Assessment of the impact of contour bunding technology (CBT) using the agricultural sustainable intensification domains in two agroecologies of southern Mali

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The Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-in-development projects supported by the United States Agency for International Development (USAID) as part of the U.S. Government's Feed the Future initiative.

Through action research and development partnerships, Africa RISING is creating opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three regional projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads the program's monitoring, evaluation and impact assessment.

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Introduction

In Malian villages, the family is sometimes composed of the grandfather, fathers, sons, grandsons, and other relatives, all of them living together. In such a family there may be over a hundred people and the grandfather is the head, no matter how old or inactive he is. In a family of this kind, women are allowed to have small farms of their own. However, the man is responsible for handling the big farm. Interviewing one of the members of such a family about his/her household is difficult. The reason given is that the respondents believe this distinction might imply division in family members. Moreover, due to the traditional culture, a woman is severely discouraged from engaging in such discussions and it could lead to discrimination. Even though the confidentiality of her responses is guaranteed, a woman would often hesitate to take part in the interview. During the interviews, a difficulty was observed for the respondents in distinguishing between family and household.

Descriptive statistics on the demographic information base of respondents

To get responses on the survey questions the household members were divided in to four groups (head, spouse, joint, and family) to identify the role of each group in the household. The first is the head of household (family) and in general a male and /or older spouse was indicated for the females married in the household (family). Joint was identified as decision-making among males and females; family was used to indicate all members in the family.

Age of respondents and household size

Table 1 presents the descriptive analysis carried out in this study. It showed that the minimum age for farmers in Bougouni was 30 years and the maximum was 58 years with an average of 44 and standard deviation of 7.57. This means that all the respondents are still effective in farm work. Among respondents the younger ones are male and the older are female. According to this study, the mean of female respondents is higher than for males. This is due to the fact the male is always the head unless he has died, and the female has taken his position. Additionally, it is common for young widows to go and marry a second husband. Hence, it was observed that female heads are usually old.

Koutiala showed results similar to those of Bougouni in terms of age distribution of farmers. However, respondents interviewed were 5 years younger than in Bougouni. Males are older than females with standard deviation of 9.60.

In Bougouni District the minimum number of responses from female household members was 8 and the maximum was 51. The mean of the respondents was 29 with standard deviation of 13.01. The minimum number of household family members was 4 and the maximum was 90 with mean of 26 and standard deviation of 24.25. In comparison of the means, household size is smaller in Koutiala than Bougouni but the household distribution in Koutiala is well spread. In one particular village in Koutiala, there were big families and these families were more than 50 people.

Table 1: Age of respondents and household size in the two districts, Bougouni (1) and Koutiala (2).

Parameters	Bougouni			Koutiala		
	Minimum	Maximum	Average (SD)	Minimum	Maximum	Average (SD)
Age	30	58	44 (± 7.57)	25	57	43 (± 9.60)
Household size	08	51	29 (± 13.01)	04	90	26 (± 24.25)

Level of education

Education of farmers in two agroecological zones of Africa RISING intervention villages is presented in Figure 1 a/b. The first district Bougouni is divided in two types of education as follows: No formal education (75%) and primary education (25%). The gender distribution in the first category was 67% male and 33% female. From this result, nearly twice as many women have no formal education above primary level. For primary education, males represented 40% and females 60%. The number of educated females is higher than of males in Bougouni district. In the second district, Koutiala, the educational sector was divided into three as follows: no formal education (56%), primary education (28%), and secondary level (16%). As the education level increased, the percentage of respondents going to school

decreased. Education by gender distribution was as follows: 57% males and 43% females with no formal education; 42% males and 58% females for primary level; 50% for both males and females for secondary level.

The number of females was also decreasing with the increase in level of education. The observation from the two districts showed that more females went to school than males. Most of the respondents were older than 30 years. Back in the old days, most of the families in villages didn't know the importance of schools owing to religious beliefs. Heads of families thought that schools are for those who don't believe in God or are Christian. Families prefer to send their children to the Koranic School. Another reason is the requirement of labor in the farms. In Malian culture, a boy is his father's heir and he has to help his father and learn what he is doing as a farmer. Heads of families (households) prefer to send female children to school instead of males because male children help in farming. To emphasize this point, in the 1990s a religious man sent two of his three boys to school He was criticized, and the village wanted to eject him from his religious position in the mosque. As a result, he did not get any help from villagers' working group.

Despite the equal number of females and males in secondary level (50%), there were more educated female farmers than male at primary level. At secondary level females abandon school for many reasons. First, their parents give them in marriage at an early age. Secondly most of them leave for the capital city and look for jobs during the dry season (November to June). They want to help their mothers, have some new clothes, and get cooking utensils for their marriage. This is the reason for the reduced number of female children in higher education even at University level.

