Effects of climate shocks and climate adaptation through livelihood diversification on gendered welfare gaps in northern Ghana

Abstract

Globally, addressing poverty levels and inequality remained one of the top priority and has been accorded the first position in the SDGs. Although Ghana as a whole is faring well in poverty reduction over the past decades, poverty levels and inequalities remained high in northern regions. This study analysed the gendered welfare gap and the effects of climate change and livelihood diversification on the welfare gap. Through multistage sampling, 432 households were selected and interviewed using a questionnaire. A selectivity bias corrected Oaxaca Blinder model was estimated using household per capita consumption expenditure as a measure of household's welfare. The result shows that there is a significant welfare gap of $45.85 (GH₵211.85), an equivalent of 11.4% between male headed and female headed households. Controlling for selectivity bias shows that the observed gender welfare gap was underestimated. Livelihood diversification had positive significant effect on the explained component of gender welfare gap. Climate change/variability had positive significant effect on welfare gap through the explained component and a negative significant effect through the unexplained component. Observed climate change and variability leads to an increase in gender welfare gap by 64.62%, the unobservable returns from climate factors contribute to a reduction in gender welfare gap by 193.26%. Since addressing unobservable climate factors is limited, there is the need to improve the climate characteristics of women. Although livelihood diversification is a necessary condition, policies such as training and education that would ensure that females also have higher returns from such strategies are sufficient to address gender welfare gaps. To improve the welfare of farmers in the midst of climate change, animal rearing should be promoted among maize crop farmers. Similarly, government's policy of one district one factory should consider improving agro-processing opportunities in the region into commercial activities.

Key words: Climate change and variability; Gender; Livelihood diversification; Welfare

1 INTRODUCTION

"We need to face the fact that we will never overcome poverty and hunger without empowering rural women" (IFAD President, Kanayo F. Nwanze on 2017 International Women's day) (www.fao.org/news/story/en/item/473008/icode/).

Comment [A1]: ies

Comment [A2]: Write in your country currency then the dollar equivalent in parenthesis.

Comment [A3]: (Nwanze, 2017). Then replace the citation with the number given to it in the list of reference

Poverty and food insecurity reduction continuous to be a global priority. Recent estimates suggests that almost a billion of people live in extreme poverty with the majority of the poor residing in rural areas where agriculture, particularly rain fed crop production remained their primary to sole source of livelihoods (World Bank, 2015 cited in [1]). The vicious cycle of hunger, poverty and low productivity impedes the development of the agricultural sector as well as general economic development. The widespread of poverty in most SSA economies have placed them into food insecurity even in periods of favourable production years. Unfortunately, climate change has been observed to affect both income and non-income dimensions of welfare, making the phenomenon more worrying. Poverty intensity is expected to worsen while more households are expected to become poor under the changing climate. It is therefore unsurprising that livelihood security and empowerment are the expected results of adaptation and a cause to future changes in climate change vulnerability [2].

Comment [A4]: es

Two of the strategies to respond to climate change or variability are mitigation and adaptation. Although mitigation to climate change is vital, adaptation is becoming more crucial to provide short-term localised gains and recover from environmental shocks. Adaptation is mostly stimulated by climate variability such as floods and droughts other than climate change [3]. Mostly, these strategies are adopted as anticipatory, reactive or proactive measures. Among others, the primary goal of adaptation is to reduce or spread risks and secure income or resources [3]. One reason for SSA, including Ghana's high vulnerability to climate change is the low adaptive capacity of the region. [3] maintained that there is the need for further scrutiny and learning from current adaptation strategies. As a local context strategy, adaptation remained the most plausible option for farmers and rural dwellers. Adaptation as a strategy allows farmers to harness opportunities and options within their means to reduce the impacts of climate change on households. Several adaptation strategies are available and adopted by farmers. One class of adaptation strategies is diversification.

Although, diversification is a long-time phenomenon, recent adoption of diversification strategies is tailored to climate change and variability. Depending on the strategy, diversification can be a proactive or reactive adaptation strategy, making it a flexible strategy for households to adopt depending on available opportunities. One of the major advantages of diversification over the other adaptation strategies is its role in reducing household climate vulnerability and at the

same time, improving household's welfare and crop production. Among others, [4] estimated that Ghanaian farming households adopts adaptation or coping strategies that are linked to livelihood diversification, hence recommend for policies that would promote diversification. Authors in [5] indicated that although diversification reduces poverty and future welfare deteriorations due to weather changes, it is less available to or harnessed by the resource poor households. Generally, diversification is an economic empowerment tool to improve the economic performance of households or group of people.

