jun	20	6	14	1	4	0	1	2	4	6	2
Jul	15	3	12	1	0	0	2	6	4	1	1
Aug	30	14	16	10	0	2	2	4	1	3	8
Sep	61	19	42	4	2	2	11	8	8	19	7
Oct	91	43	48	14	8	9	12	11	14	17	6
Nov	45	10	35	3	3	3	1	4	20	5	6
Dec	66	32	34	3	22	7	0	4	6	5	19

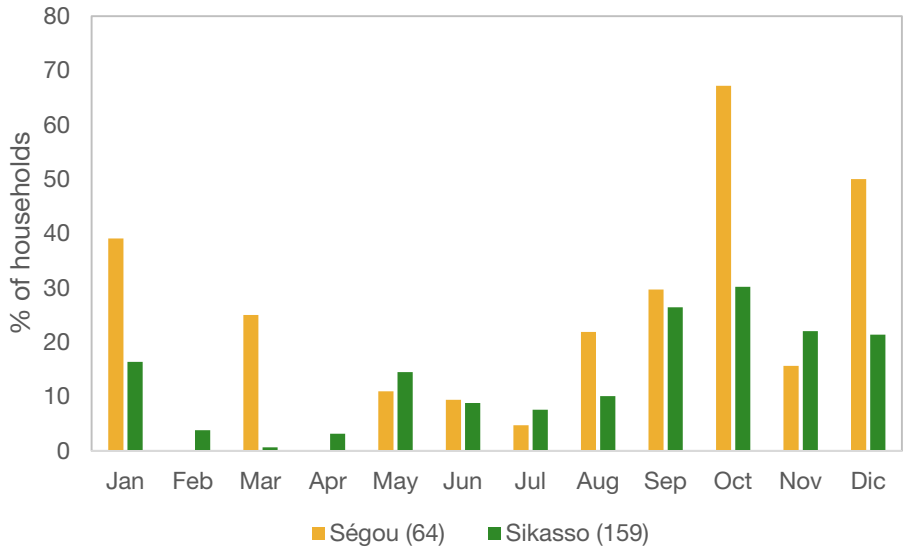

Figure 46. Vegetable consumption

Table 81. Number of households reporting frequency of consumption of vegetables

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Every day	127	57	70	11	27	8	11	14	20	17	19
Every two days	67	12	53	3	4	3	1	15	15	14	12
Twice per week	45	13	32	6	1	2	4	8	9	8	7
Once per week	32	11	21	0	4	6	1	3	8	4	6
Twice per month	11	1	10	0	0	1	0	5	2	2	1
Once every three weeks	5	0	5	0	0	0	0	1	3	0	1
Once per month	9	1	8	0	0	1	0	4	4	0	0

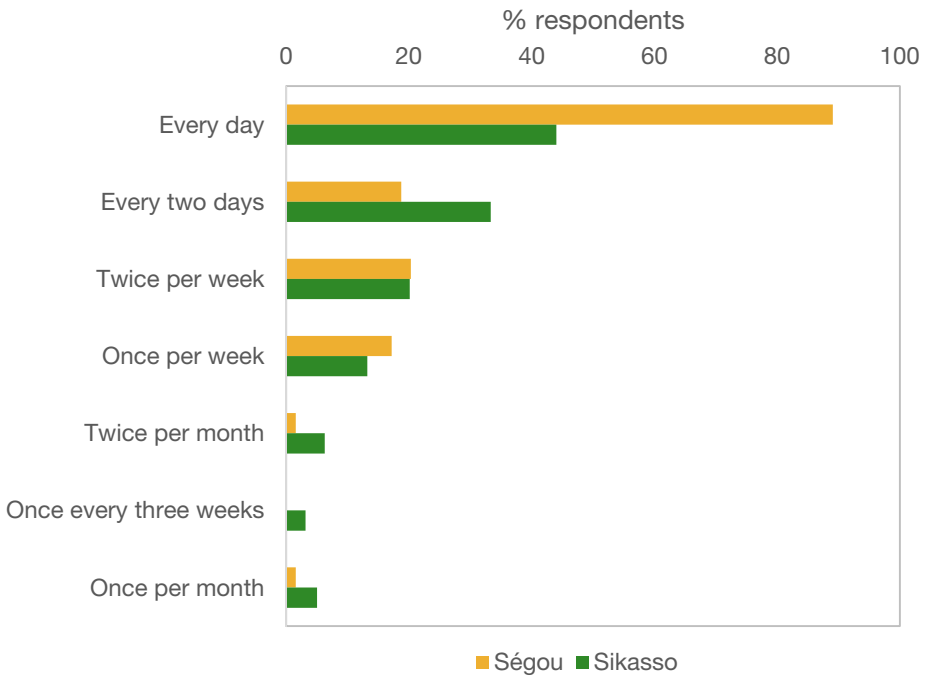

Figure 47. Frequency of consumption for vegetables

Climate change adaptation

In the household survey, both the man and woman were asked to describe the actions they have been taking to adapt to changes in the weather and environment in the last three years. Special attention was given to agrobiodiversity-based actions, especially modifications in the crops and varieties grown. The respondents were probed specifically on whether they had made changes in the crops and varieties grown. They were then asked more openly if they had made changes in crop management, use of inputs, management of soil and water, or livestock.

The focus groups revealed that the communities are facing a later start to the rainy season and temperature increase in the past ten years. Before rains would start in May, but now rains are starting in June. In Siramana and N'Gountjina the focus groups pointed out that traditional wells were drying up. Several communities noted increasing intensity of rains and there was indication that flooding events were becoming more frequent. Seven of the communities observed that soil quality was degrading, which they recognized by declining yields, the presence of *Striga* weed and a lighter color. Mechanization and reduced fallow periods were the primary reasons given for the soil degradation, but soil degradation could also be exacerbated by the hotter and dryer conditions. In Siramana and N'Gountjina the farmers observed that new insect pests had appeared. The communities considered flood, drought and pests and disease to be the major hazards to their livelihoods.

Changing crop species and varieties

Sixty percent of the households surveyed had introduced new varieties in the last three years as an action to adapt to climate change. The introduced varieties were mostly shorter cycle, higher yielding or better quality varieties. In many cases the farmers introduced drought-tolerant varieties, especially in Ségou. A quarter of households had stopped growing at least one variety in the last three years. It is noted that the number of households that stopped growing varieties was less than the number of households that introduced new varieties, suggesting a trend toward diversification of these cropping systems. This trend of diversification was also supported by results for the species level, as more households had introduced new crop species or were testing new crop species than those that had stopped cultivating species. Many households had increased or reduced the area assigned to specific crops or had stopped growing crops in a particular season. Unfortunately details on the species being acted upon were not collected.

In Sikasso, it was more common to have introduced new species or varieties, particularly shorter cycle, higher yielding and better quality varieties. It was also more common to be experimenting with new crops. The more humid environment in Sikasso may make it more possible for farmers to introduce and experiment with different crop materials, as compared to farmers in Ségou who may be more limited in their options by the more arid climate. In Ségou it was more common to have stopped growing a variety, to have introduced drought tolerant varieties or to have increased the area to an existing crop (Figure 44).