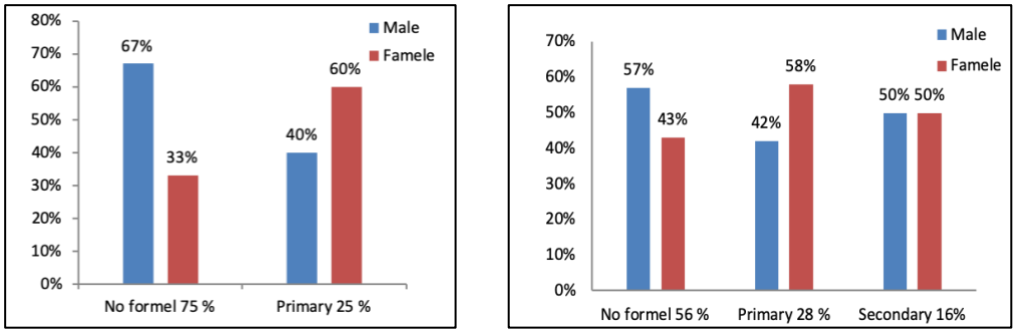

Figure 1 a/b: Farmers' education levels across two agroecological zones (a) Bougouni and (b) Koutiala.

Farm size

Land availability for farming in the two districts was assessed for land management and implementation. More than 60% of respondents were observed to cultivate more than 8 ha of land. This showed that absence of good management is the problem and not farmland availability. Farm production was affected by runoff, weeds, and delay in the rainy season that farmers indicated was the most important. The number of farmers increased with the farm size. All the small farms of 1 to 3 ha in size belonged to females. All farmers cultivated about 1 ha of CB farmland in the two districts apart from one female with 0.75 ha.

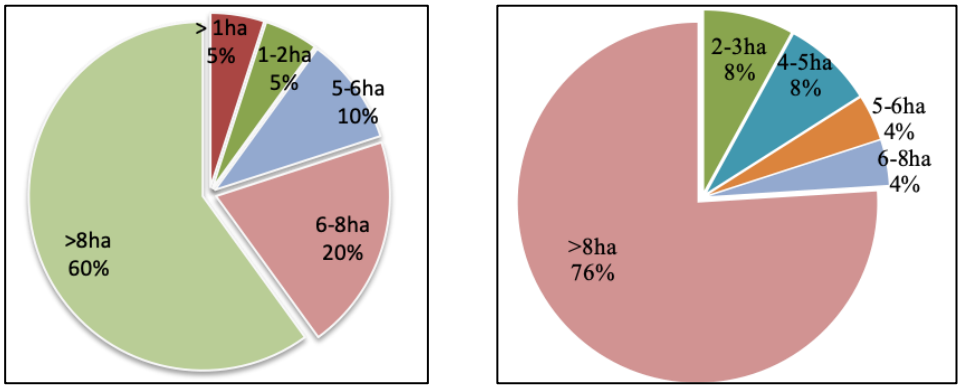

Figure 2 a/b: Distribution of farm size across two agroecological zones (a) Bougouni and (b) Koutiala in southern Mali.

Other income generating mechanisms from farmers' responses

Agriculture as a whole is the main source of income of rural people. Nowadays, this activity is supported by other sources of income. To assess a technology's impact on the agricultural sector it is necessary to evaluate other incomes from other sectors (tailor, trade…). The incomes generated by Bougouni farmers represent 20% of the respondents and 80% don't have other sources of income. Moreover, female farmers with access to other income sources were considered; 69% of male respondents and 31% of females had no other income apart from farming. However, 75% of females and 25% of males were income generators. In Koutiala District, 52% of respondents don't have any income and 48% generate some income. Males represent 67% and females 33% in the category of "no other income" but 59% of females and 41% of males had some income.

The females had more other income than males in the two districts because of the female practice to take care of condiments, whatever the price (daily fees or family daily cost). The absence of trade in Bougouni might explain the low rate of income. There is complementarity between a female spouse and male head of household. This means that where a husband is not generating income, it is up to the wife to generate it. To highlight this statement: "In M'pessoba, the female was working at the farm with the children while her husband was doing mechanic's work at the market (repairing bicycles)." In that little family both are generating income. Females were more active in generating income than males from other sources (trading, horticulture, handicrafts...). In most of the villages in Mali, females are in charge of buying clothes and shoes for their children, even healthcare needs (paracetamol, small medicines…) when the condition is not too serious.

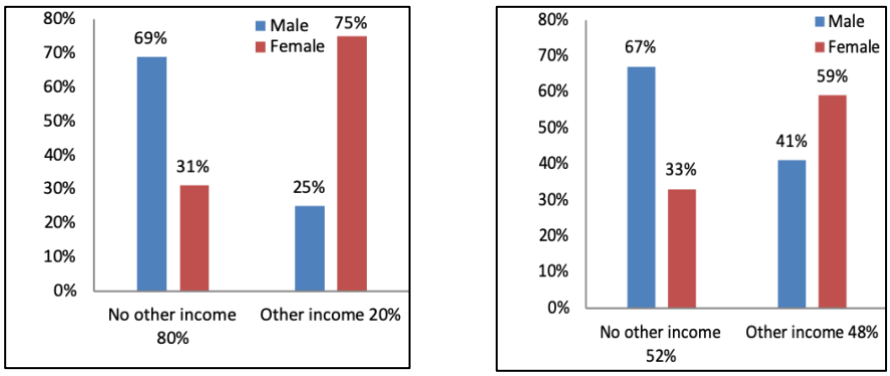

Figure 3 a/b: Farmers generating income other than from agriculture in (a) Bougouni and (b) Koutiala.

