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Women's Empowerment: A Key Mediating Factor between Cotton Cropping and Food Insecurity in Western Burkina Faso

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Abstract We examined associations between cotton cropping, women's empowerment, and household food insecurity in Burkina Faso. A cross-sectional study was conducted during the 2012 pre-harvest period. Socioeconomic characteristics and agricultural production data were collected using a questionnaire. The Household Food Insecurity Access Scale (HFIAS) questionnaire was used to assess household food insecurity. Four villages of western Burkina Faso were selected for the study. In total, 275 farmer's households, who had at least one child between the age of 6 and 59 months, participated in the survey. Food insecurity affected 67% of households. HFIAS score was negatively correlated with the Household Dietary Diversity Score (HDDS) ($r = - 0.40$, $P = 0.000006$). Cotton cropping was not directly associated with the HFIAS score, while women's workload (positively) and income-generating activities (negatively) were. Interestingly, the only village where women could own cotton fields was negatively associated with the HFIAS score. An intensive cotton production was positively associated with the amount of time women spent fetching water and was tendentiously associated with women's working time in cotton fields. Finally, the size of cotton farms was positively associated with the practice of petty trading. The relationships between cash cropping, women's daily activities, and food insecurity are dynamic, behaviour related, and should be targeted for appropriate behaviour change intervention in order to alleviate food insecurity.

Keywords: *cash cropping, food insecurity, women, Burkina Faso*

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1. Introduction

Persistent hunger and malnutrition weaken the ability of Sub-Saharan Africa to achieve the Millennium Development Goals by 2015 [1]. Food insecurity, which is present "when all people do not have, at all times, access to sufficient, safe, nutritious food to maintain a healthy and active life" [2], is an underlying cause of malnutrition [3]. In an attempt to simultaneously reduce poverty and food insecurity in rural communities, policy makers promoted the commercialization of agriculture in the 1970's [4]. In West Africa, large scale cotton production was promoted and this cash crop quickly became an important part of export earnings for many countries [5]. Burkina Faso is one of the most important African cotton producers. Following a reform of its agricultural sector in the 1990's, cotton exports tripled between 1995 and 2007 and now account for 60% of national export earnings [5,6]. While cotton production and household incomes seem to have increased with cotton cropping, effects on health and nutrition are still ambiguous. Indeed, the prevalence of child stunting remained constant among cotton farming households between 1998 and 2003 (50% of girls and 53% of boys) despite an improvement in living conditions and a continuous decline in the poverty rate [7]. In 2009, it was estimated that 84% of households in Burkina Faso were food insecure [8].

Women are key actors to ensuring food security in Sub-Saharan African countries. In these countries, women bear the responsibility for about 90% of the tasks related to food processing and cooking, as well as to providing household water and wood fuel. Women are also solely responsible for caring for children [9,10]. They play an essential role in the agricultural system where they represent almost half of the labour force [11]. Moreover, when compared to men, women generally spend a greater proportion of their income on foods, education and healthcare for their children [12]. However, women still

face many gender inequities that weaken their land rights, limit their access to farm extension services and credit, lower their level of education, break their decisional empowerment, and consequently, impair their ability to improve the food and nutrition security of their family [9,13].

Although many studies have reported on the impacts of cash cropping on nutrition [12,14,15], few have been conducted in recent years and findings remain inconsistent. For instance, von Braun (1995) reported that the commercialization of hybrid maize in Zambia had a positive impact on children's nutritional status, while the commercialization of coffee, cocoa, and palm oil in Sierra Leone seemed to have worsened it [16]. Most studies have been done using household food consumption and expenditures to evaluate impacts on food security [12,14,15]. However, food security is a complex phenomenon that simultaneously integrates dimensions of food availability, accessibility, and utilization, while considering stability over time [17]. The Household Food Insecurity Access Scale (HFIAS), which is increasingly used to monitor food insecurity in developing countries, could be a useful indicator to evaluate associations between cash cropping and food insecurity [17,18]. However, no previous study has reported on it yet. Furthermore, the effects of cash cropping on women's daily activities, which can have an impact on household food insecurity, are still poorly known [9].

