Food Security and Gender Equality under Industrial Crop Expansion in Ethiopia and Ghana

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Abstract: Sub-Sahara Africa (SSA) is home to more than a quarter of the world undernourished people and trends such as industrial crop (IC) expansion is expected to change the current state of food security in the region. This study seeks to investigate how food security varies between IC and non-IC subsistence farmers. We first assessed the current level of food security by measuring the calorie consumption at household level and then identified how internal and external factors can increase or decrease the household food security. Household surveys in rural Northern Ghana cotton farmers and Central Ethiopia sugarcane farmers captured social, economic and agricultural practices needed to measure food security, risks and potentials; focus group discussions explored the gender roles in the household; and key informant interviews provided the industry background. A proposed composite indicator provided a snapshot of the food security level. The results indicated that households engaged in IC production do not always translate into higher calorie consumption while they are having a higher gross income compared to subsistence farmers. In the case of Ghana, cotton farmers tend to have more family members than those of subsistent farmers, which results in decreasing their income per capita and affecting their food security even though the cotton farmers have a higher gross income at household scale. Higher education level of the household head appeared to improve food security. In Ethiopia, an increase of up to 20% more calorie consumption can be found as the education level from the head of the household increases. Finally, focus group in Ghana showed that women spent up to 10 times more than men on activities such as collecting firewood and reported these unpaid care work as a key roadblock to pursue other paid activities to improve their food security.

Key Words : Composite Indicator, Gender Roles, Education, Cotton, Sugarcane

1. INTRODUCTION

A special concern of food crops conversion for industrial purposes is given to regions that are struggling to be food self-sufficient. The impacts on food security produced by the increasing trend in SSA to allocate land for the production of non-food purposes or industrial crops (IC) such as cotton, sugarcane, oil palm for bio-energy, fiber and other industrial processes are yet to be fully understood[1][2]. Cotton production in Ghana represent less than 1% of Central and West Africa cotton production, this lack of progression shows how unstable the industry has been in the last four decades. Industry malpractices including companies' poaching, poor enforcement of pricing mechanisms and a lack of financing support contributed to the weak state of Ghana cotton industry[3]. On the other hand, Ethiopia is rapidly becoming one of the world's top ten sugar producer thanks to the government heavy involvement[4], soil quality and favorable climate which increases the sugarcane production compare to other countries[5]. But this accelerated plan to address the industry demand has come in decriment of non-IC subsistence farmers' land rights[6].

Furthermore, the different gender roles in a household to achieve food security needs to be acknowledged. Women in agriculture accounts for more than 50% of the workforce in SSA and they are responsible for two thirds of the food production in the region[7] while also being responsible for most of the unpaid care work including fetching water, collecting firewood and child caring, Even though women play an essential role to the household food security[8], they still lack the same opportunities as of men in regards of land ownership, education, access

to credit and extension services, leading into a lower agricultural production between 20% to 30% compared to household lead by men[9][10][11]. It has been estimated that by providing the same rights and access to women, helping them to attain their full productivity potential, it could be translated into a reduction of 150 million less people who suffers from hunger in the world[12]. The benefits of closing the gender gap is not only translated into more food quantities, but quality of life. When women have more control on how to invest, more income is allocated into food, children education, health and overall the household diversification is improved.

The objective of this paper is to assess the four pillars of food security, it will 1) produce a snapshot of the current level of food security at household level between IC farmers and non-IC subsistence farmers by measuring food "access" and "availability"; 2) capture the risk due to poor "utilization" practices on food preparations, the risk of food price "stability" and potentials of closing gender gaps; and 3) combine both objectives into a single view.

2. METHOD AND MATERIALS

(1) Study Area

The study in Ghana was conducted in two villages (Bollu and Gwollu) located 14 km apart in the Upper West region in Northen Ghana, about 640 km from the capital Accra (**Figure 1**). The village of Bollu has a population of 1,813 people and 207 households while the village of Gwollu has a population of 4,854 people and 797 households[13], the region has rainfall from May to September and a long dry season from October to April with an average rainfall of 900-1,200 mm and temperatures from 21 to 40 degrees Celsius. The study in Ethiopia was conducted in the Oromia region, at households surrounding the Wonji Sugarcane Factory located 90 km southeast of the capital Addis Ababa (**Figure 1**). The town of Wonji has a population of 14,060 people and 3,676 households[14] with a hot semi-arid climate with temperatures between 18 to 27 degrees Celsius with an average rainfall of 410-820 mm.