Contour bunding impact assessment

At the village level, there is specificity in household farm work according to age and gender. In this study household members were categorized into four groups (adult male, adult female, young adult male, and young adult female). Moreover, two categories (temporary female and male workers) were added from outside the household group. A total number of six categories of efficiency was assessed in CB building and maintenance.

First contributors

Figure 4 shows the categories contributing in CB construction for the first time where adult males and young males represented 60% of the respondents and were more active in farm work than any other members of the household. Adult males represented 15% followed by young males (10%) , adult females and young females (5%), male and female temporary laborers (5%), and then all family members (5%). Koutiala showed a result similar to that of Bougouni, adult and young males were more active in farm management (40%) followed by adult females, 32%. Other categories were classified as adult female and young males, young males, adult males and females, and then joint were represented respectively 12%, 10%, 4% and 4% of respondents. In the two districts, adult and young men were more active in constructing CB and female farmers did less. Female farm work was focused on sowing and harvesting. This is the reason for their poor contribution to CB construction and it reflected the reality of the farming system in Mali.

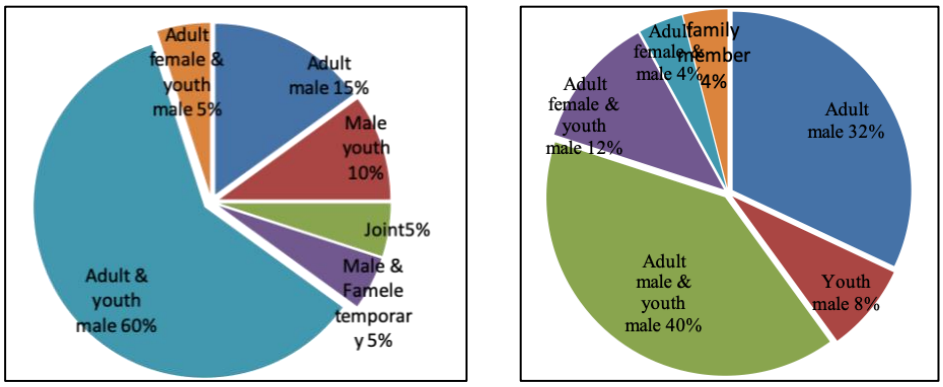

Figure 4 a/b: Household members as constructors of first CB (a) Bougouni and (b) Koutiala.

Most contributors

During CB construction, it was observed that adult males contributed more than the other categories in both districts. In Bougouni area, the percentage of adult and young men was the same (45%). Adult women represented 5% of respondents contributing most to their CB building. In Koutiala the same scenarios were repeated with females (4%) classified behind adult males (72%) and young males (20%). Hard work in the farms is generally done by men, young and old, and this is the reason for the poor participation of females among contributors to CB construction.

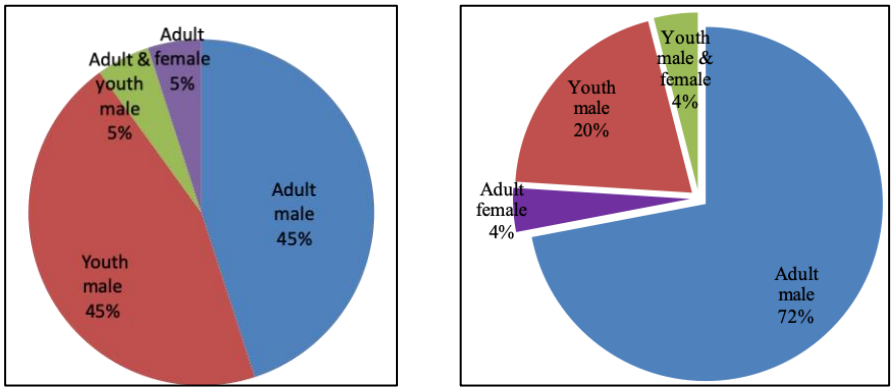

Figure 5a/b: Most contributors in CB building (a) Bougouni and (b) Koutiala.

Animals used in CB construction

Figure 6 show the contribution by animals in CB construction in the two districts. Despite the huge percentage (92%) of farmers using animals for CB construction, some farmers used manual methods to construct their CB. The reason might the level of land degradation and/or lack of animals to be used. However, a farmer in Bougouni District (Dièba) used trees and stones directly to do the Contour. Some farmers (6.67%) rented animals for CB construction at an average of 5500 FCFA/day; the majority of these farmers were female. This study showed the importance of animals in farm activities in Mali. Farmers in Bougouni used more animals in CB construction than farmers in Koutiala.

