Household Food Consumption Profile of Maize Farmers in Rural Areas: Burkina Faso's Hauts-Bassins Region Case

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ABSTRACT: Smallholder farmers are the main food providers for rural and urban people in Burkina Faso, however, they suffer from a lack of appropriate farm mechanized. The work aims to understand the current situation in regards to food security of smallholder farmers in the Hauts-Bassin Region (HBR), Appropriate-Scale Mechanization Consortium (ASMC) intervention area. Approximately 30 households per village in 32 villages totaling 946 households were surveyed. Ninety-eight percent of farmers produced maize and 34% produced vegetables for the market or family consumption. Cereal crop production per household was about 8.7 ha, 5.2 ha of which was for maize production. The average production of maize was 4300 kg per household with yields ranging from 1000 to 1700 kg/ha. Eight percent of households reported a Food Consumption Score (FCS) less than 21 (poor food consumption) while 10% reported an FCS less than 35 (borderline food consumption). However, under the standard World Food Program (WFP) scoring category, 82% of the households had acceptable food consumption score. Annual per capita food consumption expenditures in HBR varied across provinces from 45611 to 49498 CFA ($79 to $85 U.S). Although 59% of households reported having access to credit, only 42% received credit. Sixty-nine percent of households used improved high-yielding and drought-tolerant seeds. In conclusion, we determined in this study that 82% of the households had acceptable FCS. The remaining 18% of households belonging to a group of poor to borderline FCS need food assistance to improve their food situation. Therefore, formulation and implementation of food security policies targeting these vulnerable households to ensure a healthy diet are necessary. Besides, amelioration of agriculture production systems through appropriate scale mechanization will intensify sustainably while diversifying food production. Finally, a periodic food security profile study covering the various seasons' will helps understand the dynamics and implement better food security policies.

KEYWORDS: Smallholder farmers, Agriculture, Maize, Food consumption score, Food security.

1 INTRODUCTION

One out of nine people in the world does not have access to sufficient food to lead a healthy life [1]. By 2050, the world population will be around nine billion, and half of the population will live in urban areas [2]. In Burkina Faso, 80% of the 18 million population lives in rural areas and rely on agriculture for food production [3]. Smallholder farmers are the main food providers [2]. Agriculture provides income, food security, and accounts for 35 % of GDP [4]. Local knowledge of farming practices is important to understand the food security situation. In the sub-Saharan zone, 65% of energy for agriculture is from manual labor, 25% from draft animals, and 10% from an engine or electrical power [5]. In Burkina Faso, 70% of farmers use

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manual labor, 29% have access to animal traction, and only 1% used wheeled tractors [6]. The Smallholder farmers grow mainly millet, sorghum, and maize (corn) as cereals on less than 0.5 ha per household.

Food security is of critical importance in Burkina Faso, four million people were undernourished in 2017 [7]. The number of undernourished people is increasing at a rate of 1.63% per year [7]. In most Sahelian countries of Africa, the main food source is cereals and per capita consumption should be about 190 kg/year [8]. Millet and sorghum are widely grown in Burkina Faso due to favorable soil fertility and climate conditions. However, yields are low (700 to 1000 kg/ha-year) making it difficult to harvest adequate supplies to ensure food security.

Maize is grown in Burkina Faso in areas where the rainfall is higher than 700 mm a year and the soil is suitable, primarily in the western and southern parts of the country. The yield potential ranges from 2000 to 6000 kg/ha and can make a significant contribution to ensuring food security in the country. A major challenge for Sub-Saharan regions in the future is to build the capacity of rural areas to serve the growing needs of production, storage, and processing of agricultural products for sustainable food security [9]. The USAID Appropriate Scale Mechanization Consortium (ASMC) for sustainable intensification is charged with developing and adapting technologies appropriate for smallholder farmers in Burkina Faso, Ethiopia, Bangladesh, and Cambodia. The Hauts-Bassins Region (HBR), located in the western part of Burkina Faso is suitable for maize production because of favorable agro-ecological conditions. Therefore, a survey was carried out in the region at the early stages of the project to understand the smallholder farmer's current food security status and production conditions in HBR.

2 MATERIAL AND METHODS

2.1 STUDY AREA

2.1.1 SURVEY SITE LOCATIONS

Burkina Faso is divided into 13 governmental sub-areas called Regions. This study was conducted in the Hauts-Bassins Region (HBR) located in western Burkina Faso (Fig. 1. Hauts-Bassins Region Map). The Region is subdivided into three provinces, Houet, Kenedougou, and Tuy. There are 30 rural municipalities in HBR with a village as the basic level of organization. The main cities are Bobo-Dioulasso, which is the second-largest city in the country, Orodara, and Hounde. The total land area of the HBR is 25,606 km^2 and represents 9.4% of the national territory [10]. The estimated population in 2012 was 1 776 803 inhabitants, 10.54% of the population of Burkina Faso with a population density of 70 people per km^2 [10].
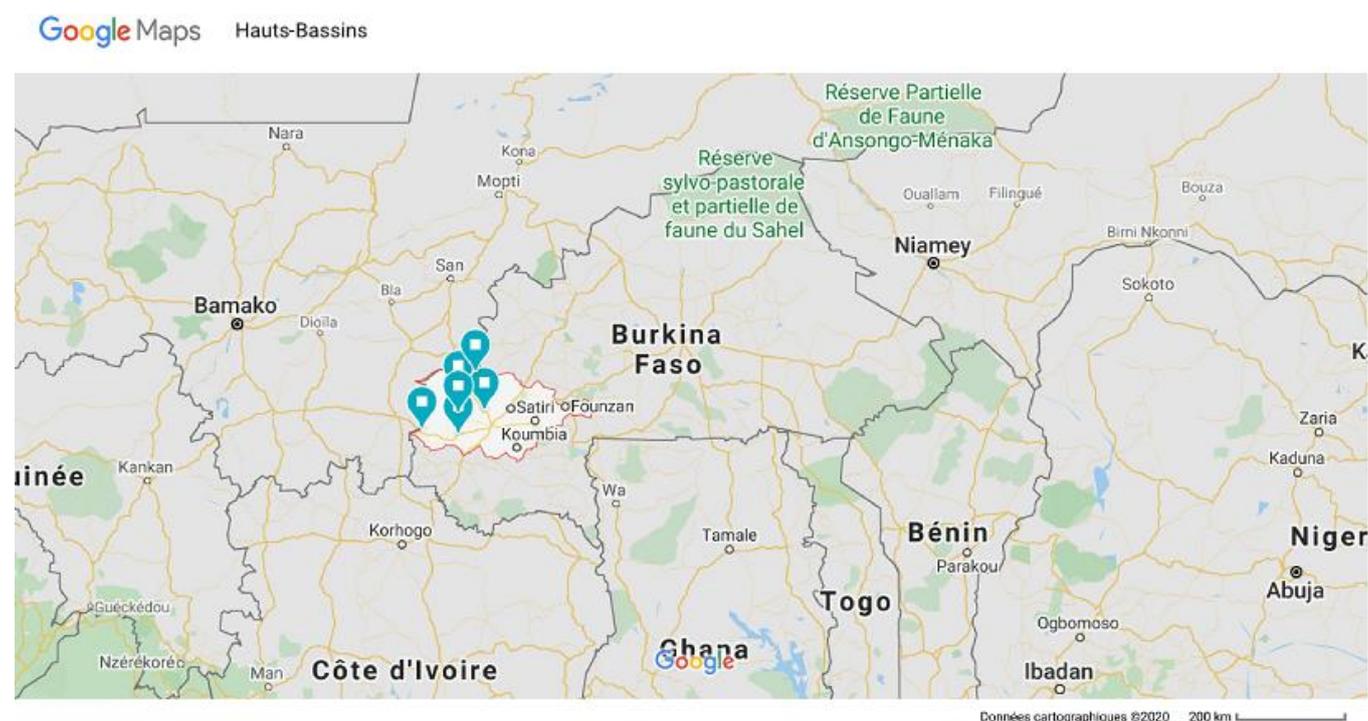