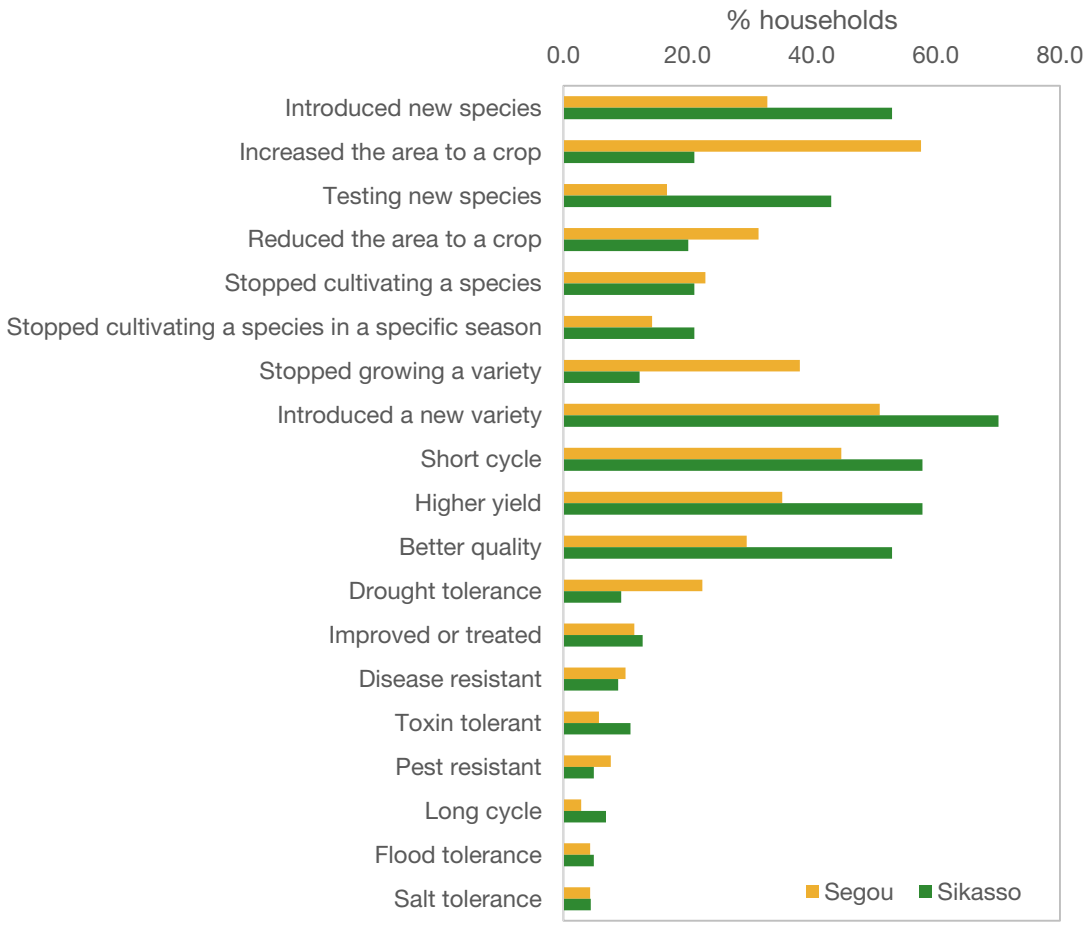

Figure 48. Changes in crops and varieties made in last three years to adapt to climate change

Table 82. Number of households modifying crop species cultivated

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Stopped growing a variety	105	80	25	12	20	20	28	4	6	4	11
Introduced a new variety	250	107	143	27	28	20	32	30	39	37	37
Characteristics of introduced varieties											
Short cycle	212	94	118	24	24	16	30	26	31	26	35
Higher yield	192	74	118	16	19	13	26	22	35	29	32
Better quality	170	62	108	14	16	11	21	18	31	26	33
Drought tolerance	66	47	19	11	10	7	19	1	8	3	7
Improved or treated	50	24	26	12	6	2	4	6	7	8	5
Disease resistant	39	21	18	2	6	2	11	7	3	4	4
Toxin tolerant	34	12	22	2	3	2	5	2	7	8	5
Pest resistant	26	16	10	2	5	2	7		3	5	2
Long cycle	20	6	14	2	1	3		1	4	7	2
Flood tolerance	19	9	10	2		2	5	3	2	1	4
Salt tolerance	18	9	9	1	3	1	4	1	4	2	2

Table 83. Number of households modifying crop species cultivated

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Introduced new crop species	177	69	108	13	20	15	21	21	31	22	34
Increased the area to a crop	164	121	43	29	28	26	38	10	16	8	9
Testing new crop species	123	35	88	12	8	4	11	25	20	16	27
Reduced the area to a crop	107	66	41	11	13	16	26	9	12	14	6
Stopped cultivating a species	91	48	43	5	14	14	15	9	16	7	11
Stopped cultivating a species in a specific season	73	30	43	5	10	6	9	10	11	12	10

Changes in crop, land, soil, water, and pest management

A shift toward earlier land preparation (70%) and sowing (65%) was clear across the sites. Earlier sowing was more common in Ségou than in Sikasso. Some households in Sikasso also indicated later sowing, which may be related to different crops or to more variable weather. Other common changes in farm management were introduction of crop rotations (66%), use of organic fertilizer, such as compost and manure (62%), and use of chemical fertilizer (42%). The use of chemical fertilizer was more common in Sikasso where 57% reported this action. Increased use of herbicide and pesticide was also more common in Sikasso, where 40% of households took this action. Some other actions that were more common in Sikasso were introducing contour plowing, stone terraces, mulching, dikes and protective walls, and better drainage.

Table 84. Change in crop, land and water management

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Introduction of crop rotations	274	140	134	37	30	35	38	23	32	40	39
Introduction of hedges	108	40	68	10	9	10	11	17	23	12	16
Introduction of intercropping	97	46	51	10	16	7	13	12	14	14	11
Introduction of a cover crop	90	43	47	7	11	17	8	8	17	11	11
Introduction of contour plowing	62	1	61		1			16	16	17	12
Introduction of stone terraces	60	16	44	8	4	2	2	8	11	10	15
Introduction of mulching	52	6	46		1	2	3	10	15	10	11
Introduction / construction of dikes and protective walls	52	8	44	2	4		2	5	10	11	18
Introduction of a better drainage system	47	2	45	1			1	7	11	11	16
Introduction of terraces	12	3	9		2		1	2	2	3	2
Start of irrigation	7	2	5	2					3		2
Introduction of more efficient irrigation techniques	6	1	5	1				1	2	1	1
Introduction of a micro-catchment basin	1		1								1