(2) Interviews, surveys and focus group

Informal interviews with open question followed by probing question were conducted in both study sites. A total of 16 interviews with farmers, research institutes, private sector, NGOs and government officials were performed in Ghana. The shorter field mission in Ethiopia allowed to conduct 4 interviews including the Sugarcane Factory, a research institution, a NGO and a farmers' Union. These interviews helped to frame and interpret the results from the focus group and household surveys in the discussion section by providing the industry background of each study site.

Questionnaire at household level in Ghana was
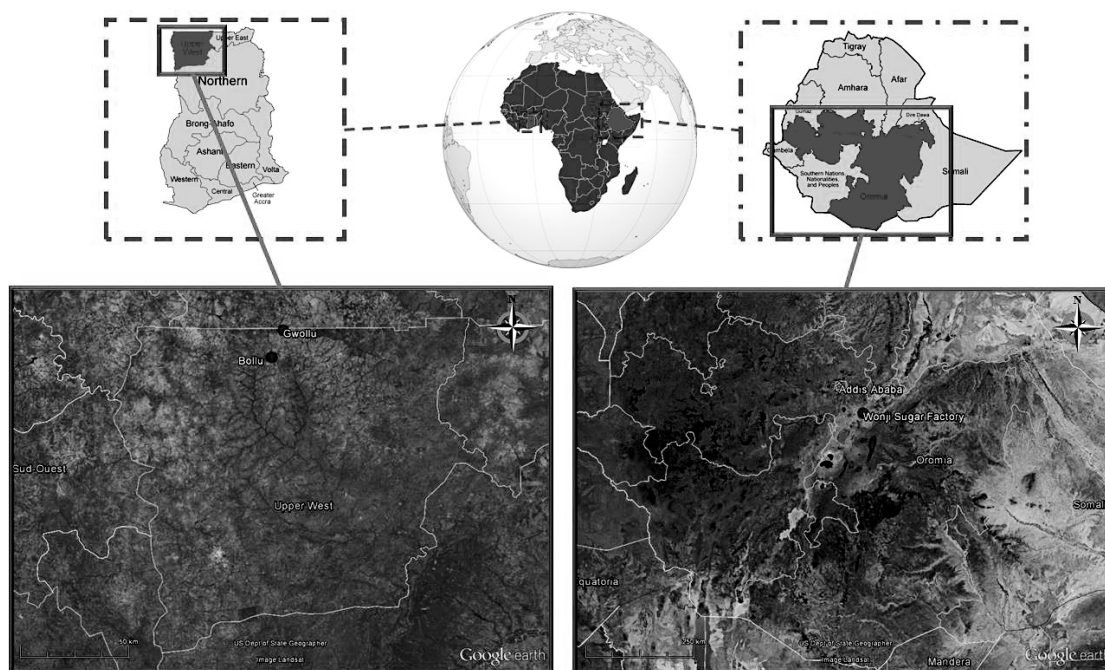
Figure 1 Study sites in Upper West Ghana Region (left) and Oromia Region in Ethiopia (right) - (Source: Google Earth, 2016)

administered from November 13 to December 6 in 2015 with a quota sampling of 20 cotton farmers and 20 non-IC subsistence farmers; while in Ethiopia the study was conducted from January 25 to February 2 in 2016 with a quota sampling of 30 sugarcane farmers and 30 non-IC subsistence farmer.

The questionnaire captured:

- Household composition including age, sex, education and time spent on unpaid care work;
- Agro-economic and livelihood practices;
- Ecosystem services usage;
- Land ownership including land size;
- Household Expenditure Survey (HES) capturing detailed food consumption in the last seven days and diarrhea cases in the last 3 months.