Fig. 1.   Hauts-Bassins Region Map

Part enclosed in the redline enclose the Hauts-Bassins Region
(Source google map 2020)

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2.1.2 Climate And Vegetation

HBR is located in the sub-humid zone where climatic conditions are characterized by the rainy season from May to October and the dry season from November to April. The average annual rainfall varies between 900 and 1,200 mm. Vegetation in the Region is typically Sudanian shaped by a combination of climatic factors and anthropogenic influences and is characterized by wooded and shrub savannah and gallery forests. The relief is made of succession trays shaped stairs, vast plains, and some hills and valleys hills. The soils are mostly ferriferous tropical soils, and most of the cropped areas are fallows and agroforestry parklands. Surface water resources are abundant with six permanent rivers (Mouhoun, Kou, Comoé, Houet, Banifing, and Tuy).

2.2 Research Methods

The current methodological research approach was applied according to Murray *et al* [11]. The approach emphasizes on agricultural production (crops and livestock), yields and incomes, including the average total production and income. The approach extended on farmer's endogenous knowledge, innovations, attitude, and practices (KAP). The KAP survey was applied to all households included in the study.

2.2.1 Sampling Procedure

The survey sample size was determined based on 80% of the total population of the Region reported to be farmers. The sample size calculation applied to each province to determine the number of villages and the number of households per village. Cluster sampling in two stages with the first-degree villages constituting the primary units and the second degree, all households were selected randomly. A stratified purposive sampling procedure was adopted. The survey involved farmer's households (agriculture and livestock) drawn from the list of households in the clusters/villages in the project area. The process included extension services agents and the criteria were based on maize producers and three categories of households were not considered: households that have not been selected; household heads that refused to answer the questionnaire; households that were not farmers. Sample size for targeted households to be investigated was determined using SCHWARTZ [12] formula (*):

$$N = \frac{eZ^2 pq}{i^2}$$

N = sample size; e = grape effect (2); i = precision (5%); Z = standard deviation (2) for 5% error; p = incidence of population constituting smallholder's farmers in project area (80% of total population) in 2006; q = 1-p = 0. 2.

$$N = \frac{2\,(2x2)\;x\;(0.80)\;x\;(0.20)}{(0.05x0.05)} = 512$$

We considered that 15 % of questionnaires won't be accurately applied and filled. That gives us a total of 512 + 77 targeted householders. An approximation of 589 correctly filled questionnaires was acceptable for this study. Questionnaires were applied to approximately 30 households per village in 32 villages. A total of 946 households were interviewed during the survey.

Table 1. List of selected provinces, municipalities, villages and sampled households

Province (Total households)	Municipalities (Total households)	Village	Total Households
Kenedougou (338)	Banzon (75)	Banzon	25
		Finzon	25
		Kounseni	25
	Koloko (90)	Koloko	30
		Sifarasso	30
		Sokoroni	30
	Kourouma (83)	Kourouma	30
		Djiguera	23
		Sougouma	30
	Sidi (90)	Sidi	30
		Dan	30
		Badara	30
Houet 360)	Karankasso-Vigue (90)	KV	30
		Kouroumanga	30
		Klessou	30
	Bama (90)	Bama	30
		Banakeledaga	30
		Sourkoudougou	30
	Satiri (90)	Satiri	30
		Sala	30
		Kadomba	30
	Koundougou (90)	Koundougou	30
		Mangorotou	30
		Samorodougou	30
Tuy (248)	Koumbia (127)	Koumbia	26
		Makognedougou	37
		Gombeledougou	32
		Sebedougou	32
	Founzan (121)	Founza	30
		Lolio	30
		Koloho	30
		Fin	31

2.2.2 DESIGN OF THE SURVEY QUESTIONNAIRE

A structured questionnaire was administrated to the selected head of household respondents. The questionnaires comprised different sections:

- Section 1 concerned information on respondent's household characterization;
- Section 2 referred to the household's current agricultural production of households, crop diversity, and agricultural equipment;
- Section 3 dealt with food diversity in the household;
- Section 4 was about crop utilization and expenses
- Section 5 concerned perceptions and actions taken to adapt climate change

2.2.3 PRACTICAL SURVEY

The questionnaire was designed in French and administered in local languages by trained enumerators that were 12 graduate students. The theoretical and practical training of enumerators (including a pre-test phase and a pilot phase) held from 16th to 17th August 2016. Time to apply the questionnaire was between 45 minutes to 1 hour. The survey was conducted

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from 19ᵗʰ to 29ᵗʰ August 2016. There was a direct supervisor from extension services for each team and the person responsible for the survey in each province was the agricultural service director who was served as supervisor. Each supervisor followed each day each investigator during the administration of at least one entire household questionnaire.