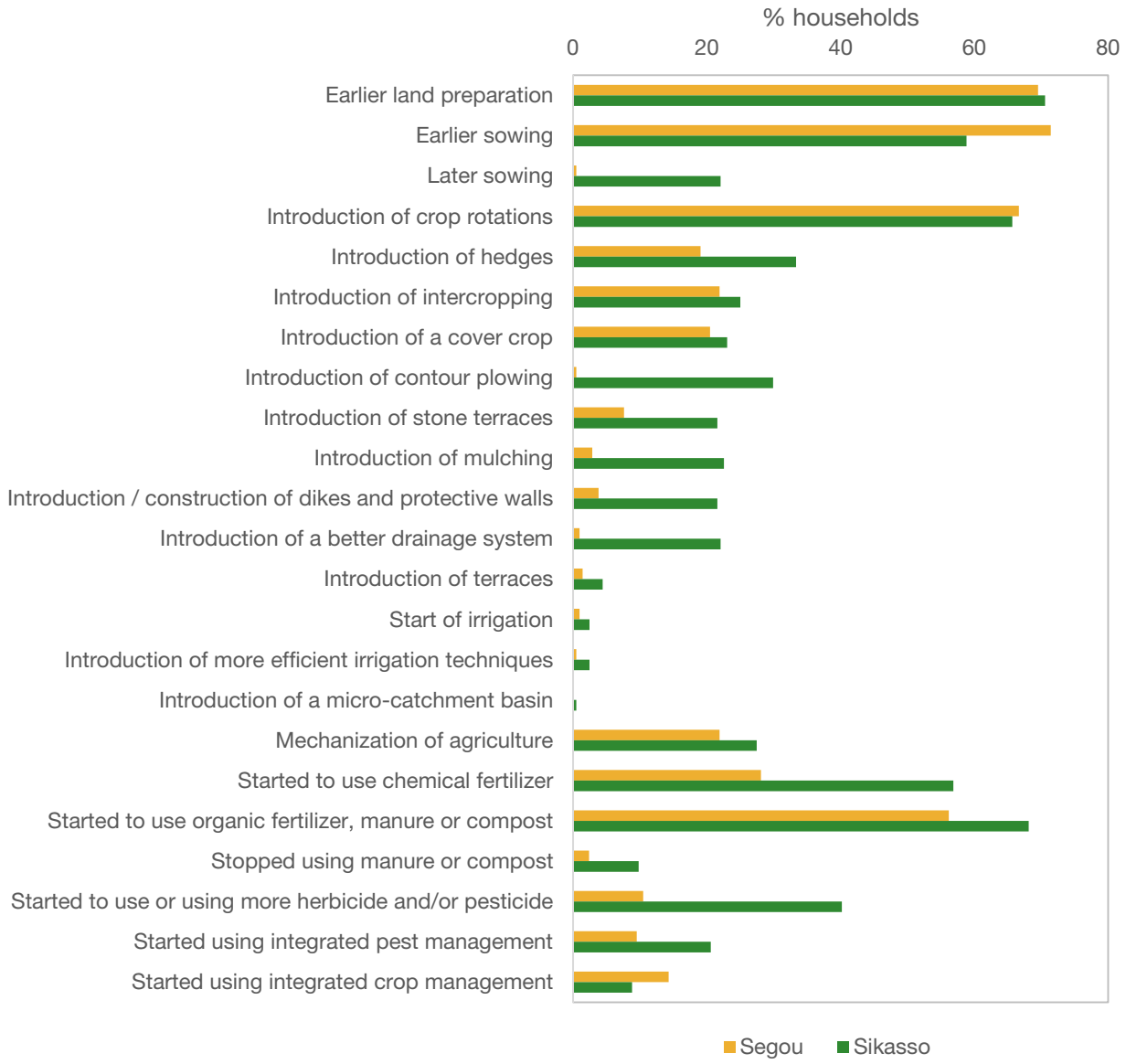

Figure 49. Changes in management of crops, land, soil, water, and pests and disease

Table 85. Change in timing of activities

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Earlier land preparation	290	146	144	34	35	36	41	24	37	40	43
Earlier sowing	270	150	120	37	37	35	41	24	28	27	41
Later sowing	46	1	45				1	10	8	16	11

Table 86. Change in inputs, mechanization and pest management

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Mechanization of agriculture	102	46	56	14	9	11	12	11	15	12	18
Started to use chemical fertilizer	175	59	116	9	29	8	13	21	29	30	36
Started to use organic fertilizer, manure or compost	257	118	139	29	27	29	33	28	40	35	36
Stopped using manure or compost	25	5	20	0	1	2	2	9	4	1	6
Started to use or using more herbicide and/or pesticide	104	22	82	8	4	2	8	7	19	28	28
Started using integrated pest management	62	20	42	6	2	5	7	10	17	6	9
Started using integrated crop management	48	30	18	8	7	5	10	8	6	4	0

Changes in livestock management

The most common changes in livestock management were introduction of fodder storage (e.g. hay or silage) (45%) and forage production (24%), followed by introduction of fences (21%), and increasing (18%) or decreasing (13%) herd sizes. Fodder production and storage were especially common in Ségou region, where introduction of trough feeding was also a more common action than in Sikasso. By contrast, in Sikasso, more households had constructed livestock fences, introduced new breeds, and increased herd sizes.

Table 87. Changes in livestock and fish management

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Introduction of fodder storage	188	160	28	36	40	42	42	5	9	7	7
Started forage production	101	73	28	14	15	20	24	5	12	5	6
Introduced fences	86	23	63	1	11	4	7	12	19	12	20
Increased herd size	75	29	46	4	15	3	7	14	10	11	11
Reduced herd size	54	30	24	3	18	3	6	4	7	8	5
Introduced a new breed	44	7	37		4		3	10	13	8	6
Introduced trough feeding	39	29	10	6	4	6	13	1	3	4	2
Introduced a new animal species	33	14	19	4	4	1	5	5	5	5	4
Introduced improved pastures	30	6	24			2	4	4	8	5	7
Changed herd composition	23	8	15	1	5		2	4	1	2	8
Stopped raising an animal species	21	7	14	2	2		3	3	1	4	6
Testing a new animal species	11	6	5	1	3	1	1		1	2	2

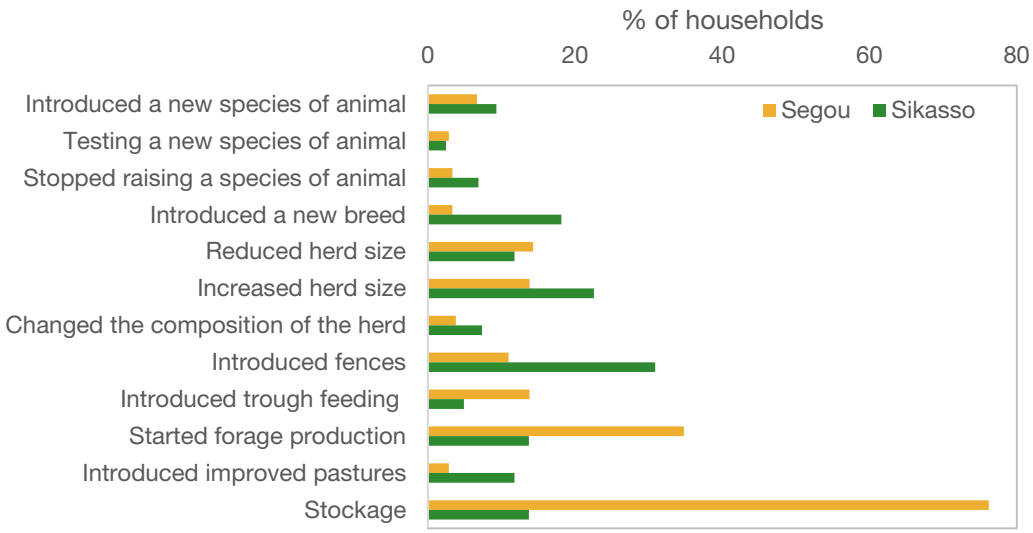

Figure 50. Changes in livestock management over last three years to adapt to climate change

Top adaptation actions

The most common actions taken to adapt to climate change were earlier land preparation, introduction of crop rotations, earlier sowing, using organic fertilizers, and introduction of new crop varieties, especially short cycle and higher yielding varieties (Table 87). These adaptation actions were common in both Ségou and Sikasso regions. Some notable differences between sites were the popularity of fodder storage in Ségou and the use of chemical fertilizer in Sikasso. In Sikasso, introduction of new varieties was also more common, as the second most popular adaptation action.

Table 88. Most common adaptation actions

Rank	Overall	Ségou	Sikasso
1	Earlier land preparation (70%)	Introduction of fodder storage (76%)	Earlier land preparation (71%)
2	Introduction of crop rotations (66%)	Earlier sowing (71%)	Introduced a new variety (70%)
3	Earlier sowing (65%)	Earlier land preparation (70%)	Started to use organic fertilizer, manure or compost (68%)
4	Started to use organic fertilizer, manure or compost (62%)	Introduction of crop rotations (67%)	Introduction of crop rotations (66%)
5	Introduced a new variety (60%)	Increased the area to a crop (58%)	Earlier sowing (59%)
6	Short cycle variety introduced (51%)	Started to use organic fertilizer, manure or compost (56%)	Short cycle variety introduced (58%)
7	Higher yielding variety introduced (46%)	Introduced a new variety (51%)	Higher yielding variety introduced (58%)
8	Introduction of fodder storage (45%)	Short cycle variety introduced (45%)	Started to use chemical fertilizer (57%)
9	Introduced new crop species (43%)	Stopped growing a variety (38%)	Introduced new crop species (53%)
10	Started to use chemical fertilizer (42%)	Higher yielding variety introduced (35%)	Better quality variety introduced (53%)

Gendered access to information, seeds, and institutions

Gendered access to information

The man or woman respondent had received some type of information about climate change in 74% of the households surveyed. More households had received information about climate change adaptation approaches (68%) than about the effects of climate change (59%), or the specific role of traditional crops in adaptation (36%). Households were more commonly informed in Ségou (85%) than in Sikasso (56%). Men had more commonly received information about climate change (70%) than women (43%). This gender difference was most apparent for information regarding climate change adaptation strategies (Figure 47).