The aim of the present study was therefore to investigate associations between cotton cropping, women's daily activities, and household food insecurity in a leading cotton production region of Burkina Faso during a pre-harvest period.

2. Materials and Methods

2.1. Study Design and Participants

This study is part of a larger project aimed to better understand how cotton cropping affects household food and nutrition security in western Burkina Faso. The research was conducted in the *Hauts-Bassins* and the *Boucle du Mouhoun*, two regions that account for about 68% of Burkina Faso national cotton production [19]. As part of the larger project, two cross-sectional surveys were carried out during a post-harvest (November/December 2011) and a pre-harvest period (June/July 2012), and some focus group discussions were conducted during the post-harvest period. The current paper reports only data from the pre-harvest period which is the most critical period of the year for food security as it is the time when most households may have to face food crop shortages.

Data were collected from farmer's households in four villages based on cotton production, physical accessibility, and regional demographics. To be included in the study, the household had to have at least one child between 6 and 59 months of age. Both the husband and wife were asked to complete a gender-specific questionnaire. Using an accidental sampling, one hundred households were recruited in each village. In other words, 400 households participated in the post-harvest survey in 2011 (first data collection).

This study was conducted according to the guidelines laid out in the Declaration of Helsinki and all procedures involving human subjects were approved by the *Comité d'éthique de la recherche de l'Université Laval* (#:2012-101/23-05-2012), the *Comité national d'éthique de la recherche en santé du Burkina Faso* (#:2011-8-53), and the *Comité d'éthique de la recherche en sciences et sciences de la santé de l'Université d'Ottawa* (#:H08-11-03). Written or fingerprinted informed consent was obtained from all participants.

2.2. Data Collection

Local trained investigators collected the data during face-to-face interviews using pre-tested questionnaires. Interviews were conducted in Dioula, the most commonly spoken local language in these regions.

2.3. Household Food Insecurity

The Household Food Insecurity Access Scale (HFIAS), already validated in Burkina Faso, was used to assess food insecurity status [18,20]. This tool evaluates whether households have experienced problems to access food of sufficient quality and quantity over the last 4 weeks. Similar to the validation study conducted by Frongillo and Nanama (2006) [18], "the last harvest" was considered instead of "the last 4 weeks" in order to take seasonal variability into account. The respondent, usually the person in charge of food preparation, answered a set of 9 questions on behalf of all household members. The HFIAS was calculated as follows. For each experience that was described, the respondent had 4 possible answers, based on the frequency of occurrence: 0 for "never"; 1 for "rarely"; 2 for "sometimes"; and 3 for "often". The level of food insecurity (secure, mildly, moderately, or severely) as well as a food insecurity severity score were established based on a composite score calculated by adding the individual scores from the nine frequency-of-occurrence questions [20]. The HFIAS score, a continuous indicator, ranges from 0 (food security) to 27 (maximum food insecurity). The Household Hunger Scale (HHS) was derived from the HFIAS by reducing the questionnaire to three items: 1) no food of any kind to eat in your household; 2) went to sleep at night hungry; and 3) went a whole day and night without eating [21]. The level of household hunger (no or little, moderate, or severe) calculated with the HHS allows assessment of household food deprivation for cross-cultural use [22].

2.4. Dietary Diversity

The Household Dietary Diversity Score (HDDS) was calculated to describe overall household dietary quality and food access [23]. Women participating in the study completed a qualitative recall by listing all food groups consumed by at least one member of their household during the previous 7 days. The 12 food groups were: cereals; tubers and roots; vegetables; fruits; meat, fish and other seafood; eggs; legumes; oilseeds; milk and milk products; oils and fat; sweets; and condiments. The HDDS ranges from 0 (no food intake over the previous 7 days) to 12 (maximum dietary diversity).