While the country as a whole is faring well in poverty reduction over the past decades, poverty levels in the northern regions still remained higher than other parts of the country. Coupled with the general poverty levels, inequality in poverty reduction and development remained a major concern to the country's policy makers. One of such inequality sources is the welfare difference between males and females. This is expected to witness some changes due to the worsening climatic conditions of northern Ghana. Therefore, since climate change effects are non-gender blind, it is important to estimate the effect of climate change on gender welfare gap in the region. Also, climate change adaptation literature suggested that livelihood diversification is a potential strategy to improve households' welfare amidst climate change. However, the literature also failed to examine the effect of livelihood diversification on gender welfare gap among households. This research seeks to address these underlining gaps in the literature and provide policy recommendations on how to improve welfare and reduce gender welfare gaps. Therefore, the objective of this study is to analyse the gender welfare gap, the sources of welfare inequality and the effects of climate change on one hand and livelihood diversification on another hand on gender welfare gap. Welfare in this chapter is defined as the per capita consumption expenditure of households in US dollar currency ($). The conversion rate used was the November, 2017 (since the data collection ended in November) exchange rate of 1$ to GH₵4.62. The peculiarity of this chapter is that it is one of the studies that used a gender decomposition model to examine the welfare inequality in the northern region of Ghana.

LITERATURE REVIEW

2.1 Livelihood diversification and welfare

Diversification involves providing other alternatives to full-time employment or engaging in multiple economic activity portfolios. Primarily, the aim of diversification is to provide well-meaning and sustainable survival for individual or households. Thus, diversification have implications on poverty reducing policies [6]. [7] provided that diversification can be as a result of the need to invest surpluses from existing activities or as a way of spreading agricultural risks. While some scholars describe diversification as a transient phenomenon, others hold the view that diversification cannot be so transient but connected with the realisation of livelihood security [8]. There are debates on diversification as a deliberate strategy (choice) versus diversification as an involuntary (necessity) response to negative events.

Livelihood diversification provides welfare insurance to households against shocks. Also, diversification is engaged by households as a capital, income or welfare accumulation purpose. Similarly, distressed households, either due to poverty or vulnerability to environmental shocks, could engage in multiple livelihoods to lift-up themselves from these distresses. Therefore, different diversification strategies may be pursued for specific purpose. But the general implication is that any purpose of diversification satisfies the objective of welfare improvement; hence the primary objective of livelihood diversification.

[9] estimated that nonfarm diversification leads to increasing welfare and the smoothening of income or consumption among households in the two upper regions of Ghana. The authors concluded that although non-farm activities cannot be a substitute to farming, the former provides a reliable compliment to the latter. Similar findings were obtained by [10] who found that non-farm activities leads to higher future expected food consumption expenditure, hence leading to a reduction in vulnerability to food poverty. Hence, while there is need to enhance non-farm opportunities to households, entry barriers must be mitigated [9, 10]. Intuitively, non-farm diversification does not only provide direct effect on welfare through income mobilisation but also, through effects on resource mobilisation for agricultural activities and improve technology adoption. [7] argued that the rural non-farm sector is viewed as solving the twin problem of unemployment and poverty, easing income inequalities and moving rural dwellers

from merely subsistence levels. Therefore, diversification ensures the smoothening of income and consumption among households.

Non-farm activities provide the opportunity for structural transformation of the economy from agriculture base to industrial base [7]. The effects of non-farm activity on household welfare is not an isolated finding as [11] also estimated that crop farming households who diversify into high valued crops are able to escape poverty. [12] recommended that in order to enhance the welfare of households, livelihood diversification options that are not directly affected by climate change should be promoted. Aiming at interventions that offer opportunity for diversification would ultimately lead to improved welfare [13].

The mixed effects of different diversification options on wellbeing still remain an issue to be addressed. This was recounted by [15]. The author noted that agricultural diversification options may lead to unique level of effects on wellbeing from diversification into non-agricultural strategies, therefore, it is unclear whether different diversification strategies would lead to same welfare outcome. [16] argued that although diversification is a welfare increasing strategy, the final effect of diversification on welfare depends on the weight of push and pull factors of diversification since push factors leads to lesser welfare while pull factors leads to improved welfare.