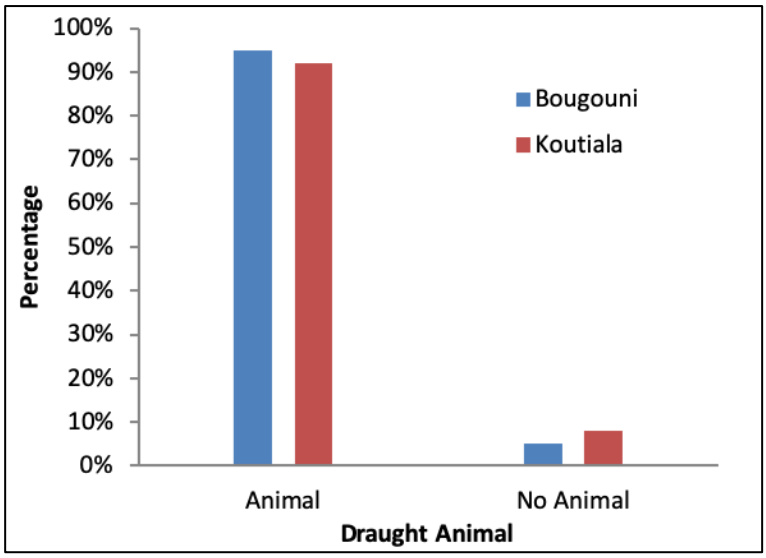

Figure 6: Draught animals used in construction of the CB in farms.

Ownership of draught animals

As shown in Figure 7 on the importance of animals in farm activities, it was necessary to determine the ownership of the animals. In this study, there were three groups (head, joint and rented) who owned animals used for draught. In Bougouni District 79% of animals used were owned by heads of households while in Koutiala it was 87%. There was an equal percentage of joint and rented animal ownership in Bougouni District while in Koutiala there was twice as much rented ownership.

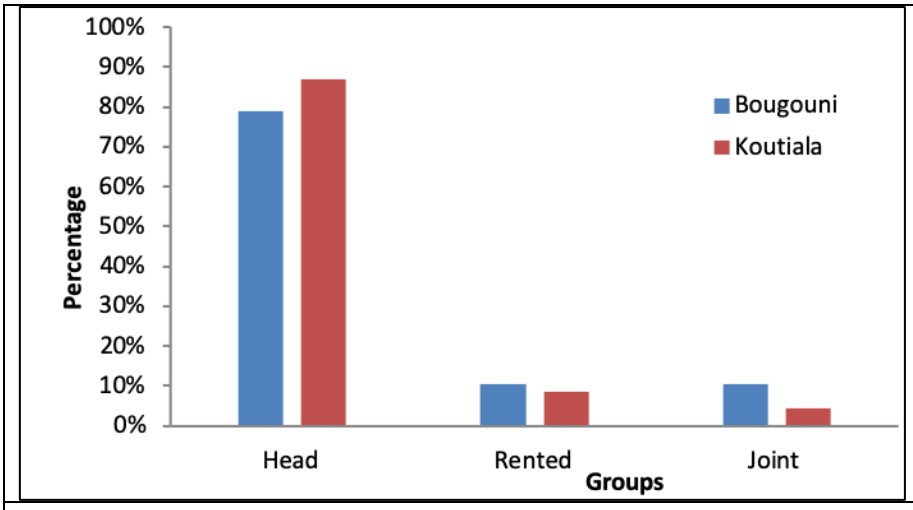

Figure 7: Household ownership of animals used for CB construction.

Maintenance of CB after construction

Contour bunding is constructed where the amount of runoff is plentiful, and the slope is steep. Despite the equal percentages of the youth (15%) to maintain CB in both districts, 76% of bunds in Koutiala were maintained by adult men and 60% in Bougouni. Adult men were more active in maintaining the CB followed by the youth. This result revealed that adult females contributed least in maintaining CB in both districts. In farm activities at village level, adult males are in charge of coordination and repair of minor items so that young men continue with their activities.