2.5. Women's Daily Activities

The following indicators were used to define women's daily activities: the amount of time spent working in

cotton fields and fetching water; the practice of petty trading or farming as income-generating activities (IGA's); and childcare responsibility while women worked in the cotton fields. These variables were selected based on 1) a typical day of an African woman [10]; 2) the role of women in the following pillars of food security: food availability, accessibility, and utilization [9]; and 3) the findings from the focus groups held during the post-harvest period (Sanou *et al*, unpublished results).

2.6. Cotton Cropping

Information was collected about the size of the cotton farm, the cotton grain yield, and the cotton production index. The cotton production index was defined as the intensity at which cotton crops were produced compared to food crops.

2.7. Statistical Analysis

Data management and analyses were performed with SPSS for Windows version 21.0 (SPSS Inc., Armonk, NY, USA). Frequencies and means were used to describe participants' characteristics. Pearson's correlations and multivariate linear and logistic regressions were done to explore the relationships among key variables of interest. Households that did not produce cotton were excluded from regression analyses because of their small sample size (n = 15).

Missing variables defining agricultural production (n = 66) were imputed with the Markov Chain Monte Carlo method to decrease the amount of missing data and increase statistical power [24]. Only these variables were imputed because they were considered as randomly missing. Missing data from women's questionnaires were not imputed because they could not be considered as randomly missing (e.g. women could have been embarrassed with some questions).

Independent variables were included in regression models if there was *a priori* evidence that they could be independent predictors or outcome confounders. The selected variables were: villages; the size of cotton farm (small, medium, or large); cotton grain yield (kg/ha); cotton production index (kg cotton/kg total production); time spent by women working in cotton fields (hours/week); petty trading (no, yes) and farming (no, yes) as IGAs for women; time spent by women to fetch water (≤ 30 min or >30 min); and the person responsible for childcare while women worked in the cotton fields (the mother herself or others). Models were first adjusted for the type of marriage (monogamous/polygamous), women's age and their level of education (illiterate/at least some formal education), and the number of children in the household. These variables were removed from models due to their minimal effect on outcomes and the frequency of missing data. Type 1 error rate was set at 0.05 for all analyses.

3. Results

3.1. Baseline Characteristics

During the pre-harvest follow-up survey, 336 of these 400 households were available and accepted to participate. Largely due to the rainy season that is an opportune time for growing crops (June to September), participants who did not take part in the follow-up were those working in the fields or who had to leave quickly to work after a rainfall. Of the 336 completed questionnaires, 209 were completed by both husband and wife, 66 by the wife only, and 69 by the husband alone. Table 1 summarizes the distribution of the participants by village. For the purpose of this paper, results are derived from the women's questionnaires (n = 275), except for answers pertaining to agricultural production, because men knew more about this aspect.

Table 1. Distribution of Participants during the Pre-Harvest Period

	Villages								Total	
	Bondoukuy		Boni		Bama		Noumoudara			
	n	%	n	%	n	%	n	%	n	%
Households[a]	64	76.2	33	40.2	65	70.7	47	60.3	209	62.2
Only men	6	7.1	36	43.9	5	5.4	14	17.9	61	18.2
Only women	14	16.7	13	15.9	22	23.9	17	21.8	66	19.6
Total	84	100.0	82	100.0	92	100.0	78	100.0	336	100.0

[a] Households: male farmer and one of his wives have both answered their respective questionnaire

Among the 275 participating women, 55% lived in a monogamous household and 45% in a polygamous one with 1 to 3 co-wives (Table 2). The mean number of children under 5 years of age was 2.04 ($_{SE}$ 0.06) per household.

Women were, on average, 30.41 ($_{SE}$ 0.43) years old. Nearly two-thirds of them were illiterate and less than two-thirds owned agricultural land. Approximately 45% of women sold food crops grown on their own land and 72% did petty trading. Women spent on average 42.03 ($_{SE}$ 0.44) hours per week working in cotton fields. Most young children were being taken care of by the older children of the family when their mothers were working in cotton fields. Forty nine percent of women reported fetching water for more than thirty minutes per day.