A total of four education level including primary, secondary, college and graduate school was capture in the survey for each household member. Each completed level received a score of 2, 1 for partial completion and 0 (zero) for no formal education.

The first objective was captured with the HES. The HES provided the calorie intake per household per day[15] from three different sources including food produced within the household, purchases from the market and food received as gift, measuring the availability and access pillars of food security.

The second objective assessed risks and potentials. Food price increase captured the stability pillar of food security. The formula presented (1a) estimates the price stability (S) risk and estimate the calorie loss based on the impact of inflation expected in 2017 over the household consumption sourced from market purchases, where (χ) represents the calorie consumed in each household per person per day obtained from the HES output and (δ) represents the forecasted inflation for 2017:

$$S = \chi \left(\frac{\chi}{(1+\delta)} \right) \qquad (1a)$$

The utilization pillar measured in this study consider the risk from poor sanitation practices in food consumption through the proxy indicator of diarrhea cases. For each case of diarrhea reported in the household, the calorie loss of one member for one day is estimated from the HES. The formula presented (1b) shows the calorie at risk due to poor utilization (U) where (χ) represents the calorie consumed in the household per day, (n) represents the cases of diarrhea reported and (m) the number of people in the household adjusted by gender and age based on the HES methodology:

$$U = \chi \left(\frac{\left(\frac{n}{90} \right)}{m} \right) \qquad (1b)$$

The gender equality potential was captured through the unpaid care work. The total time each household required for unpaid care work performed by adults was rebalanced equitably among the adult household members disregarding the sex. The resulting time gained by women in the household from sharing the workload with men served to calculate the potential income gain based on the average minimum salary in the region if women pursued paid activities. A potential increase of calorie was obtained from this income based on each household food purchases pattern. The formula to capture the time gained by closing the gender gap (G) is presented (1c) where (n) represent the count of adult women in the household, (m) the count of adult men in the household, (α) the hours that each woman spends on unpaid care work and (β) the hours that each member spends on unpaid care work:

$$G = \sum_{n}^{n}(\alpha) - \left(\frac{n}{n+m} \sum_{n+m}^{n+m}(\beta) \right) \qquad (1c)$$

The third objective was achieved by addig the HES output from the first objective with the estimated potential and risk obtained in the second objective, since all indicators were express in the same calorie per household per day. The final result is a composite indicator that measures all four pillars of food security, its risks and the potentials of bridging the gender gap of unpaid care work.

Focus group provided insight of key concerns toward achieving food security by sex. A total of 4 focus groups were conducted, 2 in each country and within each country, the groups were organized by sex and at the same village. A total of 5 questions were asked to groups ranging between 6 to 14 members aged between 19 to 70 years. Each session lasted aproximate 1 hour. Local interpreters helped to conduct each session. Participants were asked open question, probing question and open ranking question to assess topics including unpaid care work, factors that impact their food security, investment priorities, gender roles, livelihood diversification and main roadblocks to achieve food security.

3. RESULTS

(1) Household profile from study sites

The characteristics of the study site including

household composition, income, food expenses, land ownership, agricultural practices, consumption pattern, time spent on upaid care work and education level are shown in **Table 1**. All household interviewed in Ghana reported being Muslim and in average they had 8.5 family members, which represents 61% more compare to Ethiopia, where 92% of the household reported being between Orthodox Christian and Christian. Ghana also showed a higher number of children (members aged 16 and below) with an average of 4.5 children per household compared with the 2.3 children in Ethiopia. While household size between sample groups in Ethiopia was 11% higher for non-IC subsistence farmers, in Ghana household size of IC farmers was 75% larger than that of non-IC farmers.

a) Household Income

IC farmers in both study site reported a higher gross annual income compared to non-IC subsistence farmers. In Ghana cotton farmers had 8% higher gross income while in Ethiopia sugarcane farmers had 19% higher gross income. When income per capita is revised, sugarcane farmers in Ethiopia still accounts for the higher gross income sample group with 11,417 Ethiopian Birr (ETB) representing 50%

more compared to non-IC farmers, while in Ghana a reversal occurs where non-IC subsistence farmers becomes the group with higher gross income by 71% having 1,563 Ghanaian Cedis (GHS) per capita, driven by their larger household size.

b) Education Level

Higher level of education is observed within Ethiopia's household with an average score of 2.0 (representing completed primary school) compared with households in Ghana with an average score of 1.2 (representing between some primary education to completed primary education) and in all groups of both study sites, the level of education of men is higher than women.