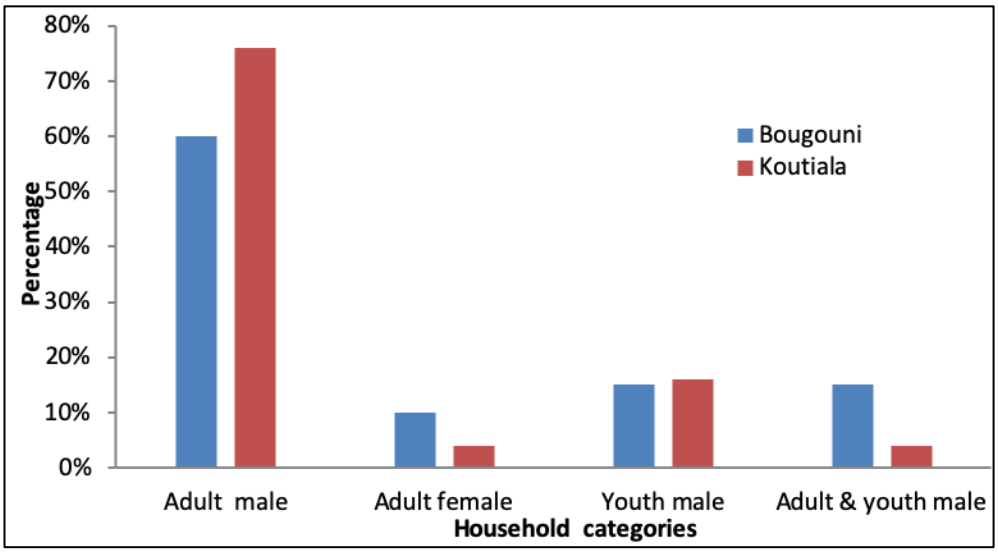

Figure 8: Household members maintaining CBs from erosion.

Different crops cultivated in CB fields

Different crops grown in CB farms were evaluated in the two districts. In all farms, there were rotations or intercropping. In Bougouni District, the rotation or intercropping between maize and cotton was equal in percentage with the combination of maize, cotton, and groundnut while the percentages for all other rotations were the same. Maize, cotton, and groundnut were the crops most cultivated in CB fields. In Koutiala area the crops most cultivated in CB plots were sorghum and millet followed by sorghum and maize, millet and maize, maize and groundnut. Sorghum and millet were most cultivated; however, maize; sorghum, and millet were very often cultivated in CB fields.

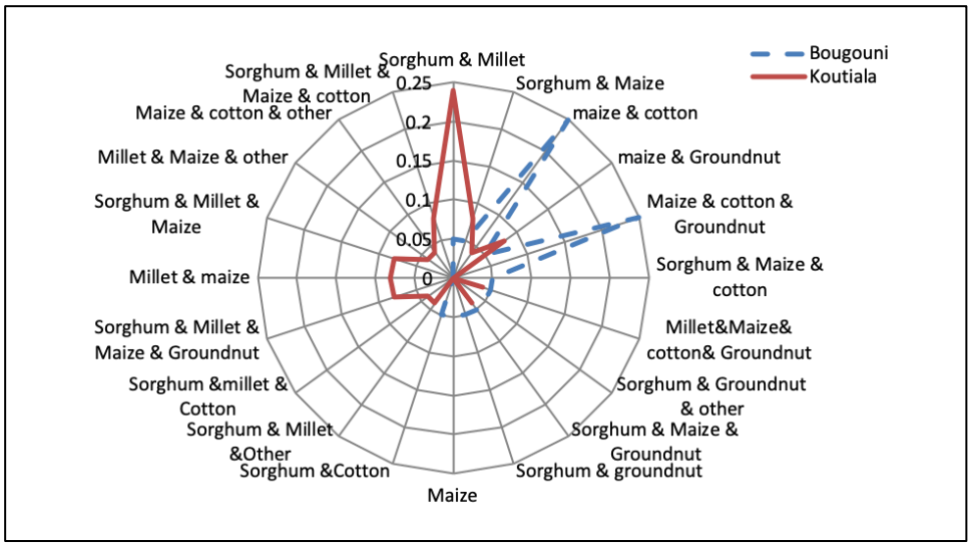

Figure 9: Crops grown in different districts: Bougouni (blue dashes) and Koutiala (red line).

Crop classification

Land fertility, availability of rainfall, and arable land are the main challenges for the villagers in rural Mali. Many crops are cultivated in different CB fields. The best crops adopted by farmers in CB fields were assessed. During the survey the crops were classified from one to four by each farmer. In Bougouni district 55% of the respondents used maize as first crop, cotton (50%) as second, and groundnut (30%). Sorghum and millet were used by a small number of farmers (Fig. 10a). In Koutiala district maize was first with 44% followed by sorghum (36%) and millet (8%). Cotton and groundnut are cash crops with 8% each (Fig. 10b). This result showed that maize, sorghum, and cotton were the crops most adopted in the CB fields.

Figure 10c shows the perception of farmers on crops adoptability in CB farms. Five crops were mainly used by farmers in CB fields. These crops were classified based on the income. Maize was classified as the first crop followed by sorghum (second), millet (third), cotton, (fourth) and groundnut (fifth). Maize yield increased more than for other crops with the use of CB although it is the main crops in these two districts. This showed the importance and the benefit of CB in the region.