2.3 CONSUMPTION AND FOOD SECURITY OF THE HOUSEHOLD

FCS was calculated as described by WFP [13] and USAID [14]. The frequency weighted diet diversity score or "Food consumption score" is a score calculated using the frequency of consumption of different food groups consumed by a household during the 7 days before the survey. Calculation steps were: a) Using standard VAM 7-day food frequency data, group all the food items into specific food groups. b) Sum all the consumption frequencies of food items of the same group, and recode the value of each group above 7 as 7. c) Multiply the value obtained for each food group by its weight and create new weighted food group scores. d) Sum the weighed food group scores, thus creating the food consumption score (FCS). e). Using the appropriate thresholds, recode the variable food consumption score, from a continuous variable to a categorical variable. These are the standard Food Groups and current standard weights used in all analyses (Table 2).

Table 2. The typical thresholds are

FCS	Profiles
0-21	Poor
21.5-35	Borderline
> 35	Acceptable

The survey gathered information on both household perceptions of food security, as well as the frequency of intake of certain food groups and items. The mean count of affirmative responses to the experience-based food insecurity questions were more than three in the sample. However, in each province the range in responses was from zero to six, indicating a spectrum of food security conditions.

2.4 DATA MANAGEMENT AND STATISTICAL ANALYSIS

2.4.1 DATA ORGANIZATION

The survey questionnaire was coded according to the question. Each question had one or several answers and a numbering system was assigned to answer. Furthermore, the answers of an individual household questionnaire were entered in excel data sheets and the data for all farmers followed the same type of data organization.

2.4.2 STATISTICAL ANALYSIS

The data were subjected to descriptive statistics using SPSS software version 21. The main areas were: i-Households socio-demography characteristics, ii- Livestock production; iv-Land tenure, v-Crops production and yields, vi-Consumption and food security of the household, viii-Crop utilization and Markets, ix-Access to information, x-Leadership and management at the Household, xi-Self-reported credit accessibility, xii-Perception of safety and security, viii-Expenditure, and xiv-Strategies to adapt climate change.

3 RESULTS

3.1 HOUSEHOLDS' SOCIO-DEMOGRAPHY CHARACTERISTICS

Household heads interviewed were 98.4% male-headed (Table 3). These household heads ages were between 20 and 85 years with an average of 45 years. The average age for males was 45 years and 46 years for females (Table 4). Most of the farmers were above 25 years old. The illiteracy rate was about 38.3%. It has been found that 3.3% of farmers went to school but stopped after primary school, 7.7% reached secondary school and stopped there and very few (0.2%) reached high school. In general, the farmer's education level was very low both for males and females. The other types of schools were Islamic education for learning religion and mother tongue learning by reading and writing. Households were divided into two groups regarding settlement period: 27% were migrants and 73% were endogenous inhabitants. Three percent of household settlements in HBR was less than 10 years. Half of households had their members that emigrated and 23% of those migrants

sent money home. Also, 10% of households declared to rely on this money for survival. Concerning the wealth perception, household heads declared themselves as 8% very poor, 51% poor, 34% average, 7% wealthy.

Table 3. Household main socio-economic characteristics

Variables	Percentage (%)
Gender	
Female	1.6
Male	98.4
Head of household Education Level	
None (illiterates)	38.3
Literates	61.7
Migration status	
Allochthones	26.6
Autochthones	73.3
Settling	
<10 years	2.6
10 to 20 Years	60.4
20 to 50 years	8.7
>50 years	28.1
House members migrated	
No	49.6
Yes	50.4
Migrated Sending money back	
No	77.4
Yes	22.6
Sum for survival	
No	89.8
Yes	10.2
Socio-economic group	
Very poor	7.7
Poor	50.6
Medium	34.3
Wealthy	7.4
Number of observations N= 946	

Table 4. Distribution of head of household year

Locality	Mean of year	Minimum	Maximum
Houet			
Female	52.6	44	63
Male	45.7	22	85
Kenedougou			
Female	40.0	34	51
Male	45.2	20	78
Tuy			
Female	48.3	42	55
Male	44.5	23	83
HBR			
Female	46.4	34	63
Male	45.2	20	85

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The size of the households averaged 15 peoples and whereas median was 11 and mode was 8 (min: 3 and max: 85 people) (S1). This shows clearly that most of the farmer's families were large. Water sources on farms were mostly protected hollow well for 18.6% of farmers, Faucet/fountain/drilling for 34% of them, and inadequate water sources (river) for 47.4% of households (S2).

The survey revealed that 92.1% of households had a sanitary system versus 7.7% that had no sanitary toilette (S3). All household was using firewood for cooking. In addition to firewood, one household was using a bio-digester system, three households used charcoals and three others used butane gas. The use of cell phones was popular and it was found that 97% of farmers had cell phones for communication and 80% listened regularly to the radio. In some farms family, most of the house furniture was owned by women (87%), food fryer (100%), and refrigerators (98.5%) (Table 5). Among the females, 40% of cell phones were bought by women but only 7% of them used for communication. Furthermore, 59% of men were cell phone owners (Fig 2). The reason for having cell phones was for calls for 40% of farmers and 60% of farmers used for light, music, and game.