Table 89. Number of men and women respondents that had received information on specific topics

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Received information on climate change effects											
Men	177	111	66	37		27	47			33	33
Women	158	103	55	26	26	14	37	16	13	15	11
Households	*246*	*148*	*98*	*38*	*26*	*31*	*53*	*16*	*13*	*34*	*35*
Received information on adaptation to climate change											
Men	261	164	97	37	40	43	44	21	21	27	28
Women	142	91	51	23	21	13	34	16	11	13	11
Households	*280*	*173*	*107*	*38*	*41*	*43*	*51*	*23*	*24*	*29*	*31*
Received information on the role of traditional crops in climate change adaptation											
Men	98	72	26	32			40			15	11
Women	101	80	21	19	18	12	31	7	4	7	3
Households	*148*	*110*	*38*	*34*	*18*	*12*	*46*	*7*	*4*	*16*	*11*
Received information on any of above topics											
Men	285	171	114	39	40	43	49	21	21	35	37
Women	177	108	69	28	26	15	39	19	17	18	15
Households	*306*	*179*	*127*	*40*	*42*	*43*	*54*	*25*	*29*	*35*	*38*

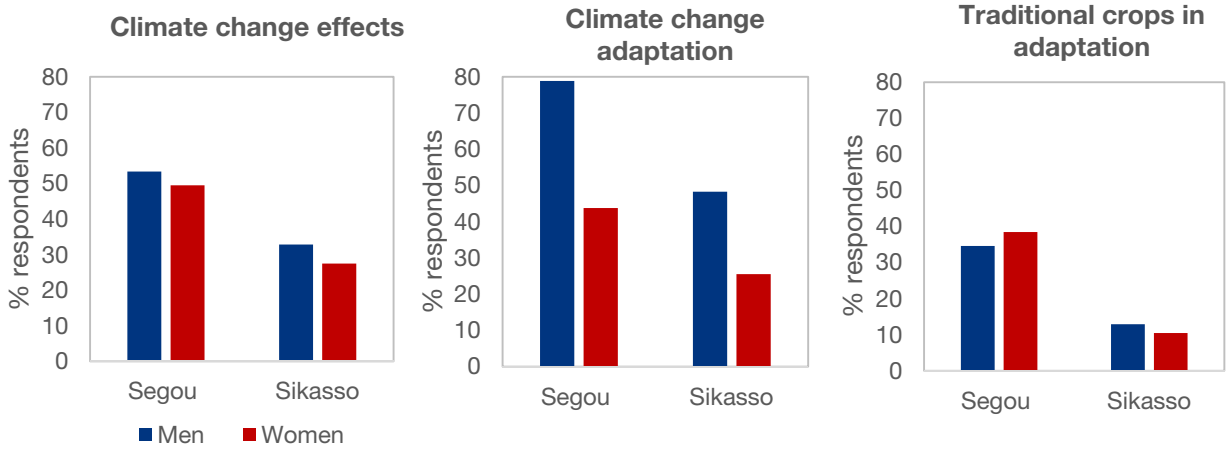

Figure 51. Percent of men and women respondents that had received information on climate change

Table 90. Sources of information on climate change

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Men											
Radio	193	111	82	21	23	35	32	13	18	28	23
Diversity field	70	70		18	28	1	23				
NGO	61	27	34	12	4	6	5	7	11	8	8
Extension	52	46	6	11	4	12	19			1	5
Word of mouth	51	29	22	3	9	11	6	6	7	4	5
Project	39	38	1	13	5	13	7	1			
Elder	38	34	4	6	13	7	8	1	1		2
CBO	32	14	18	7	4		3	5	4	3	6
Television	31	11	20	3	1	5	2	3	6	5	6
Own observations	19	17	2	3	4	5	5		1	1	
Preacher	4	1	3			1		3			
Women											
Radio	98	56	42	14	8	9	25	7	9	15	11
Word of mouth	45	28	17	5	9	7	7	4	4	6	3
Diversity field	37	37		11	14	1	11				
Elder	33	33		7	10	6	10				
Extension	21	19	2	1		3	15				2
NGO	19	7	12	3	1		3	4	4	1	3
Television	14	6	8	3	1	1	1	3	3	1	1
Project	14	13	1	5		3	5	1			
Own observations	9	9		3	1	2	3				
CBO	8	3	5	1	1		1	3			2
Preacher	2	1	1			1		1			

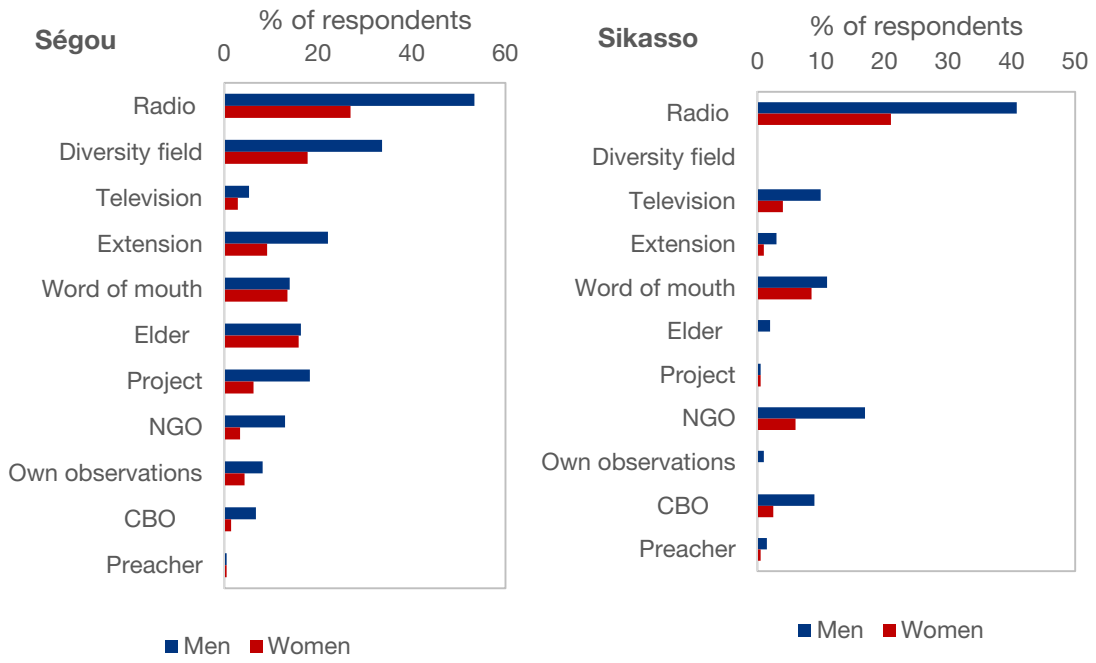

Figure 52. Information sources of male and female respondents

The most common sources of information on climate change were the radio (50%), the diversity field (20%), word of mouth from other farmers or villagers (20%) and elders (14%), NGOs (16%), extension workers (14%), and projects (10%). The presence of diversity fields in Ségou may be one reason respondents in Ségou were more informed than respondents in Sikasso, as they were a notably common source of information in the region. Diversity fields have not been implemented in the surveyed villages in Sikasso region. Men were more likely to have received information from effectively all the sources noted. Word of mouth and elders stood out as important sources of information on climate change for women. In eight cases, women cited that their husband had shared the information with them.

Gendered seed sources

Men and women respondents were asked where they obtained seed. The most common sources were their own production or a relative in the community. Other sources were the market, the community seed bank, non-relatives in the community, relatives and non-relatives outside the community, aid, government, and seed fairs. At least some men and women were obtaining seed from all these sources, but men were more likely to have received seeds from most sources. For women in Ségou, the market and their own production stood out as important seed sources.