Table 2 (overleaf) shows the calorie intake by the level of education of the head of the household. Ethiopinan household calorie intake raises as the level of education improves with the highest increase from household with no formal education to household lead by members with primary school education by 20% more calorie consumption.

c) Unpaid Care Work

While in both study sites the average time that women engage on unpaid care work is higher than men, in the case of Ghana the ratio of time spent

Table 1 Profile of household interviewed in Ethiopia and Ghana

	Variables	Ethiopia (n=51)			Ghana (n=33)		
		No IC (n=24)	IC (n=27)	Total	No IC (n=16)	IC (n=17)	Total
Household Members	**Total**	**5.5**	**5.0**	**5.3**	**6.1**	**10.7**	**8.5**
	Adult Men	1.6	1.5	1.6	2.1	2.6	2.3
	Adult Women	1.8	1.1	1.4	1.2	2.0	1.6
	Children	2.2	2.3	2.3	2.8	6.1	4.5
Household Income/Expense (Local Currency)		**Ethiopian Birr (ETB)**			**Ghanaian Cedis (GHS)**		
	Total Income (year)	**32,427**	**38,587**	**35,688**	**6,202**	**6,719**	**6,468**
	Food sold (year)	19,288	14,559	16,784	4,306	3,911	4,102
	Industrial Crop income (year)	-	19,518	10,333	-	1,941	1,000
	Other Income (year)	13,139	4,509	8,570	1,896	868	1,366
	Food bought (weekly)	308	309	308	89	98	94
	Total Income/capita (year)	**7,636**	**11,417**	**9,638**	**1,563**	**914**	**1,229**
	Food Expense/capita (weekly)	**77**	**86**	**82**	**22**	**14**	**18**
Agricultural Practices	**Total Land (ha)**	**1.66**	**2.14**	**1.91**	**8.57**	**7.75**	**8.15**
	Unused Land (ha)	0.03	0.04	0.03	4.15	1.98	3.03
	Food crops Land (ha)	1.63	0.90	1.24	4.42	4.65	4.54
	Industrial Crops land (ha)	0.00	1.21	0.64	0.00	1.12	0.58
Calorie intake by source	**Total (Kcal/househould/day)**	**2,110**	**2,493**	**2,313**	**2,604**	**2,269**	**2,431**
	% Produced	24.5%	2.3%	11.8%	41.1%	56.5%	48.5%
	% Bought	75.4%	97.0%	87.8%	57.2%	41.9%	49.8%
	% Gifted	0.1%	0.7%	0.4%	1.7%	1.6%	1.7%
Unpaid Care Work	**Household Average (Hours/day)**	**3.1**	**3.4**	**3.3**	**2.9**	**2.9**	**2.9**
	Adult Men Average (Hours/day)	1.2	1.5	1.4	2.1	1.9	2.0
	Adult Women Average (Hours/day)	4.5	5.2	4.9	3.8	3.4	3.6
Education Level	**Household Average**	**1.6**	**2.4**	**2.0**	**1.6**	**0.9**	**1.2**
	Head of the Household	**0.8**	**1.7**	**1.3**	**1.5**	**0.5**	**1.0**
	Adult Men Average	1.6	2.4	2.0	1.7	1.0	1.3
	Adult Women Average	1.3	1.2	1.2	1.4	0.8	1.1

Table 2 Calorie intake by education level of the head of the household in Ghana and Ethiopia

Group		Ethiopia				Ghana			
		Calories	STD Dev	Change	n	Calories	STD Dev	Change	n
IC	No Formal Education	2,385	207	-	4	2,299	421	-	13
	Primary School	2,474	458	4%	18	1,816	440	-21%	3
	Secondary/College	2,650	278	7%	5	3,231	-	78%	1
No IC	No Formal Education	1,899	456	-	11	2,456	503	-	8
	Primary School	2,271	585	20%	11	2,595	189	6%	4
	Secondary/College	2,390	480	5%	2	2,911	321	12%	4

between women and men is lower compared with Ethiopia (1.8x versus 3.6x) representing an average 3.6 hours per day in Ghana and 4.9 hours in Ethiopia.