Table 5. House furniture's

Holding	Equipment		Ownership		
	Yes	No	Male	Female	Jointly
The radio	80.2	19.8	87.3	5.4	7.3
Television	38.2	61.7	76.6	11.1	11.3
Satellite Antenna	10.6	89.3	80.0	1.0	18.0
Laptop	1.6	98.4	6.7	86.7	6.7
Sewing machine	2.2	97.8	71.4	19.0	9.5
Solar panel	59.6	40.4	87.6	1.1	11.4
Electric water heater	0.3	99.7	100.0	0	0.0
Non-farm equipment (specify)	31.9	68.1	77.0	1.0	22.0
Brewing equipment	2.3	97.6	52.9	5.9	41.2
Food fryers	0.7	99.3	0.0	100	0.0
Refrigerators	1.4	98.5	1.4	98.5	11.1
Cell phone	97.4	2.6	59.0	1.1	39.9
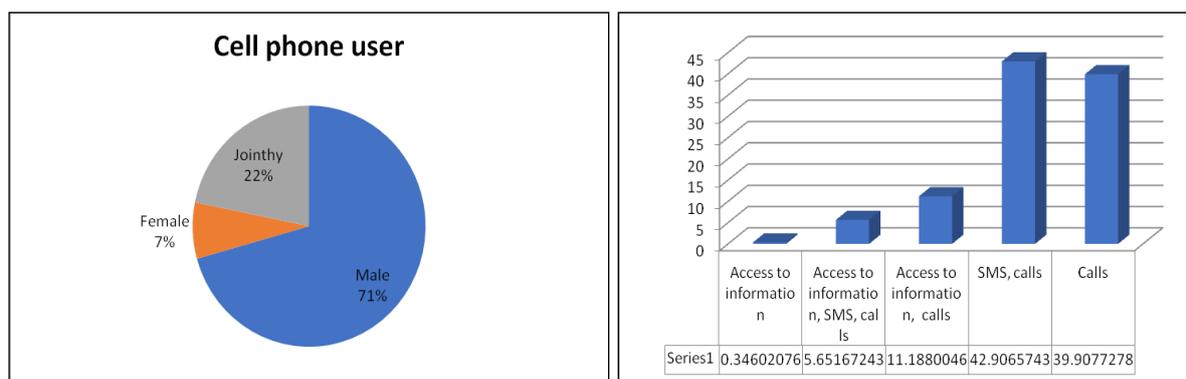
Fig. 2.   Cell phone user in the household and reasons for phone usage

3.2   LAND TENURE

In HBR cereal fields' average size was about 8.7 ha (Table 6). Larger cereal field was found in Tuy's province (14.3 ha) whereas smaller farmers were located in Houet (5.7 ha). The same trend was observed in maize production where average field sizes were 3.9, 5.8, 6.2, respectively, for Houet, Kenedougou, Tuy; and 5.2 ha for HBR. Each household possessed up to 5 fields in Houet, 6 fields in Kenedougou, and 20 fields in Tuy. The average price of land was about 212,540 CFA per ha in HBR.

Table 6.   Status of land used for farming

Province	Cereal Field Size (ha)	Maize field size (ha)	Range corn field	Average ha price (CFA)
Houet	5.76	3.92	1-6	
Kenedougou	7.80	5.83	1-5	
Tuy	14.3	6.20	1-20	
Hauts-Bassins	8.7	5.19	1-20	212540

3.3   CROPS PRODUCTION AND YIELDS

We found that 98% of surveyed households produced maize in the past growing season before the interview (Table 7). Similarly, 34 % of households produced vegetables for consumption or market. Households from the Houet province had higher rates of crop production (48%) as compared to Tuy province (16%) and Kenedougou (33). Results revealed the existence of disparity within HBR in maize production and yield (Table 8). The average production of maize in HBR was 4.3 tons for a single household, with 6.2 tons per household in Kenedougou province, 3 tons in the Houet province, and in Tuy province. The corn yield was 1700 kg/ha in Kenedougou, 1600 kg/ha in Houet, and 1000 kg/ha in Tuy province, respectively (Table 9).

Table 7.   Maize farming

Growing maize	Frequency	Percent	Cum.
Yes	922	97.98	97.98
No	19	2.02	100
Total	941	100	

Table 8.   Vegetable farming

Growing vegetables	Provinces			HBR
	Kenedougou	Houet	Tuy	
Yes	112	173	40	325
	33.23%	48.06%	16.13%	34.39%
No	225	187	208	620
	66.77%	51.94%	83.87%	65.61%
Total	337	360	248	945

Table 9.   Production and productivity of maize in HBR

Locality	Production/household's (Mean± SD)	Productivity/ha
Kenedougou	6201.5 ± 6051.1	1655.5 ± 1221.3
Houet	2904.7 ± 3596.1	1567.9 ± 2454.3
Tuy	3725.1 ± 3638.2	1060.3 ± 988.1
HBR	4298.0 ± 4855.1	1468.9 ± 1775.3

Data presented are Mean± SD. Units are in Kg

In HBR, households in the lowest quartile of livestock ownership had animals worth less than $273 while the livestock wealth of the top quartile topped $4191. It's important to note that 19% of households did not own livestock at all. The median value of livestock household holding was $1800 (Table 10).

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Table 10. Livestock value: Percentages by province

Livestock value	Province of the household			Total
	Kenedougou	Houet	Tuy	
No Livestock	44	58	74	176
	13.02%	16.16%	29.96%	18.64%
Less than $273	17	33	8	58
	5.03%	9.19%	3.24%	6.14%
Between $273 and $1800	67	113	51	231
	19.82%	31.48%	20.65%	24.47%
Between $1800 and $4191	96	88	49	233
	28.4%	24.51%	19.84%	24.68%
More than $4191	114	67	65	246
	33.73%	18.66%	26.32%	26.06%
Total	338	359	247	944
	100	100	100	100

Categories of livestock values are defined by quartiles

3.4 CONSUMPTION, FOOD SECURITY, AND DIETARY DIVERSITY

In Tuy, Provinces (76%) households worried more about running out of food compared to Kenedougou (56%) and Houet (49%). Almost all household chefs felt they should improve food quality. Almost all household heads felt they need to diversify the consumed food. In Tuy, 14% of households who were not eating regularly were double of those in Houet. In Kenedougou, 2% of the household had the same response. In Tuy, 74% of households felt they were not eating sufficiently which is very high compared to Kenedougou (43%) and Houet (49%). Whereas lack of food seemed to not be related to money in Kenedougou (5.5), the connection to lack of money was about 28% in Houet and 36% in Tuy giving an average of 22% for the region.

The overall percentage of households experiencing hunger (HH) who indicated food insecurity on all six dimensions was 9 percent. The highest food insecurity incidence by this measure was Tuy, with 27 percent. By contrast, in Kenedougou, over 5 percent of respondents indicated no food insecurity, compared to less than one percent in Tuy.

Table 11. Food security measures by province

Panel A: Average

	Kenedougou	Houet	Tuy	All provinces
	Mean (Std. Dev.) [min - max]	Mean (Std. Dev.) [min - max]	Mean (Std. Dev.) [min - max]	Mean (Std. Dev.) [min - max]
6-point food security score	3 (1.13) [0 - 6]	3.02 (1.20) [0 - 6]	3.91 (1.57) [0 - 6]	3.25 (1.35) [0 - 6]

Panel B: Frequency

Food security score	Province			
	Kenedougou	Houet	Tuy	HBR
0	15	9	2	26
1	5	10	21	36
2	70	122	12	204
3	80	64	55	199
4	116	128	78	322
5	0	4	3	7
6	3	13	63	79
Total	289	350	234	873
NB: 0 – 6, increasing food insecurity. A household that records 0 is considered as food secure, and a household that records 6 is considered as food insecure with hunger.				