Household cotton field size ranged from 0 to 25 hectares, with a mean of 2.99 ($_{SE}$ 0.22) hectares. The mean production of cotton was 3012 ($_{SE}$ 291) kg and the mean yield was 965 ($_{SE}$ 39) kg/ha. Cotton incomes ranged from -200 000 CFA (indebted households) to 4 500 000 CFA (500 CFA= $1 US). Cotton incomes were positively related to cotton field size (r= 0.69; P= 0.00000; data not shown). The mean cotton production index was 0.42 ($_{SE}$ 0.02) kg cotton/kg total production.

3.2. Food and Nutrition Insecurity Status

The mean HFIAS score was 4.52 ($_{SE}$ 0.30) with a median of 3.0 (data not shown). After categorization, more than two-thirds of households (67%) were food insecure during this pre-harvest period (Table 3). Nearly 33% of households suffered from moderate food insecurity, while 7% suffered from severe food insecurity.

With regards to hunger, 1.5% of households suffered from moderate hunger and 1.1% from severe hunger.

Table 2. Characteristics of Participating Households

	Frequencies		Means
	%	% 95% CI	Mean (± SE)
Household structure, *n = 274*			
Monogamous	55.11	47.18, 63.04	
Polygamous	44.89	36.10, 53.68	
2 wives	35.04	25.49, 44.58	
3 wives	7.30	0.00, 18.70	
4 wives	2.55	0.00, 14.24	
Number of children under 5 y-old in the family, *n = 274*			2.04 (0.06)
Main source of drinking water, *n = 275*			
Safe: mineral water, tap, hydrant, drilling, water tower	46.91	38.30, 55.52	
Less safe: traditional and improved wells	46.18	37.51, 54.85	
Unsafe: creeks, rivers, streams, rain	6.91	0.00, 18.31	
Participating women characteristics			
Age (years), *n = 246*			30.41 (0.43)
Level of education, *n = 271*			
None	61.62	54.25, 69.00	
Literate	14.76	3.77, 25.75	
Some level of formal education	23.62	13.21, 34.02	
Field ownership, *n = 272*			
Yes	63.97	56.83, 71.10	
No	36.03	26.52, 45.53	
Income generating activities, *n = 251*			
Farming (% yes)	44.62	35.42, 53.83	
Petty trading (% yes)	71.71	65.13, 78.29	
Working time in cotton field (hours/week), *n = 244*			42.03 (0.44)
Person responsible for childcare while women worked in the cotton fields, *n = 270*			
The mother herself	7.78	0.00, 19.23	
Older children	85.56	81.02, 90.09	
Other	6.67	0.00, 18.19	
Time fetching water per day, *n = 274*			
≤ 30 min	51.09	42.81, 59.38	
> 30 min	48.91	40.44, 57.37	
Cotton production and assets			
Size of cotton farm, *n = 208*			
Small (< 1.5 ha)	28.4	16.89, 39.91	
Medium (≥ 1.5- < 3.0 ha)	30.8	19.49, 42.11	
Large (≥ 3.0 ha)	40.9	30.45, 51.35	
Field dimension (ha), *n = 208*			2.99 (0.22)
Production (kg), *n = 205*			3012 (291)
Yield (kg/ha), *n = 190*			965 (39)
Cotton income (CFA), *n = 190*			273981 (38204)
Cotton production index (kg cotton : kg total production), *n = 186*			0.42 (0.02)

Table 3. Household Food Insecurity and Related Conditions During the Pre-Harvest Period of 2012†