(2) Composite indicator

Table 3 shows the breakdown of the composite indicator by sample group and by the potential and risk indicators. The output of the HES produces the current level of calorie intake at the moment of the study. The average of Ghanaian households was 2,431 kcal out of the recommended 3,000 Kcal for adults with moderate activity[15], while the average of Ethiopians was 2,313 Kcal. While sugarcane farmers in Ethiopia have a higher calorie intake compared with non-IC susbsitence farmers by 18%, in Ghana the opposite is observed where non-IC subsistence farmers have 15% more calorie intake than cotton farmers.

a) Stability and Utilization Risk

The main source of risk comes from the stability of calorie obtained from food purchases. Food products inflation forecast in Ethiopia put at risk 7% of the calorie consumed in the surveyed households dropping to 2,143 Kcal compared to the present levels. Meanwhile in Ghana, food inflation forecast leads to a drop to 2,328 Kcal among the surveyed household, a reduction of 4% compared against the present levels (**table 3**).

b) Gender Equality Potentials

The gains from balancing the time spent on unpaid care work activities between all adult members revealed a potential to improve calorie consumption within the surveyed households. Ethiopia showed a potential of increasing by 8% the calorie consumption compared to present levels reaching 2,509 Kcal

Table 3 Composite indicator by sample group

Group		Present	Potential	Risk	Total
Ethiopia	**Total**	**2,313**	**2,509**	**2,143**	**2,339**
	Non-IC	2,110	2,254	1,977	2,120
	IC	2,493	2,735	2,291	2,532
Ghana	**Total**	**2,431**	**2,533**	**2,328**	**2,429**
	Non-IC	2,604	2,722	2,476	2,594
	IC	2,269	2,355	2,188	2,274

while in Ghana the increase reaches to 2,533 Kcal representing a 4% improvement compared to present levels (**table 3**).

c) Combined indicators

When both indicators of risk and potential were combined into a total indicator, it can be observed that price stability risks and poor utilization practices of food preparation can be mitigated by the potential of bridging the gender gap from inequalities of the unpaid care work. In Ethiopia, the composite indicator shows a calorie consumption of 2,339 Kcal (a 1% improvement compared to the present levels) while in Ghana it shows a calorie consumption of 2,429 Kcal (a less than 0.1% change compared to the present level).

4. DISCUSSION

(1) Industrial Crop Income Inprovement

Although the data obtained supports that households that engage in farming industrial crop has a higher total income, it does not always translate into a higher food security compared to subsistence farmers. As seen in the case of Ghana, cotton farmers have 8% higher gross income compared to subsistence farmer (**Table 1**) and yet their calorie consumption is 13% lower (**Table 3**) driven by cultural and social factors of larger household size in order to work the land. An interview with a farmer in the village of Gwollu revealed that "men marry as a strategy to increase the labor force for their farm" and an interview with national research institute confirmed that "Cotton harvest is almost impossible with small household".

Furthermore, the higher dependence on food purchases translated into a higher market price stability risk. As observed in Ethiopia, their high dependence on food purchase of up to 88% compared to the 50% in Ghana as the main source of calorie consumption (**table 1**) led them to have a risk of 7% drop compared to present levels, being sugarcane households more vulnerables at 8% compared to 6% from non-IC subsistence farmers (**table 3**).

(2) Education towards Food Security

The improvement in food security seen by the increased education level supports other studies where a high correlation between primary education and food security were found. Past studies have showed that countries with low income such as Mali, has a potential to improve food security between 20% and 25% if the access to primary school is doubled[16].