Reflecting on a diverse diet in the region, this measure suggested a more widespread degree of food security than was indicated by the responses to the six questions food security module. However, under the standard WFP scoring category, 82% of the households had acceptable food consumption score. Only 8% of households reported an FCS less than 21, associated with poor food consumption while 10% of households reported an FCS less than 35 indicating that those households were on the borderline food consumption according to the WFP. The overall average FCS score in each province was above the 'acceptable food consumption score' threshold (>35) in Burkina Faso (15).

Table 12. Food consumption score by province

	Province			
	Kenedougou	Houet	Tuy	HBR
	Mean (Std. Dev.) [min - max]	Mean (Std. Dev.) [min - max]	Mean (Std. Dev.) [min - max]	Mean (Std. Dev.) [min - max]
Food Consumption Score (FCS)	66.23 (31.67) [15.83– 112]	59.05 (16.29) [21 – 107]	47.05 (22.57) [19.33– 107]	60.33 (26.31) [19.33 – 107]
FCS, 0 – 21 is characterized as poor food consumption; FCS, 21.5 to 35 is characterized as Borderline food consumption; and FCS greater than 35 is considered as acceptable food consumption.				

Table 13. Distribution of food consumption scores (FCS) per households

FCS quartiles	Freq.	Percent	Cum.
FCS ≤ 40	187	19.77	19.77
FCS 41 - 67	185	19.56	39.32
FCS 68 - 78.5	178	18.82	58.14
FCS 78.6 - 112	396	41.86	100
Total	946	100	

Table 14. Distribution of food consumption scores (FCS) by Provinces

FCS quartiles	Kenedougou	Houet	Tuy	HBR
FCS ≤ 40	25.44	10.56	25.40	19.77
FCS 41 - 67	11.24	33.89	10.08	19.56
FCS 68 - 78.5	23.37	21.39	8.87	18.82
FCS 78.6 - 112	39.94	34.17	55.65	41.86

Table 15. Food consumption groups by FCS

Food consumption group	Freq.	Percent	Cum.
Poor food consumption	73	7.72	7.72
Borderline food consumption	97	10.25	17.97
Acceptable food consumption	776	82.03	100
Total	946	100	

3.5 CROP UTILIZATION AND MARKETS

Half of the households in Houet reported having sold all their produced maize. However, 34 and 28 percent of households sold their entire harvested maize respectively in Kenedougou and Tuy. In the entire sample, 39 percent of households traded all their produced maize (Table 16). Prices of maize varied from 116, 125, and 130 CFA (local currency) respectively for Tuy, Houet, and Kenedougou (Table 17). On average, the reported price of maize was higher in Kenedougou than in other provinces.

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Table 16. Utilization of the maize

Proportion of production sold	Province			
	Kenedougou	Houet	Tuy	HBR
Some	138	129	117	384
	40.83	35.83	47.18	40.59
Half	85	46	62	193
	25.15	12.78	25	20.4
All	115	185	69	369
	34.02	51.39	27.82	39.01
Total	338	360	248	946

Table 17. Price of maize in CFA francs

Province	Maize price (kg)		
	Mean	sd	Median
Kenedougou	130.3	21.53	120
Houet	125.38	68.02	120
Tuy	116.73	13.38	125
Total	124.34	41.64	125

3.6 ACCESS TO INFORMATION

Overall 59 percent of producers reported having access to market information about their crops (S4). Households in Houet reported the highest access to market information, followed by Kenedougou. Only 12 percent of producers in Tuy reported having access to market information about their products. Fifty-three percent of self-declared poor producers had access to market information about their products. However, this percentage is 69 percent for self-declared "not poor" (S5).

3.7 LEADERSHIP AND MANAGEMENT AT THE HOUSEHOLD

3.7.1 MEMBERSHIP TO A GROUP

About 76 percent of producers were members of community association (e.g. cooperative, microfinance, religious) with the highest incidence in Kenedougou and Tuy (Table S6). Group membership did not appear to vary substantially with a self-reported socio-economic group. Approximately ¾ of both self-identified poor and non-poor individuals were group members (S7).

3.7.2 DECISION MAKING WITH THE HOUSEHOLD

Almost all households head in Kenedougou (99.7%) decided to attend to activity in the last 12 months compared to those from Houet (88%) and Tuy (86%.4%). Decisions making in the family about attending agricultural activity was mainly done by the head of the household solely, their spouse or jointly by both. The highest involvement of women (spouse) making a decision was seen in Houet province (36%) which is two times of that in Kenedougou and Tuy. Kenedougou household heads contributed the most in most or all decision making (91%) as compared to those in Houet and Tuy that were about 75%. The contribution of Household heads to income use was 93%, 79%, 73%, and 81% respectively for Kenedougou, Houet, Tuy, and the region (Table S8-12).

3.7.3 SELF-REPORTED CREDIT ACCESSIBILITY

Households were asked both whether they had "access" to credit and whether they received credit. Although 59 percent of households report having access to credit, 42 percent of them received credit (S13). Reported credit access was highest in Kenedougou (71 percent) and lowest in Houet (42 percent). However, the actual receipt of credit was nearly identical in all provinces (S14).

3.7.4 PERCEPTION OF SAFETY AND SECURITY

In Tuy, the fear for personal safety that affects the ability to participate is high in agricultural production (60% vs 26% in Kenedougou and 36% in Houet), in the processing of agricultural products (51% vs 3% in Kenedougou and 1% in Houet), in the marketing and sale of agricultural products (53% vs 16% in Kenedougou and 6% in Houet) (S15).

3.8 EXPENDITURE FOR FOOD

The yearly per capita food consumption expenses (in CFA) varied across provinces with 45610.6, 49497.5, and 48195.8 respectively for Kenedougou, Houet, and Tuy. Houet province had the highest food consumption expenses versus Kenedougou where expenses were the least (Table 18).