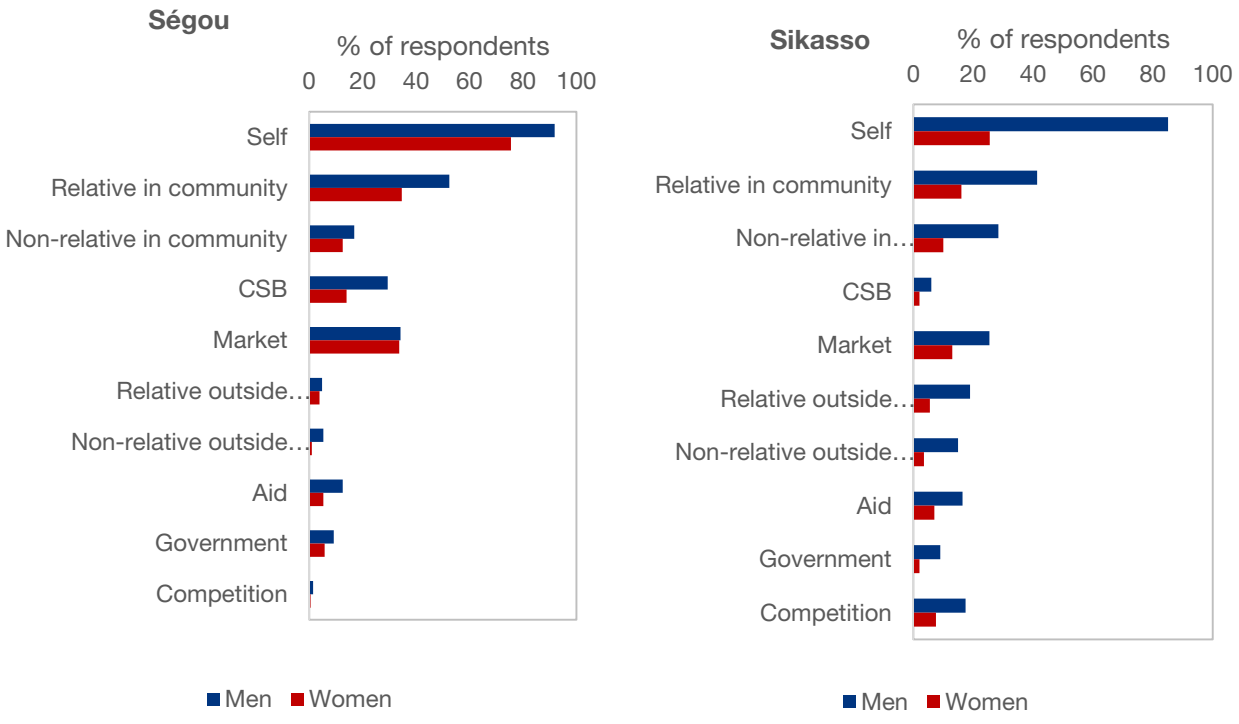

Figure 53. Seed sources of male and female respondents

Table 91. Seed sources of men and women respondents

Source	Gender	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Own production	Men	362	191	171	42	48	49	52	45	43	44	39
	Women	208	157	51	36	38	37	46	17	10	13	11
Relative in community	Men	192	109	83	25	23	29	32	15	27	20	21
	Women	104	72	32	12	12	19	29	7	11	6	8
Non-relative in community	Men	92	35	57	6	7	12	10	10	16	13	18
	Women	46	26	20	1	7	7	11	1	7	7	5
Community seed bank	Men	73	61	12	22	18	2	19	2	2	1	7
	Women	33	29	4	14	8		7	2			2
Market	Men	122	71	51	16	19	16	20	12	13	14	12
	Women	96	70	26	16	16	15	23	7	6	7	6
Relative outside community	Men	48	10	38	3	1	1	5	12	6	8	12
	Women	19	8	11	3		2	3	5		2	4
Non-relative outside community	Men	41	11	30	2	5	2	2	8	6	7	9
	Women	9	2	7	1		1		3	1	1	2
Aid	Men	59	26	33	19		5	2	7	13	4	9
	Women	25	11	14	5	2	1	3	6	5	2	1
Government	Men	37	19	18	6	5		8	5	3	4	6
	Women	16	12	4	3	6		3	2	1	1	
Private seed company	Men	38	3	35			1	2	5	13	7	10
	Women	16	1	15				1	2	6	4	3

Gendered access to institutions

Sixty two percent of households had at least one member involved in a community institution. Twenty three percent of households had at least one member with a leadership position in a community institution. Slightly more households in Sikasso were involved in community institutions than in Ségou. More households had male members involved in community institutions than female members in both regions. A similar trend was seen for leadership positions.

Table 92. Seed sources of men and women respondents

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Participating in community institutions											
Men	201	110	91	27	37	27	26	24	24	16	27
Women	113	62	51	8	28	8	16	14	5	15	17
Households	*256*	*127*	*129*	*31*	*42*	*25*	*29*	*34*	*29*	*28*	*38*
Leadership											
Men	79	32	47	11	7	11	7	11	8	11	17
Women	24	9	15	3	2	3	3	4	1	3	7
Households	*97*	*36*	*61*	*12*	*9*	*7*	*8*	*15*	*9*	*14*	*23*

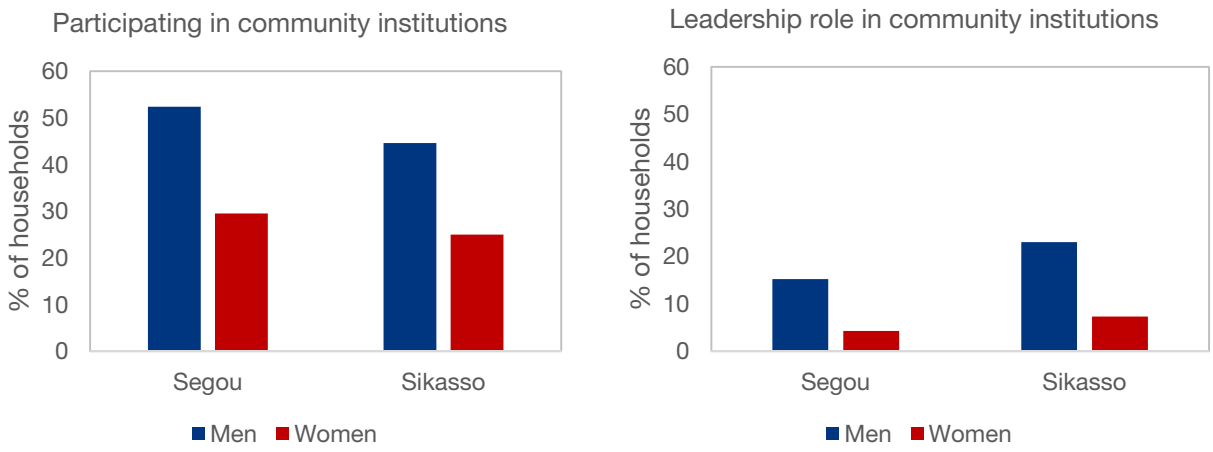

Figure 54. Percent of households with men and women participating in community institutions

Table 93. Institutions with female participants (#households with female participant)

Association	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Women's'	29	20	9	8	2	4	6			5	4
Benkadi	27	20	7		18	1	1				7
Savings group (tontine)	17		17					7	1	8	1
Gardening	8	8			5	1	2				
Siguitè mogoson	6		6					5	1		
Diversity field	5	5		3	1		1				
Agrognètasso	4		4								4
Gnoubouarissi	3	3				1	2				
Mougnoussi	3	3					3				
Parissi	3	3				1	2				
Dèmédé (entre aide)	3		3					3			
Korote mogoson	2		2					2			
Mogo tala kan tô	2		2								2
NGO	2		2						1	1	1
Ançardine	2		2								2
Ton sènè	2		2					1			1
Village	2		2								2
Sabougnouma	2	2			2						
Hèrèssi Ton	1	1					1				
Séniwè	1	1		1							
World vision	1	1				1					
Mutuelle Santé	1	1					1				
Anka fara gnogonkan	1	1					1				
CGS	1	1				1					
Dièkabara	1	1			1						
Groupe Gamiba	1		1							1	
Local shool	1		1					1			
Saniya jèkoulou	1		1								1
SCOM	1		1							1	
Tièsiri	1		1							1	