Moreover, discussions from focus group revieled that education was an important factor for their food security, as explained by a participant of Ethiopia's men focus group "there is difference in agriculture productivity between educated and non- educated, the educated one applies the skill and concept acquired and maximizes productivity"

5. CONCLUSION

This study underlined the complex interactions that exists between economic, social and cultural factors towards achieving food security in Ghana and Ethiopia. While gross income improvement was realized by IC practices, it was not the definitive element that influences food security in the study area. Aspects such as family size and education level can either enforce or decrement food security. Furthermore, this study identified variables that looks beyond the present levels of food security and portrays what risk are inherited from a higher dependency on food purchases rather than relying on own production.

Assessment with the composite indicators can help to overcome nationwide gaps where food distribution among households, and relationships between household characteristics and food security levels are loss through national averages.

REFERENCES
1) Müller, A., Schmidhuber, J., Hoogeveen, J., and Steduto, P. : Some insights in the effect of growing bio-energy demand on global food security and natural resources. *Water Policy*, Vol. 10, No. S1, pp. 83-94, 2008.
2) Escobar, J. C., Lora, E. S., Venturini, O. J., Yáñez, E. E., Castillo, E. F., and Almazan, O. : Biofuels: environment, technology and food security. *Renewable and sustainable energy reviews*, Vol. 13, No. 6, pp. 1275-1287, 2009.
3) Ghana Country Report : State of Cotton Industry and Prospects for the Future in Ghana, available at: https://www.icac.org/meetings/plenary/67_ouagadougou/documents/country_reports/e_ghana1.pdf (accessed November 1, 2015), 2008.
4) USDA (United State Department of Agriculture) : Ethiopia Aims to Become One of the World' s Top 10 Sugar Producers. Vol. 16, 2015.
5) Ethiopian Investment Agency : Sugar Cane Plantation and Processing in Ethiopia, Ethiopia Embassy, available at: http://ethemb.se/wp-content/uploads/2013/07/Sugar-Cane-Plantation-and-Processing-in-Ethiopia.pdf (accessed March 11, 2016), 2012.
6) Amrouk, E. M., Rakotoarisoa, M. A., and Chang, K. : Structural changes in the sugar market and implications for sugarcane smallholders in developing countries, 2013.
7) World Bank. : Gender in Agriculture: Sourcebook. *Agriculture and Rural Development*, Vol. 15, http://doi.org/10.1596/978-0-8213-7587-7, 2009.
8) Meludu, N. T., Ifie, P. A., Akinbile, L. A., and Adekoya, E. A. : The role of women in sustainable food security in Nigeria: A case of Udu local government area of Delta State, *Journal of Sustainable Agriculture*, Vol. 15, No. 1, pp. 87-97, 1999.
9) World Bank : Gender Equality and Development: World Development Report, 2012.
10) Backiny-Yetna, P., and McGee, K. : Gender differentials and agricultural productivity in Niger, World Bank Policy Research Working Paper, 2015.
11) Oseni, G., Corral, P., Goldstein, M., and Winters, P. : Explaining gender differentials in agricultural production in Nigeria, *Agricultural Economics*, Vol. 46, No. 3, pp. 285-310, 2015.
12) FAO (Food and Agriculture Organization) : The State of Food and Agriculture. Women in Agriculture: Closing the Gap for Development, Vol. 2, available at: http://www.fao.org/docrep/013/i2050e/i2050e.pdf (accessed December 10, 2015), 2011.
13) Ghana Statistical Service : 2010 Population & Houseing Census – District Analytical Report, available at http://www.statsghana.gov.gh/docfiles/2010_District_Report/Upper%20West/SISSALA%20WEST.pdf (accesed March 15, 2016), 2014.
14) Central Statistical Agencia of Ethiopia : The 2007 Population and Housing Census of Ethiopia, available at http://www.csa.gov.et/newcsaweb/images/documents/pdf_files/regional/Oromya1.pdf (accessed March 15, 2016), 2011.
15) Smith, L. C., & Subandoro, A. : Measuring Food Security Using Household Expenditure Surveys, available at: http://www.ifpri.org/publication/measuring-food-security-using-household-expenditure-surveys (accesed October 12, 2015), 2007.
16) FAO (Food and Agriculture Organization) : Education for Rural People and Food Security: A Cross Country Analysis, 2007.