Table 18. Yearly per capita food consumption expenses (in CFA) by province

Province	Mean	sd	Median	Min	Max
Kenedougou	45610.62	30302.62	38224.56	7222.22	260000
Houet	49497.51	41788.98	34047.62	6933.33	202222
Tuy	48195.79	35104.39	40617.22	7090.90	260000
Total	46958.49	33682.14	39000	6933.33	260000

3.9 STRATEGIES TO ADAPT CLIMATE CHANGE

3.9.1 NUMBER OF INDIVIDUALS ADOPTING IMPROVED LAND / NATURAL RESOURCE MANAGEMENT TECHNIQUES: ZAÏ, ANR, INTERCROPPING, COMPOSTING, REFORESTATION, IMPROVED FIREPLACES

To be more resilient and adapt to climate change, farmers adopted some techniques. Techniques related to water harvesting and management in the field (Zaï, half-moon) were adopted in the region 94%. Assisted natural regeneration was adopted and concerned wildlife management in the fields (49%), composting (69%), crop rotation (80), agroforestry: tree planting in the fields were well adopted (52%) (Table 19). In the region, few people 14% didn't hear about plant clinics, 9% visit plant clinicians, 12% were visited by clinicians, 15% got advice from clinicians, and 15 are utilizing those advices in practice (Table 20). Sixty-nine percent of households surveyed had used improved seeds in the last 3 years where 32% about improved high-yielding and drought-tolerant seeds. Tuy province (27%) is the center of basic improved seed production zone but Kenedougou farmers benefit more from the redistribution (Table 21). All Farmers were willing in participating in training in corn production or workshop and ready to be contacted for further research (S16).

Table 19. Adaptation to climate change (%)

	Kenedougou		Houet		Tuy		HBR	
Techniques NAS	Yes	No	Yes	No	Yes	No	Yes	No
Zaï	7.1	92.9	2.8	97.2	6.1	93.9	94.4	5.5
Assisted Natural Regeneration (NAS): Wildlife Management in the fields	62.1	37.9	59.3	40.7	15.3	84.7	48.8	51.2
Cropping association (two or three or more associated)	21.9	78.1	26.9	73.1	27.8	72.2	25.2	74.8
Composting	57.1	42.3	74.7	25.3	75.4	24.6	68.6	31.2
Reforestation	31.4	68.6	30.6	69.4	21.8	78.2	28.6	71.4
Improved fireplaces	3.8	96.2	7.2	92.8	8.9	91.1	6.5	93.5
Half-moon	11.8	88.2	0.8	99.2	4.1	95.9	5.6	94.4
Crop Rotation	84.0	16.0	73.8	26.2	84.3	15.7	80.2	19.8
Agroforestry: tree planting in the fields	58.3	41.4	44.3	55.7	54.7	45.3	52.0	47.9

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Table 20. Plants Clinic: attendance and advice (%)

Plants Clinic	Kenedougou		Houet		Tuy		HBR	
	Yes	No	Yes	No	Yes	No	Yes	No
Have you ever heard of a Plant Clinic?	12.1	87.9	4.6	95.4	29.3	70.7	13.7	86.3
Do you visit a plant clinic?	2.4	97.6	2.5	97.5	28.2	71.8	9.2	90.8
Visit to Plant Doctors / Nurses	9.8	90.2	3.1	96.9	27.9	72.1	12.0	88.0
Have the advice of been helpful?	8.6	91.4	10.9	89.1	29.8	70.2	15.5	84.5
Use / practice	7.9	92.1	14.0	86.0	25.9	74.1	15.0	85.0

Table 21. Adoption of high-yielding and drought-tolerant seeds (%)

Techniques GRN	Kenedougou		Houet		Tuy		HBR	
	Yes	No	Yes	No	Yes	No	Yes	No
Did you use improved seeds in the last three seasons, including the current one in 2016/2017?	66.6	33.4	74.1	25.9	64.1	35.9	68.8	31.2
Have you used basic seed in the last three seasons, including the current one, 2016/2017?	12.7	87.3	0.6	99.4	27.0	73.0	11.9	88.1
Are you benefiting from improved high-yielding and drought-tolerant seeds?	36.4	63.6	13.6	86.4	51.2	48.8	31.6	68.4
Are you a beneficiary of basic seed?	36.4	63.6	0.3	99.7	17.5	82.5	5.7	94.3

*"**Basic Seed**: According to the law N ° 010-2006 / AN regulating plant seeds in Burkina Faso in chapter II, article 5, the basic seed is usually represented by the symbol "G4" to signify that it constitutes the seed Fourth generation or multiplication of the strain seed. It is produced and strictly managed by the research institutions either at the research station level or by seed producers supervised by them. The basic seed is produced under the quality control of an official certification body"*

4 DISCUSSION

Heads-of-household were predominately male (98.4%) and their literacy rate was (61.7%). Twenty-seven percent of the households self-reported as migrants have settled in the HBR within the past 10 years. The size of the households averaged 15 peoples whereas median was 11 peoples and mode was 8 peoples (Ranged for 3 to 85 people). The findings of this work are similar to reported earlier [15] whereby in the sub-humid zone of Burkina the head-of-household was male and the average household included 18 people. Nearly one-half (47.4%) of households had a non-drinkable water source, and 7.7% had no sanitary toilet. All households used firewood for cooking. The use of a cell phone was popular (97%) and 80% listened regularly to the radio. The high penetration of media and ICT can help reach farmers and improved their productivity. Those ICTs showed improving agriculture productivity in developing countries [16; 17].

In the HBR, the average production area for cereal crops was 8.7 ha, of which 5.2 ha was for maize production. Household land areas ranged from five to 20 separate fields. A large number of fields imply crop diversification. Crop diversification can be implemented in various forms and at a variety of scales, thereby allowing farmers to choose a strategy that increases resilience and renders economic benefits [18]. The average cost for one ha of land was 212540 CFA ($366 U.S.) in the HBR. The average maize yield was 4300 kg per household, 1000 to 1700 kg/ha. The average yield was similar to the West African average of 1.5 tons per hectare [19] but lagged behind the 2,000 to 5,000 kg/ha yields for improved varieties [20]. Half of the households sold all their maize production just after harvesting whereas 39 % of households sold their maize progressively. The price of maize ranged from 116 to 130 CFA ($0.20 to $0.22/kg).