Table 94. Institutions that female household members participated within

	All	Seg	Sik	Bol	Bom	Bun	Som	Fin	Kan	NGu	Sir
Diversity field	36	36		18	10		8				
Village	36	7	29	1	2	4			6	10	13
Benkadi	31	27	4		18	6	3			1	3
CVCV	20		20						4	2	14
Youth	17	11	6	2	7	2				3	3
Men's (work collective)	14	14		3	1	2	8				
Siguitè mogoson	13		13					5	8		
Parisin	9	9		4		4	1				
Sabougnouma	7	7			7						
Tontine	6		6					5	1		
Ançardine	5	1	4				1		2		2
Unspecified	5	3	2			1	2				2
Waséniwè	5	5		5							
Red Cross	4	4		4							
Developpement du village (ADV)	4	4				3	1				
Fandara	4		4								4
Korote mogoson	4		4					2	2		
Dèmédé (entre aide)	3		3					3			
Dièkafô	3	2	1	1	1				1		
Fôtè môgôban	3		3						1	2	
Gnoubouarissi	3	3		1			2				
Projet	3	1	2	1							2
Ton sènè	3		3					1	1		1
Christian	2		2							2	
Students	2		2								2
Groupe Gamiba	2		2							2	
Lion Siramana	2		2								2
Municipality	2	2					2				
Mutuelle Santé	2	2					2				
ONG	2		2						1		1
Sugu Sigi	2		2							2	
Thianvessi atonousey	2	2		2							
Tiomikoui	2	2					2				
Vanitoa	2	2		2							
(ùyèciè,asie) miniankan	1		1						1		
Anka fara gnogonkan	1	1					1				
Bèdia Kafo	1		1							1	
Education for development CED	1	1					1				
Caisse d'épargne	1	1					1				
Chikolekolo (Ton)	1		1						1		
Commuaute locale de l'ecole	1		1					1			
Fasodjigui	1	1				1					
Jigifa	1	1		1							
Kayira (Ton)	1		1						1		
Kotoyon-gotala	1	1			1						
Thianworo	1	1		1							
Ton AV (cotton)	1		1						1		
Tontine (cultivateur)	1		1						1		
UACT	1	1			1						
Wôtie	1		1						1		

Most institutions were related to agriculture in each community, except for Bountenisso where only one agricultural-related facility was documented and there were instead a larger number of mutual-aid institutions. One institution in Somo village was related fonio commercialization but otherwise, there were no other institutions specifically working with fonio or Bambara groundnut. Further analysis is needed to understand if some agriculture institutions may be working with these species in addition to others, providing more general service for all the crops cultivated. Several institutions were focused on women, enabling them better livelihood opportunities (processing and marketing) or helping them to get access to credit. A notable number of institutions were dedicated to education and schooling. There were also health related institutions.

Synthesis and closing remarks

The farmers in the eight villages included in this study have integrated crop and livestock farming systems for a mix of subsistence and market production. Households maintained a mean of 4.5 livestock species and 6.5 crop species, meanwhile 12 species of livestock and 39 crop species were documented across the communities. Crops and livestock were vital to household incomes, while off-farm work (labor or service) was also an important contribution to livelihoods. The primary crops grown by the most households and in largest areas were cereals (sorghum, pearl millet, and maize), peanut, and—in Sikasso region—cotton. These crops had central roles in the livelihoods of the eight surveyed communities, providing staple food and income. However, other more minor crops also had important roles in the farmers' livelihoods.

Fonio and Bambara groundnut

Fonio and Bambara groundnut were not negligible in the livelihoods of these communities. Around half of households overall were growing Bambara groundnut, albeit in a fairly small area (mean 0.4 Ha). Eighteen percent of households were making an income from Bambara groundnut and 8% considered the crop among their top income sources. Fonio was a popular crop in Ségou, where it was grown by three quarters of surveyed households, but it was much more rarely grown in the villages surveyed in Sikasso region. Fonio was grown in larger areas than Bambara groundnut (mean 0.8 Ha) but in much smaller area than other cereals. Twelve percent of households overall were making an income from fonio and in some cases (3%) it was considered a top income source The mean income earned for Bambara groundnut was 157,999 CFA/Ha (approximately 240 €/Ha) and for fonio was 127,413 CFA/Ha (approximately 193 €/Ha). In a context where the households had a 72% mean likelihood of of living below the poverty line of 322.24 CFA/day/person (approximately 0.60€/day/person; Schreiner 2010), and households had an average of 14 members with a mean 13.9 hectares of land, it can be seen that these crops alone would be inadequate for enabling households to overcoming poverty.

The quality of land where fonio and Bambara groundnut are produced (e.g. order in crop rotation), the varieties used, and the production techniques could be factors limiting returns on these crops. Fonio and Bambara groundnut were strictly produced under rainfed conditions. Just a quarter of producers reported using inputs in the cultivation of these species, which was most commonly fertilizer (organic or chemical). Farmers sourced their seed for Bambara groudnnut and fonio mainly from their own production or the market. The varieties used were almost exclusively local varieties. One improved variety of fonio from Burkina Faso (CVF477) was documented in the focus groups. Mean yields of fonio were 580 kg/Ha and Bambara groudnnut were 550 kg/Ha, noting that these are very coarse estimates dependent on the accuracy of farmers recall for area planted and mass harvested. The mean price achieved for fonio waas 212 CFA/kg (approx €0.32/kg) and the mean price for Bambara groudnnut was 250 CFA/kg (approx €0.38/kg). Various prices were reported from different buyers (local market, mobile traders, retailers, wholesalers, etc) but the patterns were not very clear for one buyer paying higher prices than others. No household reported selling processed fonio, although there are facilities in the regions to support processing and packaging of cleaned and pre-cooked fonio. Only a few households reported selling processed Bambara groudnnut—grilled or dehulled. A more detailed value chain study will be conduced in

the Project which will more clearly map the actors in the value chains of these species and identify the key bottlenecks in securing the full value of these traditional crops.

While fonio and Bambara groundnut were making only a minor contribution to the incomes of the surveyed households, they did have distinct roles in the food security and nutrition. Bambara groundnut and fonio were produced primarily for household consumption. Three quarters of fonio producers and half of Bambara groundnut producers were not selling the crop at all. For those that did sell these crops, much of their production was retained for household consumption. About half of the surveyed households were consuming these crops at some point of the year. Bambara groundnut was eaten all year round, especially from June to December and with peak consumption in October. Fonio was eaten beteween August and December, also with peak consumptionin October. Consumption of fonio was more common in Ségou region, where it was more commonly produced. The consumption of fonio and Bambara groundnut was notably high during periods of food insufficiency, which peak in August but occur May to October when some households reported inadequate provisioning for their households. October is when the harvest of the major cereals happens, wheras some varieties of fonio can be harvested as early as August (Vall et al. 2011).

Diet diversity and food security

Our survey took place in October when a majority (57%) of households were found to be food secure but still 35% were mildly to moderately food insecure and 22% were severely food insecure according to the HFIAS indicator. The number of food secure households would likely be higher in November and December after the harvest is complete, but would be be much lower in August at the height of the lean sason. In terms of diet quality, only half of the women of reproductive age were found to have reached the minimum diet diversity (MDD-W) threshhold. Women who had not consumed at least five food groups in the last 24 hours had less commonly eaten dark green leafy vegetables, other vitamin-A rich fruits and vegetables, or other vegetables. They were also less likely to have eaten nuts and seeds, pulses, meat, poultry, fish, or dairy. Effectively all the women had eaten starchy foods in the last 24 hours. These are important sources of energy but are less nutrient dense in terms of essential vitamins, minerals, and proteins. Production area was highly biased toward production of starchy cereals, while much smaller areas were devoted to nutrient dense pulses, nuts and seeds, and vegetables. Production of fruits was nearly negligible. The profile of staple-dominated farming systems was reflected in nutritionally inadequate staple-dominated diets.