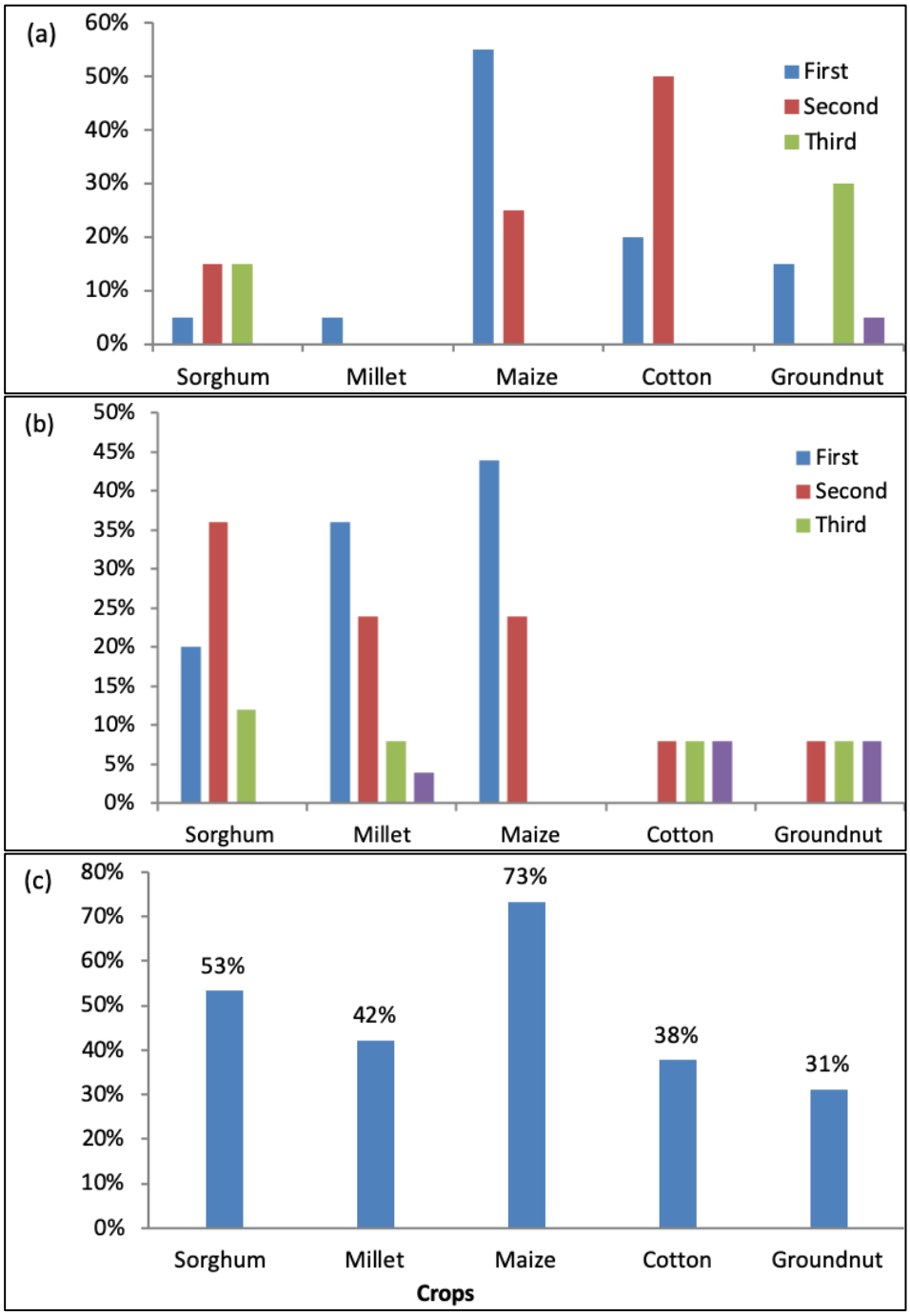

Figure 10 a/b/c: Crops classified according to their importance (a) Bougouni, (b) Koutiala, and (c) aggregated.

Income control from crops in households

As for CB construction, household members were grouped into four for assessing income control and decision-making about income from CB fields. In Bougouni District, the head of the household controlled more than 80% of the income from maize, cotton, and groundnut and 71% from sorghum. The spouse was classed as second for controlling the income from sorghum (29%), groundnut (10%), and maize (6%). Joint control and family groups were the weakest in the control of income from CB plots. This result is due to the Malian family structure where the head of the family is the ultimate decision-maker. However, after harvesting, some crops were put at the disposition of spouses, such as groundnut and Hibiscus sabdariffa used for making soup. Sorghum is also partly controlled by spouses

because they use it in making a local drink; cotton is 100% controlled by the head of the household who in most cases is a male farmer.

In Koutiala, incomes from all crops were controlled by the head of the household (60%). Spouses were least in controlling incomes compared to the family and joint decisions. The size of the family affects female decisions. This result showed that joint decisions and those by family members followed the head of the family. Income from women's CB plots might be controlled by the heads (their husbands) of households as confirmed by farmer 6 in Flola. She said, "After I harvest, the income will be added to the family income and put under the control of my husband (head)". In some villages, all of the spouses' properties belonged to the husband because they belonged to him. However, a husband might sell the income from spouses without informing them and use the gain for his needs. Moreover, in polygamous family these actions are sometimes sources of conflict among spouses.