2.2 Climate change impacts on welfare

The pathways out of poverty are not smooth, and many non-poor (in addition to the poor) households are vulnerable to poverty in events of shocks [1]. Weather-related risks basically affects rural livelihood and explains the vicious cycle of the poor. Climate change affects both the income and non-income components of welfare and the effects can direct or indirect. Therefore, climate change exacerbates existing levels of poverty, inequality and wellbeing, hence, climate change is described as a 'threat multiplier' [5 p.802]. Similarly, [15] concluded that climate variables are important factors that affects expected per capita consumption as well as its variance. In northern Ghana, climate variability has been found to negatively influence household welfare and agriculture income [12] and this impacts are worst in the north savannah zones [16].

There are increasing evidence suggesting that climate variability and change would worsen the vulnerability of the poor households, thereby worsening incidence, severity and persistence of poverty in the developing countries and hindering global poverty reduction efforts [17]. The impacts of climate change on welfare are particularly pronounced among the poor as the adaptive capacities are less, high dependence on natural resources and spends large share of their income on food. These explains why the agrarian communities are more vulnerable to climate change. However, the urban and industrial sector also suffers through productivity loss of farmers as food and raw materials become scarce and expensive.

2.3 Gender welfare gap (inequality), growth and development

Gender inequality exists globally, although more pronounced in poor countries than rich countries [18]. It is a major concern for most developmental organisations. The paradigm of gender in global discussions have changed over the years with recent connotation as gender and development. Thus, gender issues do not only affect growth but also development. The discussions on this recent paradigm can be summarised under two considerations [19]. Firstly, the negative implications of gender inequality in resource distribution and opportunities on women's welfare and human rights. Secondly, the fact that other developmental goals can be achieved through addressing gender inequality. While some scholars document the existence of gender inequality, others also provided evidence that poverty reduction, agricultural productivity and general welfare can be improved through gender equality [19, 20].

There are valid concerns on the role of gender inequality on economic growth and effect of economic growth or underdevelopment on gender inequality [15, 19]. The former relationship is valid due to its implications on changes in per capita output through market participation on one hand and on the other hand, its effects on fertility and capital accumulation that influences long term equilibrium of per capita output [21]. Empirically, [21] estimated in a benchmarked and counterfactual analysis that in a steady state, 50 percent increase in gender gap can lead to 35 percent decrease in per capita output. [22] also reported that over 100 million people could be distant from poverty by providing equal access and control of resources to women.

Labour market discrimination have remained a central reason for gender welfare differences. Historically, this discrimination does not only lead to lower income for the vulnerable group but also leads to higher income for the majority group [23]. Glass ceiling, occupational differentiation, less working hours of women due to reproductive duties as well as characteristic differences such as education explains bits of this discrimination. However, the impacts of climate change depends on the resilience level of the household [24], hence, more resilient households are less affected by climate change. [25] argued that gender inequality is the root cause of poverty.

3 METHODOLOGY

3.1 Study location

The study was conducted in the three northern regions (Upper East, Upper West and Northern regions) of Ghana (Figure 1). Agriculture is the main economic activity, employing 71.9% of the economically active group; the three northern regions has the highest proportion of agricultural households and far above the national average of 45.8%. The region is located farther from the pole, which means that the region is naturally warmer than the southern parts. The implications are long dry season associated with difficulty in food and water access [9]. Similarly, unlike the southern parts where there is bimodal rainfall, the northern regions have a unimodal rainfall, thereby creating a lot of idled agricultural labour periods.

The region is much risky to climate change than other regions of Ghana. Evidence suggests that there are increasing periodic floods, droughts and wind storms that continue to destroy properties and lives in the region. [12] noted that despite the effect of climate change on the entire country, the physical and economic vulnerability of the northern part makes households in the area most impacted by climate change. Poverty levels and inequality have always been higher in the three northern regions (55.17%) than all other regions and the country as a whole (24.2%) [26, 27, 28].