	%	% 95 CI
Household food insecurity access prevalence (%)‡, *n = 275*		
Food security	32.73	23.01, 42.39
Mild food insecurity	28.00	17.97, 38.03
Moderate food insecurity	32.73	23.01, 42.39
Severe food insecurity	6.55	0.00, 17.89
Household hunger prevalence (%)§, *n = 275*		
No or little hunger	97.50	95.63, 99.37
Moderate hunger	1.50	0.00, 13.41
Severe hunger	1.10	0.00, 12.90
Household Food Insecurity Access-related Conditions (% yes)¶, *n = 275*		
1. Worried that the household would not have enough food	52.00	43.81, 60.19
2. Not able to eat the preferred foods	43.64	34.76, 52.51
3. Ate a limited variety of foods	37.09	27.72, 46.47
4. Ate some foods that you really did not want to eat	29.09	19.14, 39.04
5. Ate a smaller meal than you felt you needed	11.64	0.53, 22.75
6. Ate fewer meals in a day	8.36	0.00, 19.68
7. No food of any kind to eat in your household	2.55	0.00, 14.21
8. Went to sleep at night hungry	2.91	0.00, 14.56
9. Went a whole day and night without eating	1.45	0.00, 13.19

† Current food situation of households since the last harvest of 2011
‡ Calculated from the individual scores of the nine frequency-of-occurrence questions
§ Calculated from the individual scores of the three frequency-of-occurrence questions (7, 8, and 9)
¶ Household Food Insecurity Access-related Conditions are the nine frequency-of-occurrence questions from which HFIAS score and HFIAS prevalence were calculated.

Household Diet Diversity Score (HDDS) is the number of food groups consumed in the previous seven days by at least one of the members of the household. HFIAS score significantly and negatively correlated with the HDDS (r = - 0.40, P = 0.000006; data not shown), which suggests that the more the households were food insecure, the less likely they were to have high dietary diversity.

3.3. Associations between Cotton Cropping, Women's Daily Activities, and Household Food Insecurity

Bondoukuy farmers were less at risk for food insecurity (Table 4). Petty trading and farming were both significantly associated with a lower HFIAS score. However, the amount of time women spent working in cotton fields and fetching water was positively associated with the HFIAS score. Cotton cropping variables (size of cotton farms, cotton grain yield, and cotton production index) and the person responsible for childcare while mother or usual caregiver worked in the cotton fields were not significantly associated with the HFIAS score. This model accounted for 34% of the variance in the HFIAS score.

Table 4. Multivariate Linear Regression Model Examining the Effects of Cotton Cropping and Women's Daily Activities on Household Food Insecurity Status in Rural Burkina Faso†‡§

	Household food insecurity scale score, *n = 217*	
	B	SE
Villages		
Bondoukuy¶	-3.61**	1.05
Boni¶	0.67	1.02
Bama¶	0.80	0.97
Size of cotton farm (small, medium, large)	-0.26	0.46
Yield (kg/ha)	0.00	0.00
Cotton production index (kg cotton/kg total production)	0.04	2.22
Time women spent working in cotton field (hrs/week)	0.10*	0.05
Petty trading as IGAs (no, yes)	-4.55**	0.87
Farming as IGAs (no, yes)	-2.71**	0.75
Time women spent fetching water (≤ 30 min, > 30 min)	1.88*	0.76
Person responsible for childcare while mother or usual caregiver worked in the cotton field (mother herself, others)	0.10	1.15

†Calculated from an imputed database.
‡ $R^2 = 0.34$.
§ Households not producing cotton were excluded from these analyses.
¶Compared with Noumoudoura village.
*P < 0.05; ** P < 0.001.

Women's daily activities varied across villages. Cotton-cropping variables predicted only some of the activities (Table 5). Indeed, the cotton production index was positively associated with time spent fetching water and tended to be associated with the number of hours spent working in cotton fields. Finally, having a large cotton field was positively associated with petty trading.