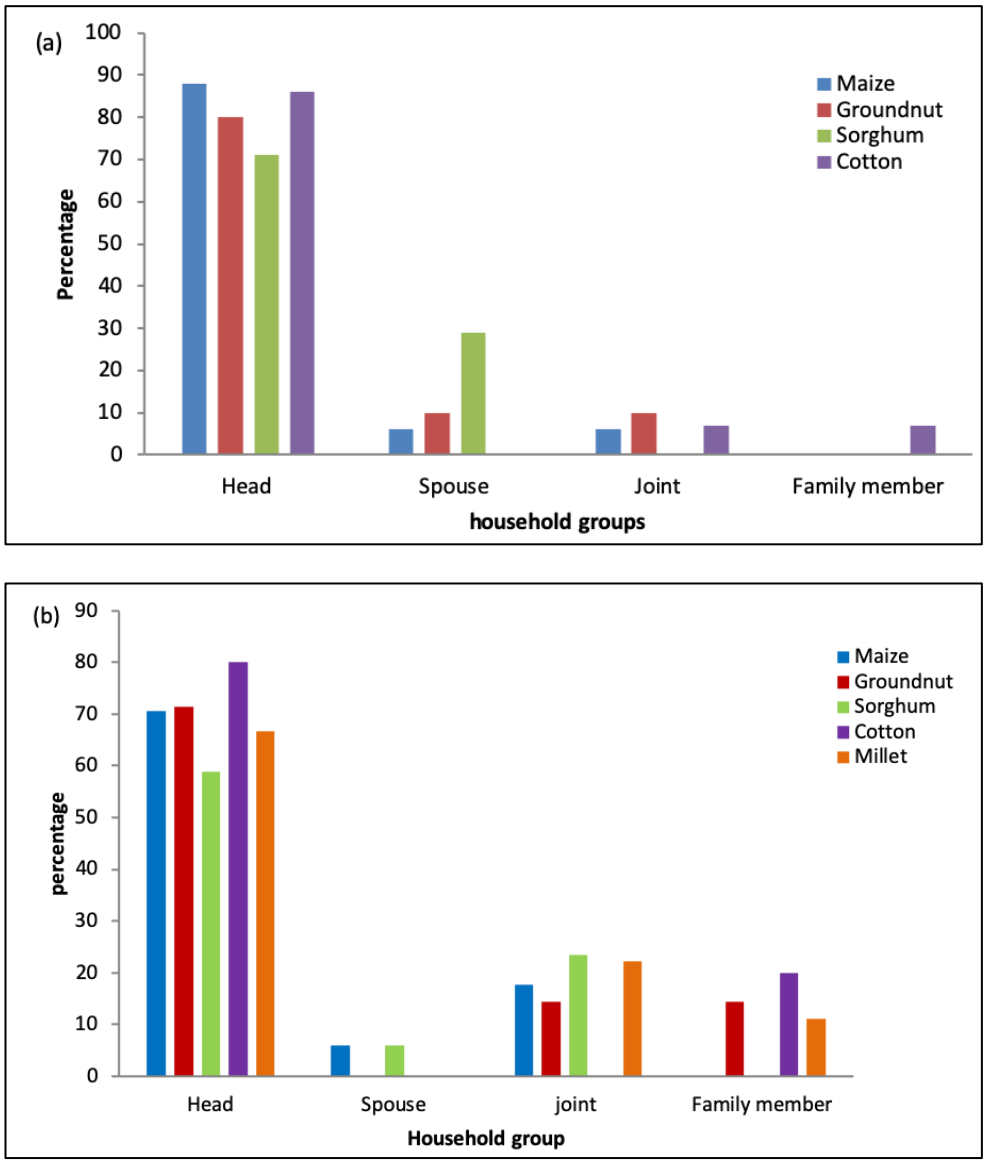

Figure 11 a/b: Crop income control by household members (a) Bougouni and (b) Koutiala.

Household decision on income from crops cultivated in the CB field

Different groups in household level decisions about income from the CB field were assessed. In Bougouni District the heads of households exercised a huge responsibility in decision-taking about the consumption of income or selling of crops. Despite the equal percentage of sorghum (43%) for head and joint ownership, other crop incomes were mostly decided by head (56%). Head and joint ownership were most represented for decisions about the consumption of crops in the household. High-level decision-taking for the spouses (14%) concerned sorghum. Generally, spouses used sorghum to make local drinks. The situation in Koutiala was similar to that in Bougouni; the head of the household (59%) dominated other groups for all crops concerning decisions on household consumption. Spousal decisionmaking on consumption was very low in the second district. This is due to the big family structure where spouses are many. Joint decisions represented 30% for each crop; this means that female decisions were taken into consideration by the husband in both districts.