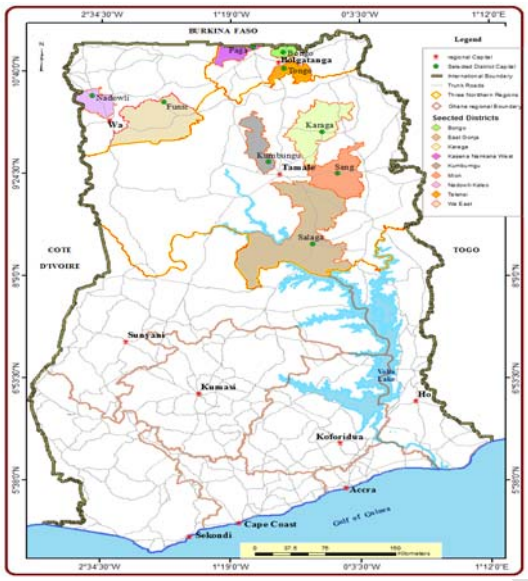

Figure 1: Map of Ghana showing the study area (the three northern regions)

Sampling design and data collection

Comment [A5]: Sampling procedure and sample size

The study used a multi-stage sampling procedure in the selection of the respondents. In the first stage, the three northern regions out of Ghana's ten administrative regions were selected purposively due to its high climate sensitivity and high poverty levels. In the second stage, stratified sampling was used to put all districts in each region into three stratum using regional poverty maps from [29]. The stratum includes poor, middle class and rich districts. The districts from each stratum were then selected using simple random sampling as in Figure 1. A total of 27 communities, three from each district, were selected by simple random. In the final stage, stratified sampling was used to the households into male and female headed households and the final respondents selected using simple random.

Comment [A6]: how many?

From the 2010 population census, 23% of the household heads in the three northern regions are females while the remaining 77% are men. Using proportion allocations in the stratified

sampling and given the above information, a total of 324 male and 108 female headed households were selected.

Comment [A7]: Given a total of 432 respondents

From the 2010 population census, there about 71.9% farm households in the three northern regions. This was used to estimate the sample using the single population proportion approach [30, 31] as:

$$n = \frac{z^2 * \hat{p}(1-\hat{p})}{\varepsilon^2}$$

Where z is the z score, ε is the margin of error, $\hat{p}$ is the population proportion. Given a proportion of approximately 72% of farming households in the three northern regions of Ghana; a 95% confidence level that the estimated sample reflects the true sample if the actual population was known, thus a Z score of 1.96; and a 5% margin of error, the sample was obtained as follows:

$$n = \frac{1.96^2 * 0.72(1-0.72)}{0.05^2} = 307$$

Therefore, a minimum of 307 farm households is enough for the study but was adjusted to 432 farm households. From each selected household, primary data was collected in 2017 through questionnaire administration. The questionnaire was designed through a comprehensive process with input from other scholars and policy makers. It was then administered by trained research assistants who are fluent in both English and local dialect.

Comment [A8]: This can be removed

3.2 Data analysis of gender productivity and welfare gaps

Comment [A9]: This can be removed

One of the economic models used in labour analysis is Oaxaca-Blinder (OB) decomposition model. The model which was independently proposed by [32] and [33] and has since gained wide applications, particularly in wage gap analysis [34, 35, 36]. The advantage of the model is that it estimates the inequality or gap, disaggregate the gap to different constituents and the contribution of individual factors to the gap.

Practically, the gendered welfare gap can simply be estimated using mean difference, headcount index or other poverty intensity/severity methods. However, a set of predictor variables differ in the contribution to the wealth among the male and female headed households. Therefore, it is crucial to identify the contribution from factor or resource endowments and gender discrimination. Admittedly, this is one of the unique studies that used the OB model in analyzing gendered welfare. The OB model is illustrated as follows.

Given gender groups as male headed households (M) and female headed households (F), welfare (W), then the gendered welfare gap (G) can be estimated as:

$$G = E(W_M) - E(W_F)$$

where $E(.)$ is the expected value of welfare. Under an assumption of linear prediction, a welfare function can be stated as:

$$W_i = X_i\delta + u_i,\ E(u_i) = 0\ and\ i \in (A, B)$$

Where X is a vector of predictors, including a constant, β is a vector parameters including the intercept and u_i is the error term. Following the welfare function, the OB model follows four stages. Firstly, the aim of the OB model is to separate the observation into its group constituents and then estimate the mean difference. Therefore, at the group specific means, G can be given as:

$$G = E(W_M) - E(W_F) = E(X_M)^I \beta_M - E(X_F)^I \beta_F$$

Secondly, a further decomposition is required to estimate the effect of grouped factors such as livelihood and climate change on G. The aggregate decomposition is categorised into characteristics effects (I), which measures the contributions by X; the coefficient effect (II) which measures discrimination between the gender groups; and an interaction component (III) which measures the interaction between the first two components [32, 33, 34, 35, 36]. This can be given as:

$$G = \{E(X_M) - E(X_F)\}\beta_F + E(X_F)^I(\beta_M - \beta_F) + \{E(X_M) - E(X_F)\}\beta_F{}^I(\beta_M - \beta_F)$$