Native vegetables

Bambara groundnut could be a key crop in increasing consumption of pulses among women who did not reach minimum diet diversity. The vegetables are also an area where diet diversity and quilaty can be enhanced. Twenty four species of vegetables were cultivated in these communiteis, including four dark leafy green vegetables, five other vitamin-A rich vegetables, and 10 other vegetables. Increased production of vegetables of all kinds could help improve diet diversity, although it is acknowledged that water shortage is a major constraint to vegetable production in Mali.

Native vegetables could be interesting for increasing production and consumption of vegetables in these communities, particularly if they require less water and/or can be grown off-season from the globally

important vegetables. Very few of the vegetable species grown were native to Africa. Some of the vegetables species the communities were growing can be considered naturalized and traditional in the sense that they have been integrated in the local food traditions for hundreds of years. For example, tomato, onion, and chili are introduced crops that are essential to traditional Malian sauces. Given their important role in the diet, these vegetables could be considered under-researched in Mali, but due to their global importance, these species have received more research attention than native African vegetables. The most popular native African crop grown in these commuunities was okra. African eggplant was also a fairly common. Roselle was grown by some producers, particularly in Ségou. The calyxes of this crop are used to prepare a beverage, but it can also be eaten as a vegetable. Corchorus was grown by a few producers in the villages surveyed, but in fact the use of this species may be underdocumented in the current survey because it grows wild and is not intentionally cultivated. Other wild species growing in field margins and the forest also seemed to be important for these communities, at least in periods of climate stress, but they were not docuemneted in the cultivation-oriented survey. More attention is needed to document these wild collected plants and their role in the diets and incomes of the communities over the yearly cycle.

Vegetables are important for improving diets and also are an important source of income for producers. Compared to fonio and Bambara groundnut, vegetables were a more significant source of household income, especially in Sikasso where they were commonly cultivated. Vegetables were a source of income for 43% of households and a top income source for 11%. The native African species were not mentioned among the top income sources for any household, although they were generating at least a minor income for some househods: okra (11%), *Corchorus* (1%), roselle (1%), African eggplant (3%). A few households reporting selling dried chili, onion, okra, and tomato, which secured fairly high prices. There would be scope to increase the production of these value-added products, particularly as income sources for women who are the primary actors involved in processing in these communities.

Gender

The literature shows that gender roles in Mali are hard to generalize as different communities have different norms. However, it is common that women and men keep their own income and have distinct responsibilities for providing resources for the family. In many cases, men are responsible to provide the staple crop and women provide the “sauce” involving vegetables and pulses. There are also gendered responsibilities for covering other expenses related to household maintainance and raising the children. Households often have communal fields, where members are responsibile to provide labor to grow the staple cereals. Individual household members also have private plots assigned by the household head, which they can farm to meet their obligations to the family and generate personal income. Not all household members are necessarily assigned individual plots. Women may have smaller plots or lower quality land assigned than assigned to men, while different ranks of wives may have different levels of land access and time to work on their own fields. Tenure for private plots is not necessarily secure, as for example widows would often lose their rights to the land they farmed when their husband was alive. Women in addition to work on communal fields also have responsibilities for cooking and child care, so men tend to have more time to work their private plots. Whereas women are traditionally responsible for producing vegetables as a sauce crop, off-season vegetable production has emerged fairly recently in Mali and, in some communities,

this production space is being dominated by men, sometimes taking claim of spaces where women have farmed vegetables in the past.

With these considerations about the gender norms in Mali from the literature, it can be said that the data on production systems is not fully reflective of the complexitities of gendered landholdings, crop management and income. Whereas fonio and Bambara groundnut were fairly minor components of the household cropping system and income, it remains unclear how important they were to the women in the households surveyed. Given the complexity of the households in these communities—typically involving multiple family units where individuals hold their own private plots, the fact that questions on landholdings, production and income were directed only to the male head of the household means that the data near unavoidably do not capture the complete picture of all the resources cultivated and the variety of livelihood sources drawn on by the household. The data provide a good overview and reveal broad trends for the cropping systems and livelihood sources in these communities but further investigation is needed to fully appreciate the role of underutilized crops in the livelihoods of women and other vulnerable members of these communities. Attention to the status of women, such as different ranks of wife, widows and unmarried women would sharpen the picture of who relies on fonio, Bambara groudnnut and underutilized vegetables for their livelihoods and how these crops can contribute more to incomes and food security in rural Mali. Further study in the Project will give attention to these aspects.

Climate change adaptation

The eight surveyed communities reported facing a delayed start to rains and a shorter rainy season. Soil degradation is also a growing problem, which may be partially linked to climate change, as well as shortened fallow periods, mechanization of agriculture, and use of chemical inputs. Many producers have delayed land preparation and sowing in response to the late rains. Numerous households have introduced new varieites—especially shorter cycle and higher yielding varieites, as well as new crops. More households reported introducing crops and varieties than stoppping growing crops or varieties, suggesting a move toward diversification of these cropping systems. Greater diversity and introduction of varieties with needed traits (e.g. shorter cycle, drought tolerance) are key in mitigating risks from climate change which is bringing greater unpredictability in conditions. Other actions commonly taken by the farmers seem to be targeted at improving soil qualitly such as increasing use of fertilizers (organic and chemical). Fodder production and storage were common adaptations of livestock management in Ségou region. More detail on which specific crops were acted on would be interesting to reveal further the role of underutilized crops in farmers adaptation strategies. Fonio and Bambara groundnut could be key aspects of diversification approahces for facing cliamte change, especially due to the short cycle of fonio, their adaptation to the arid conditions of the region, and the high intraspecific diversity in these crops seen in the region in the form of multiple landraces.

The man or woman interviewed had received information on climate change adaptation practices in 68% of the households surveyed. Fewer households had received information on the role of traditional crops in adaptation (36%). The main source of information overall was the radio. In Ségou, a wider range of information sources was reported. In particular the diversity field and extension were more common sources of information source on climate in this region. Men were were more likley to have received

information on climate change and adaptation. One reason for the gender difference in level of information could be that more men were participating in community iinstutions than women. These community institutions were an important sourec of information. Men also seems to have more interaction with extensionists and projects, such as the diversity field activities, than women. As both men and women are producers in these communities, ensuring access of information to women as well men will be improtant to build adaptive capacity in these communities.

Conclusions

This baseline survey provided an overview of the crop and livelihood systems of eight communities in Mali—six of which are being targeted by the Project with activities to increase the cultivation, commercilaization and use of fonio, Bambara groundnut and native vegetables. The results document the level of cultivation, commericalization and consumption of these crops prior to the interventions. The study also reveals how these species contribute to the livelihoods of the surveyed communities and the roles they could have in further improving food security, nutrition, and incomes. Fonio and Bambara groundnut stood out as key staples in the lean period before the major staples were harvested. Both crops were minor income sources for the households surveyed but had potential to increase revenues through production and sale of value-added products. Vegetables had a more prominent contribution to household income, especially in Sikasso region and stood out as crops that could improve diet quality. The potential for Native African vegetables to support increased consumption of vegetables under water-limited conditions will be explored further in the Project. This analysis is a beginning point for more detailed analysis on the value chains of our target species, the varieties cultivated and their unique characteristics, the native vegetables collected for consumption and sale, the relevance of these species in the livelihoods of men and women and their adaptation to the threats of climate change.