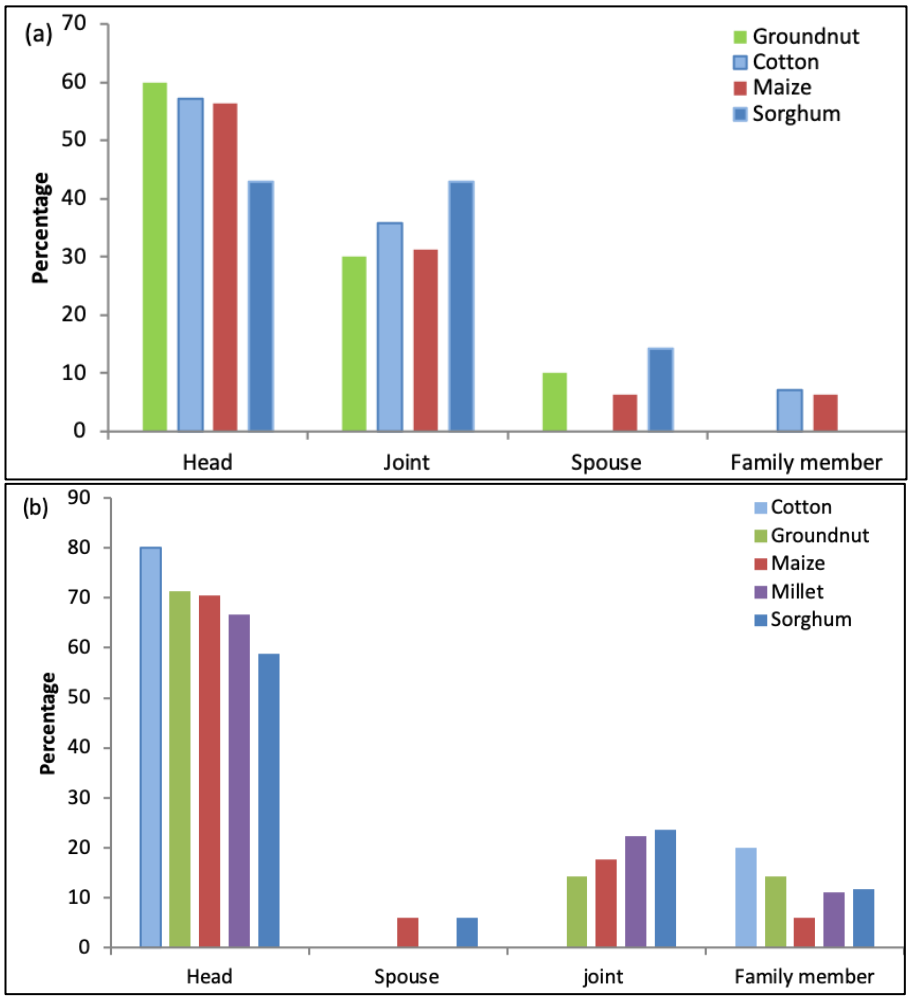

Figure 12a/b: Decisions taken concerning income (a) Bougouni and (b) Koutiala.

Food security availability after implementation of CB

Table 2 shows the statistical analysis of household food security in days for crops cultivated (sorghum, millet, and maize). Cotton and groundnut were quantified in kg as cash crops. In Bougouni District, sorghum consumption ranged between two and six months with an average of 94 days and standard deviation of 43.91. Maize increased food security from 21 days to nine months with an average of 104. There was more nutrition security from maize from sorghum and millet. Maximum production of cotton and groundnut was 2 t; the minimum was 120 and 200 kg respectively. As a result of CB application, the average increase of production for cotton was 605 kg and for groundnut 680 kg.

Food security in Koutiala district was assessed after the application of CB. This technology has increased average food availability as follows: sorghum by about 84 days, millet by 112 days, and maize by 165 days Concerning cash crops, there were increases averaging 553 kg for cotton and 483 kg for groundnut. Maize was classed as the first crop to improve food security in both districts. Sorghum was classified as second crop in Bougouni and millet in Koutiala. Production in Koutiala was higher than Bougouni in terms of maximum and mean while the minimum was lower. The production of groundnut was higher than cotton in both districts because it is used as a cash crop and for consumption. By applying CB, maize and groundnut were the crops to most increase food security.

Table 2: Improvement of food availability in days after CB application.

Parameters	**Bougouni**			**Koutiala**		
	Min.	**Max.**	**Avg. (sd)**	**Min.**	**Max.**	**Avg. (sd)**
Sorghum (days)	60	180	94 (± 43.91)	30	300	84 (± 70.33)
Millet (days)	–	–	–	05	420	119(± 107.83)
Maize (days)	21	270	104 (± 75.73)	15	600	165(± 157.38)
Cotton (kg)	120	2000	605 (± 503.26)	60	850	553(± 296.67)
Groundnut (kg)	200	2000	680 (± 617.88)	100	1000	483(± 354.50)

Table 3: Descriptive statistics of food availability in days after CB application.

Parameters	**Minimum**	**Maximum**	**Mean**
Sorghum (days)	30	300	87,08
Millet (days)	05	420	120,26
Maize (days)	15	600	135,79
Cotton (kg)	60	2000	597,64
Groundnut (kg)	100	2000	550