Table 5. Multivariate Linear and Logistic Regression Models of the Effects of Cotton Cropping on Women's Daily Activities, that Are Related to Household Food Insecurity Status, in Rural Burkina Faso†‡

	Time women spent working in cotton field[1] n = 244		Petty trading as IGAs[2] (no, yes) n = 236		Farming as IGAs[3] (no, yes) n= 236		Time spent fetching water[4] (≤ 30 min, > 30 min) n = 259	
	B	SE	B	SE	B	SE	B	SE
Villages								
Bondoukuy§	-4.21**	1.25	-2.11**	0.70	0.90*	0.41	2.58**	0.47
Boni§	0.36	1.41	-1.63*	0.80	-0.06	0.51	0.39	0.49
Bama§	0.86	1.14	-3.56**	0.67	2.35**	0.41	0.24	0.37
Size of cotton farm (small, medium, large)	0.46	0.57	0.73**	0.26	0.04	0.22	0.06	0.19
Yield (kg/ha)	-0.0012	0.0010	-0.00010	0.00029	0.000041	0.00023	0.00016	0.00035
Cotton production index (kg cotton/kg total production)	4.47#	2.37	-1.56	1.05	0.14	0.87	2.60*	0.97

† Calculated from an imputed database.
‡ Households not producing cotton were excluded from these analyses.
§ Compared with Noumoudara village.
* P < 0.05; ** P < 0.01; # P < 0.1.
[1] $R^2 = 0.12$; [2] $R^2 = 0.25$; [3] $R^2 = 0.20$; [4] $R^2 = 0.22$.

4. Discussion

This study mainly sought to explore potential associations between cotton cropping, women's daily activities, and food insecurity in western Burkina Faso during a pre-harvest period.

Firstly, the overall prevalence of food insecurity in the study area remained high (67%), but much lower than the 2009 national estimate of 84% in Burkina Faso [8].

Seasonal, annual, and regional variations could explain this discrepancy. Frongillo and Nanama (2006) reported an important variation in the mean HFIAS score between 2002 and 2003 and between the pre- and post-harvest periods of the same years [18]. In addition, important food crop productions in the regions of *Boucle du Mouhoun* and *Hauts-Bassins*, which are the most self-sufficient regions in cereal production in Burkina Faso could also contribute to the low prevalence of food security [25].

The important food production could also explain the low prevalence of hunger (2.7%) when compared to studies conducted in other African countries during pre-harvest periods (between 25% and 57%) [22]. Indeed, in the current study, it appears that the most important cotton farmers also have the biggest food crop production, suggesting a potential synergy between cotton cropping and food availability.

The correlation seen between the HDDS and the HFIAS score is consistent with the literature [8,23,26,27,28]. For example, in a cross-sectional study in Northern Ghana where chronic undernutrition was persistent, Saaka and Osman (2013) observed a significant negative correlation between the HFIAS score and the food group consumption frequency, an indicator that was used to calculate the HDDS [28].

Regression analyses examining the effects of cotton cropping and women's daily activities on household food insecurity suggest that women's land ownership could be one of the factors that most influenced food security status of surveyed households. In fact, living in Bondoukuy was negatively associated with the HFIAS score. Results from the focus groups highlighted the fact that this village was the only one where women could own a cotton field (Sanou et al, unpublished results). In other villages, owning a cotton field was reserved to men. Several authors have shown that increasing women's land rights, which seems to facilitate a better control over selected food crops and income, was generally associated with higher household food expenditures and energy higher household food expenditures and energy consumption [13,14,15]. It is also likely that women will produce, on their own land, nutrient dense foods such as legumes and vegetables that will be used for their family's diet, thus increasing food diversity and overall diet quality.

Cotton cropping indicators were not significantly associated with the HFIAS score. Since cotton usually generates higher income than food crops, it would have been logical to expect a decrease of the HFIAS score, assuming that cotton income would be used to purchase more food. This kind of inconsistency was also found in many other studies [14]. For example, Niemeijer et al (1988) observed that households in Kenya that had a greater dependence on commercial production of irrigated rice had higher income but lower food consumption and a poor nutritional status [29]. Indeed, unequal distribution of cash cropping income within households, and the prioritization of non-food/health related expenses might explain these inconsistent results. Participants in focus groups were asked how they would use cotton income (Sanou *et al*, unpublished results). While men would allocate, on average, only 2.5% of their income on food for the household and 4% for healthcare services, women would invest at least 50% of their income on food, education and healthcare for their children. Unfortunately, due to social norms, only men being the head of the household control cotton income.