The first quartile of household food consumption score was lower to 40 while the fourth quartile starts from a food consumption score of 78.6. More than 40 percent of households were concerned about running out of food during the year. Nine percent of respondents indicated food insecurity in all aspects. Eight percent of households reported a food consumption score (FCS) less than 21 (poor food consumption) while 10% reported an FCS less than 35 (borderline food consumption). However, under the standard WFP scoring category, 82% of the households had acceptable food consumption score. The overall average FCS score in each province was above the acceptable food consumption score threshold (>35). The acceptable food consumption score may also be linked to the association of maize and vegetable production in the HBR. In fact, 98% of

farmers produced maize, and 34 % produced vegetables for family consumption or sale. It appeared emergent to assist that 18% of the household's to improve their food consumption status through proper formulation and implementation of food security policies targeting those vulnerable households to ensure a healthy diet. Also, the quality of the household's diet was obviously better in Burkina Faso Centre-West Region where 44% of households had acceptable food consumption score [21]. The HBR scored higher than the majority of countries in Africa and is in a Food Consumption Group (FCG) similar to Sudan and Laos according to the WFP Guide [13, 14]. It was noted that the dietary diversity was calculated at the household aggregate level and many households in the sample were very large.

In the HBR, 59% of farmers reported having access to agricultural market information. Access to information was related to well-being (53% for self-declared 'poor' and 69% for self-declared 'not poor'). We supposed access to agricultural market information is crucial for farmers to make decisions and due to high penetration ICT (mobile phone, radio), a training may increase the access rate. Use of software such a SIMAgri [22] could help to (1) sell to new buyers, (2) facilitate the negotiation, (3) save time, (4) weight product before selling, and (5) get informed. SIMAgri has been successfully used in Tanzania [22]. Seventy-six percent of farmers were members of a community group (e.g. cooperative, microfinance, religious) and membership did not vary substantially with the self-reported socio-economic group. Decisions making in the family about attending agricultural activities were made by the head-of-household, their spouse or jointly by both, and the head-of-household made 81% of the household financial decisions.

In the HBR, households in the lowest quartile of livestock ownership had animals worth less than 158,340 CFA ($273 U.S.) while the livestock wealth of the top quartile topped 2,430,780 CFA ($4,191). Nineteen percent of households did not own any livestock. The median value of livestock per household was 1,044,000 CFA ($1,800). Although 59% of households reported having access to credit, only 42% received credit. Access to credit was higher in the HB Region compared to a national average of 9.3% [23]. Annual per capita food consumption expenditures varied across provinces from 45,611 to 49,498 CFA ($79 to $85 U.S). The amount allocated to food consumption was below the food security threshold of 108,697 CFA/year (≈$187 U.S./year) [24]. Houet province had the highest food consumption expense likely due to its proximity to Bobo-Dioulasso, the second-largest city in Burkina Faso.

In-field water harvesting techniques common in some regions of Burkina Faso (zaï, half-moon) were uncommon in the HBR. Besides, assisted natural regeneration (ANR), macrobiota management in the fields, composting, crop rotation, and agroforestry (tree planting) were common practices. Farmers were more concerned about soil fertility than water management. Farmers were interested in improved seed varieties. Sixty-nine percent had used improved seeds in the previous three years, and 32% used improved high-yielding and drought-tolerant seeds. The use of drought-tolerant seed is likely a strategic response to increasingly unpredictable rainfall. All farmers were willing to participate in training in maize production and further research.

5   CONCLUSION

In the HBR, 82% of the households had an acceptable food consumption score. Ninety-eight percent of farmers produced maize and 34% produced vegetables for the market or family consumption. Cereal crop production per household was about 8.7 ha, 5.2 ha of which was for maize production. The average production of maize was 4300 kg per household with yields ranging from 1000 to 1700 kg/ha. Eight percent of households reported an FCS less than 21 (poor food consumption) while 10% reported an FCS less than 35 (borderline food consumption). However, under the standard WFP scoring category, 82% of the households had acceptable food consumption score. Annual per capita food consumption expenditures in HBR varied across provinces from 45611 to 49498 CFA ($79 to $85 U.S). Although 59% of households reported having access to credit, only 42% received credit. Sixty-nine percent of households used improved high-yielding and drought-tolerant seeds. Firstly, the household's belonging to group of poor to borderline FCS need food assistance to improve their food situation. In that, formulation and implementation of food security policies targeting vulnerable households to ensure a healthy diet is necessary. Secondly, amelioration of the agriculture production system through appropriate scale mechanization will intensify sustainably while diversifying the production. Lastly, a periodic food security profile study covering the season will help understand the dynamic and implement better food security policies.

CONFLICT OF INTEREST

There is no conflict of interest reported by the authors. The work was conducted under their supervision and each contributed to various aspects of the design, execution, writing, and review of the manuscript.

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ANNEX

S1: Distribution of household members by age group and sex

Descriptive Statistics								
	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation
	Statistic	Statistic	Statistic		Statistic	Statistic	Std. Error	Statistic
0-5 M	946	14	0	14	1422	1.50	0.056	1.714
0-5 F	944	17	0	17	1497	1.59	0.057	1.744
6-14 M	944	14	0	14	1673	1.77	0.059	1.810
6- 14 F	946	15	0	15	1649	1.74	0.060	1.835
15-24 M	943	16	0	16	1451	1.54	0.067	2.063
15- 24 F	942	12	0	12	1212	1.29	0.056	1.705
25-49 M	946	18	0	18	1705	1.80	0.069	2.134
25-49 F	943	26	0	26	2063	2.19	0.074	2.282
50+ M	946	10	0	10	527	0.56	0.025	0.761
50+ F	945	11	0	11	570	0.60	0.031	0.938
Valid N	932				13769	14.58		

F: female; M: Male

S2: Water sources

Water source		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	phw	176	18.6	18.6	18.6
	phw, uhw	1	0.1	0.1	18.7
	phw, uhw, sw	6	0.6	0.6	19.3
	phw, uhw, rw, ffd	1	0.1	0.1	19.5
	phw, uhw, sw, ffd	13	1.4	1.4	20.8
	phw, uhw, ffd	3	0.3	0.3	21.1
	phw, sw	4	0.4	0.4	21.6
	phw, sw, rw	1	0.1	0.1	21.7
	phw, sw, rw, ffd	13	1.4	1.4	23.0
	phw, sw, rw,	1	0.1	0.1	23.2
	phw, sw, ffd	5	0.5	0.5	23.7
	phw, rw, ffd	10	1.1	1.1	24.7
	phw, ffd	59	6.2	6.2	31.0
	uhw	234	24.7	24.7	55.7
	uhw, sw	3	0.3	0.3	56.0
	uhw, sw, rw, ffd	16	1.7	1.7	57.7
	uhw, sw, rw, ffd	1	0.1	0.1	57.8
	uhw, sw, ffd	1	0.1	0.1	57.9
	uhw, rw	1	0.1	0.1	58.0
	uhw, rw, ffd	9	1.0	1.0	59.0
	uhw, ffd	30	3.2	3.2	62.2
	sw	15	1.6	1.6	63.7
	sw, rw, ffd	1	0.1	0.1	63.8
	sw, ffd	12	1.3	1.3	65.1
	rw	1	0.1	0.1	65.2
	rw, ffd	7	0.7	0.7	66.0
	ffd	322	34.0	34.0	100.0
	Total	946	100.0	100.0	