References

Adoukonou-Sagbadja, H, Dansi, A., Vodhoue, R, and Akpagana, K. (2006) Indigenous knowledge and traditional conservation of fonio millet (*Digitaria exilis, Digitaria iburua*) in Togo. *Biodiversity and Conservation* **15**, pp. 2379-2395

Azam-Ali, S.N., Sesay, A., Karikari, S.K., Massawe, F.J., Aguilar-Manjarrez, J., Bannayan, M., and Hampson, K.J. (2001) Assessing the potential of an underutilized crop–a case study using Bambara Groundnut. *Experimental Agriculture* **37**, pp. 433-472

Azam-Ali, S. (2007) Agricultural diversification: The potential for underutilised crops in Africa's changing climates. *Rivista di Biologia/Biology Forum* **100**, pp. 27-38

Benor, S., Demissew, S., Hammer, K., and Blattner, F.R. (2012) Genetic diversity and relationships in *Corchorus olitorius* (Malvaceae s.l.) inferred from molecular and morphological data. *Genetic Resources and Crop Evolution* **59**(6), pp. 1125-1146

Bilinsky, P. and Swindale, A. (2010) *Months of Adequate Household Food Provisioning (MAHFP) for Measurement of Household Food Access: Indicator Guide* (v.4). Washington, D.C.: FHI 360/FANTA

Brink, M. and Belay, G.M. (2006) *Céréales et légumes secs*. Wageningen: PROTA

Butt, T.A., McCarl, B.A., Angerer, J., Dyke, P.T., and Stuth, J.W. (2005) The economic and food security implications of climate change in Mali. *Climate Change* **68**(3), pp. 355-378

Cernansky, R. (2015) The rise of Africa's super vegetables. *Nature* **522**(7555)

Challinor, A. J., Koehler, A.-K., Ramirez-Villegas, R., Whitfield, S. and Das, B. (2016) Current warming will reduce yields unless maize breeding and seed systems adapt immediately. *Nature Climate Change* **6**, pp. 954–958

Coates, J., Swindale, A., and Bilinsky, P. (2007) *Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide* Version 3. Washington: FANTA

Decker-Walters, D., Staub, J., Sesé, L., and Nakata, E. (2001) Diversity in landraces and cultivars of bottle gourd (*Lagenaria siceraria*; Cucurbitaceae) as assessed by random amplified polymorphic DNA. *Genetic Resources and Crop Evolution* **48**(4): 369-380

Ebert, A. W. (2014) Potential of underutilized traditional vegetables and legume crops to contribute to food and nutritional security, income and more sustainable production systems. *Sustainability* **6**(1): 319-335

Foltz, J. (2010) *Opportunities and Investment Strategies to Improve Food Security and Reduce Poverty in Mali through the Diffusion of Improved Agricultural Technologies*. USAID-Mali AEG group

Grameen Foundation (2016) *Progress out of Poverty Index* [Online] Available from: http://www.progressoutofpoverty.org/

Hillocks, R.J., Bennett, C., and Mponda, O.M. (2012) Bambara nut: A review of utilisation, market potential and crop improvement. *African Crop Science Journal* **20**(1), pp.1-16

Khoury, Colin K., Harold A. Achicanoy, Anne D. Bjorkman, Carlos Navarro-Racines, Luigi Guarino, Ximena Flores-Palacios, Johannes M. M. Engels, John H. Wiersema, Hannes Dempewolf, Steven Sotelo, Julian Ramírez-Villegas, Nora P. Castañeda-Álvarez, Cary Fowler, Andy Jarvis, Loren H. Rieseberg, Paul C. Struik. (2016) Origins of food crops connect countries worldwide. *Proceedings of the Royal Society B.* **283**(1832)

Kumar, S., Dognoko, S., Haougui, A., Ratnadass, A., Pasternak, D., and Kouame, C. (2010) Okra (*Abelmoschus* spp.) in West and Central Africa: Potential and progress on its improvement. *African Journal of Agricultural Research* **5**(25), pp. 3590-3598

Kundu, A., Topdar, N., Sarkar, D. Sinha, M.K., Ghosh, A., Banerjee, S., Das, M., Balyan, H.S., Mahapatra,

B.S., and Gupta, P.K. (2013) Origins of white (*Corchorus capsularis* L.) and dark (*C. olitorius* L.) jute: a reevaluation based on nuclear and chloroplast microsatellites. *Journal of Plant Biochemistry and Biotechnology* **22**(4): 372-381

Mkandawire, C.H. (2007) Review of Bambara groundnut (*Vigna subterranean* (L.) Verdc.) production in sub-Saharan Africa. *Agricultural Journal* **2**(4): 464-470

Nordeide, M. B., Hatløy, A., Følling, M., Lied, E. & A. Oshaug. (1996) Nutrient composition and nutritional importance of green leaves and wild food resources in an agricultural district, Koutiala, in Southern Mali. *International Journal of Food Sciences and Nutrition* 47(6)

Ojiewo, C. Tenkouano, A. Hughes J. d'A., and Keatinge J.D.H. (2013) Diversifying diets: using indigenous vegetables to improve profitability, nutrition and health in Africa. IN Fanzo, J., Hunter, D., Borelli, T. and Mattei, F. Eds *Diversying food and diets using agricultural biodiversity to improve nutrition and health*. Oxon: Routledge.

Osei-Kwarteng, Mahunu, G.K., and Yeboah, E. (2012) Baseline survey on the seasonal market share of exotic and indigenous leafy vegetables produced, sold and consumed in Tamale, Ghana. *Ghana Journal of Horticulture* **10**

Padulosi S., Amaya, K., Jäger, M., Gotor, E., Rojas, W., and Valdivia, R. 2014. Holistic Approach to Enhance the Use of Neglected and Underutilized Species: The Case of Andean Grains in Bolivia and Peru. *Sustainability* **6**, pp1283-1312

Padulosi S., Bhag Mal, King, O. I. and Gotor, E. (2015) Minor Millets as a Central Element for Sustainably Enhanced Incomes, Empowerment, and Nutrition in Rural India. *Sustainability* **7**(7), pp8904-8933

Padulosi S., Meldrum G., and Gullotta G., Editors (2016) *Agricultural biodiversity to manage the risks and empower the poor. Proceedings of the International Conference 27-29 April 2015, Rome, Italy*. Bioversity International, Rome, Italy

Pasquini, M.W., Assogba-Komlan, F., Vorster, I., Shackleton, C.M., and Abukutsa-Onyango, M.O. (2009) The production of African indigenous vegetable in urban and peri-urban agriculture: A comparative analysis of case studies from Benin, Kenya and South Africa. IN African indigenous vegetables in Urban Agriculture (Eds. Shackleton, C., Pasquini, M. and Drescher, A.W.). London: Earthscan

Rana, R.B. (2005) Four-cell analysis as a decision-making tool for conservation of agrobiodiversity on-farm. *On-farm conservation of agricultural biodiversity in Nepal. Volume 1: assessing the amount and distribution of genetic diversity on-farm. Proceedings of the second national workshop, Nagarkot, Nepal, 25-27 August, 2004*, pp.15-24

Satya, P., Karan, M., Kar, C.S, Mahapatra, A.K. Mahapatra, B.S. (2013) Assessment of molecular diversity and evolutionary relationship of kenaf (*Hibiscus cannabinus* L.), roselle (*H. sabdariffa* L.) and their wild relatives. *Plant Systematics and Evolution* **299**(3), 619–629

Schreiner, M. (2010) *Simple poverty scorecard Mali*. Grameen Foundation. [Online] Available from: http://www.simplepovertyscorecard.com/MLI_2001_ENG_2005_PPP.pdf

Tadele, A. and Assefa, K. (2012) Increasing food production in Africa by boosting the productivity of understudied crops. *Agronomy* **2**, pp.240-283.

Takenaka, K., Yamada, M., Shinohara, T., and Miyazaki, R. (2013) Role of indigenous horticultural crops for rural smallholders in Mali. *Acta Horticulturae* **1006**, pp. 355-36

Tchientche Kamga, R. Some, S., Tenkouano, A., Balma Issaka, Y., and Ndoye, O. (2016) Assessment of traditional African vegetable production in Burkina Faso. *Journal of Agricultural Extension and Rural Development* **8**(8), pp. 141-150

Traore, B., Descheemaeker, K., van Wijk, M.T., Corbeels, M., Supit, I., Giller, K. E. (2017) Modelling cereal crops to assess future climate risk for family

food self-sufficiency in southern Mali. *Field Crops Research* **201**, pp. 133-145

Vall, E., Andieu, N., Beavogui, F. and Sogodogo D. (2011) Les cultures de soudure comme stratégie de lutte contre l'insécurité alimentaire saisonnière en Afrique de l'Ouest: le cas du fonio (*Digitaria exillis* Stapf). *Cahiers Agricultures* **20**(4), pp.294-300

Bioversity International is a
member of the CGIAR Consortium.
CGIAR is a global research
partnership for a food-secure future.