Income-generating activities (petty trading or farming) were associated with a decreased HFIAS score. This confirms the importance of women empowerment and household food and nutrition security. As mentioned earlier, women's income is primarily used to fill the basic needs of their children and household [9]. As expected, an increased women's workload induced by working in cotton fields or fetching water was associated with a higher HFIAS score. According to Wandel and Holmboe-Ottesen (1992) and Nti et *al* (1999), women often try to compensate for the time spent in agricultural work by reducing either the time devoted to cooking, the number of their daily meals, or sometimes their children's meals [30,31].

The last regression models that explain the effect of cotton cropping depict differences between villages related to women's daily activities. For instance, in Bondoukuy, a village better equipped with more modern agricultural tools (a mean of 2.0 plows and 0.8 trolleys per household vs. 1.4 and 0.6 in other villages, respectively; data not shown), women may work less in cotton fields and, therefore, have more time and opportunity for IGAs and childcare. Cotton cropping variables also had an impact on women's daily activities. Working time in cotton fields was not significantly related to the overall size of the farm but tendentiously with the intensity of cotton grown by the household. These outcomes could be explained by the divided workload caused by a significantly higher number of active members in the larger cotton farms than in the smaller ones (5.1 vs. 4.3 $P = 0.00000$; data not shown). Further studies are needed to clarify this relationship. Having a big cotton farm was not associated with the practice of farming but was positively associated with the practice of petty trading. This last finding could be due to the trading of "dolo", a traditional beer. In the focus groups, women reported that "dolo" was frequently sold when men received cotton income (Sanou *et al*, unpublished results). Lastly, the cotton production index was positively associated with time spent fetching water. Participants in the focus groups explained that when a household produced cotton more intensively, they had to withdraw to hamlets to facilitate access to cotton lands. Furthermore, findings suggested that many households do not have access to a source of tap water, and therefore rely on natural sources of water, which are often far from the households. This could explain why women take more time to fetch water (Sanou *et al*, unpublished results).

This study is the first to report on the associations between cash cropping, women's daily activities, and household food insecurity using the HFIAS. The study clearly suggests that gender related issues, such as women's workload and opportunities for income generating activities, are important factors that can mediate the relationship between cash cropping and food and nutrition security. However, missing data limited the choice of indicators for women's daily activities. Indeed, women were at times uncomfortable answering some of the questions. For instance, very few women answered the question about the amount of money received from their husband, limiting our ability to use this information. More studies should try to explore the patterns for other gender

equity indicators such as control over resources, participation in household decision-making processes, and land ownership. Intervention studies could also be aimed at enhancing or controlling these indicators to help better understand the dynamics between cash cropping and nutrition security.

Food groups used to calculate the HDDS were slightly different from those recommended by the FAO [32], which limits comparing the results with those of other regions. Performing a 24-hour recall of activities with men and women during the cotton farming season could be useful for future studies to better understand and evaluate gender effects on the agriculture-nutrition-health triad. Also, the authorities of each village could complete a questionnaire in order to provide more information about cotton sector policies and the distribution of assets between men and women (land, credit, seeds, fertilizer and pesticides), local infrastructure and local education, as well as health and sanitation systems. It is important to investigate why households achieved a higher food security in one village. This might help identify better practices or enabling factors that may influence future interventions.

5. Conclusion

Findings have shown that despite cotton cropping, the prevalence of food insecurity remains relatively high in western Burkina Faso. Intensive cotton production seems to increase women's workload, but cotton cropping also seems to encourage IGAs. Therefore, the relationships are dynamic, behaviour and culture related, and can be targeted for appropriate behaviour change communication in order to reverse downward linkages.

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Statement of Competing Interests

Funders had no role in the design, analysis or writing of this article. We declare that we have no competing interest.

List of Abbreviations

HDDS = Household Dietary Diversity Score
HFIAS = Household Food Insecurity Access Scale
HHS = Household Hunger Scale
IGAs = Income generating activities
WHO = World Health Organization

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