Protected hollow well (phw): 01; Unprotected hollow well (uhw): 02; Surface water (stream, shoal, rivers) (sw): 03; Rainwater (rw): 04; Faucet / fountain / drilling (public or private) (ffd): 05.

S3: Sanitary status

Sanitary					
		Frequency	Percent	Valid Percent	Cumulative Percent
	TWS	144	15.2	15.3	15.3
	TWS, TVST	1	0.1	0.1	15.4
	TWS, TVST, PL	1	0.1	0.1	15.5
	TWS, PL	100	10.6	10.6	26.1
	TWS,4	2	0.2	0.2	26.3
	TVST	289	30.5	30.6	56.9
	TVST, PL	93	9.8	9.9	66.7
	PL	234	24.7	24.8	91.5
	PL, LF	1	0.1	0.1	91.6
	LF	4	0.4	0.4	92.1
	None	73	7.7	7.7	99.8
	Oth	2	0.2	0.2	100.0
	NR	2	0.2	100.0	
	Total	946	100.0		

S4. Access to market information about your product by province

Market access	Province			
	Kenedougou	Houet	Tuy	HBR
No access	109	60	218	387
	32.34	16.76	87.9	41.04
Access	228	298	30	556
	67.66	83.24	12.1	58.96
Total	337	358	248	943

S5. Access to market information about your product by self-attributed socio-economic group

Access to market	Self-attributed socio-economic group		
	Poor	Not Poor	HBR
No access	256	122	378
	47.5	30.89	40.47
Access	283	273	556
	52.5	69.11	59.53
Total	539	395	934

S6. Group membership by province

Membership	Province			
	Kenedougou	Houet	Tuy	HBR
Yes	293	192	207	692
	86.69	56.97	86.25	75.63
No	45	145	33	223
	13.31	43.03	13.75	24.37
Total	338	337	240	915

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S7. Group membership by self-attributed socio-economic group

Membership	Self-attributed socio-economic groups		
	Poor	Not Poor	HBR
Yes	387	298	685
	74.71	76.61	75.52
No	131	91	222
	25.29	23.39	24.48
Total	518	389	907

S8. Decision to attend activity in the last 12 months

Response	Kenedougou		Houet		Tuy		HBR	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Yes	337	99.7	316	88.0	209	86.4	862	91.8
No	1	0.3	43	12.0	33	13.6	77	8.2

S9. Person taking decision in the Household

Response	Kenedougou		Houet		Tuy		HBR	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Household head	180	56.3	178	56.3	165	76.4	523	61.4
spouse	52	16.3	115	36.4	34	15.7	201	23.6
Other female household member			2	.6	5	2.3	7	.8
Other male household member	3	.9	10	3.2	1	.5	14	1.6
Other female not household member								
Other female not household member			1	.3			1	.1
jointly	85	26.6	9	2.8	11	5.1	105	12.3
Not Applicable			1	.3			1	.1

S10. Contribution when you have had to make decisions about

Response	Kenedougou		Houet		Tuy		HBR	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
No contribution	1	.5	21	6.6	9	4.2	31	4.2
contribution in certain decisions	13	6.3	54	17.1	42	19.4	109	14.7
Contribution in most or all decisions	189	91.3	238	75.3	160	74.1	587	79.4
None in the decisions taken	3	1.4	3	.9	5	2.3	11	1.5

S11. To what extent do you feel that you can make your own personal decisions about [the activity] if you want?

Response	Kenedougou		Houet		Tuy		HBR	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Not at all			3	.9	5	2.3	8	1.1
Low Measure	7	3.4	36	11.4	5	2.3	48	6.5
Average range	11	5.3	103	32.6	62	28.7	176	23.8
To a large extent	189	91.3	174	55.1	144	66.7	507	68.6

S12. Your contribution to decisions on the use of income generated

Response	Kenedougou		Houet		Tuy		HBR	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
No contribution in some decisions decisions			6	1.9	7	3.2	13	1.8
Contribution in certain decisions	12	5.8	60	19.0	51	23.6	123	16.6
Contribution in most or all	193	93.2	249	78.8	158	73.1	600	81.2
No contribution taken	2	1.0	1	.3			3	0.4

S13. Potential credit accessibility

	Kenedougou	Houet	Tuy
Have access to Credit	71.3	41.64	59.92
Have No access to Credit	26.33	56.51	38.87
Don't know	2.37	1.86	1.21

S14. Credit received

	Kenedougou	Houet	Tuy	HBR
Someone received credit	43.32	40.11	42.11	41.78
No one received credit	51.04	58.22	57.09	55.36
Don't know	5.64	1.67	0.81	2.86

S15: Farmer appreciation of safety and security in Haut Bassin Region (%)

Questions	Response	Kenedougou	Houet	Tuy	HBR
Fear for personal safety affects ability to participate in agricultural production	Yes	27.5	37.0	60.3	39.7
	No	72.5	63.0	39.7	60.3
Fear for personal safety affects ability to participate in the processing of agricultural products	Yes	3.0	1.4	50.6	14.6
	No	97.0	98.6	49.4	85.4
Fear for personal safety affects ability to participate in the marketing and sale of agricultural products	Yes	16.0	6.1	52.8	21.9
	No	84.0	93.9	46.8	78.0

S16. Monitoring

	Kenedougou		Houet		Tuy		HBR	
Monitoring	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Would you be interested in participating in training in corn production or workshop?	99.1	0.9	99.4	0.6	99.6	0.4	99.4	0.6
Are you willing to be contacted for further research?	99.4	0.6	99.7	0.3	100.0	0	99.7	0.3