The objective of the third stage is to estimate the contribution to G by factors in blocks such as climate change factors and livelihood diversification strategies. In this case, the coefficients on these terms measure the extent to which the blocked factors contribute to G via the characteristics effect and also via the returns effect [34]. Finally, in the fourth stage, the contribution of individual factors to G is estimated. The effect of the individual factors on welfare can also be estimated at the fourth stage. In this study, the welfare function is nonlinear since the research suspected the presence of selectivity bias in the inclusion of livelihood diversification. Therefore, this must be corrected in the OB model. This study follows the [37] and the subsequent treatment effect model principle of correcting selectivity bias[1] which was also adopted in [38]. Theoretically, this involves estimating the livelihood diversification function (in this study, a multivariate probit model[2]) and obtain the predicted values and use to construct an inverse mills ratio (IMR, often described as lambda, λ). The λ is then used as additional variables in the OB model.

The λ is estimated as $\lambda_i = \frac{\phi(-Z_i'\beta)}{1-\Phi(-Z_i'\beta)}$. Where Φ is the cumulative density function and ϕ is the standard normal function. Therefore the welfare function becomes:

$$w_i = X_i\delta + \rho\sigma\lambda_i = X_i\delta + \theta\lambda_i$$

Hence the stage two of the OB model must be redefined as:

$$\begin{aligned} W_M - W_F &= (\bar{X}_M \hat{\delta}_M + \theta_M \hat{\lambda}_M) - (\bar{X}_F \hat{\delta}_F + \theta_F \hat{\lambda}_F) \\ &= \bar{X}_F(\hat{\delta}_M - \hat{\delta}_F) + (\bar{X}_M - \bar{X}_F)\hat{\delta}_M + (\hat{\theta}_M \hat{\lambda}_M - \hat{\theta}_F \hat{\lambda}_F) \end{aligned}$$

Empirically:

[1] See Maddala, G. S. (1983). *Limited-dependent and qualitative variables in econometrics*. Cambridge University Press, for detailed explanation of correcting selectivity bias.

[2] Refer to Adzawla W. and Kane A. (2018). Gender perspectives of the determinants of climate adaptation: The case of livelihood diversification in Northern Ghana. *Review of Agricultural and Applied Economics, 2,* 113-127. DOI: 10.15414/raae/2018.21.02.113-127 for the detailed analysis and results on the multivariate probit.

$$Welfare = \delta_0 + \delta_1 Heads'education + \delta_2 Household's education + \delta_3 Household\ size + \delta_4 Dependency + \delta_5 Credit\ access + \delta_6 Land\ ownership + \delta_7 Upper\ East + \delta_8 Upper\ West + \delta_9 Flood + \delta_{10} Drought + \delta_{11} Windstorm + \delta_{12} Forest\ fire + \delta_{13} C\lim ate\ perception + \delta_{14} C\lim ate\inf ormation + \delta_{15} LVI + \delta_{16} On-farm + \delta_{17} Animal + \delta_{18} Trading + \delta_{19} Agro\ proces\sin g + \delta_{20}\Pr of/Skilled\ job + \delta_{21} IMR$$

Table 1: Definition of variables

Variable	Definition or measurement	A priori sign	VIF
Education	The total number of years of formal education by household head.	+	1.16
Household's education	Total number of household members who completed JHS.	+	1.43
Household size	Total number of adult equivalents in a household sharing and pooling resources.	-	1.49
Dependency	The ratio of the total number of household members under 16 to total number of household older than 15.	-	1.13
Credit access	Dummy: 1 if household head had access to credit in the production season and 0 if otherwise.	+	1.31
Land ownership	Dummy: 1 if household head own land and 0 if otherwise.	+	1.29
Upper East	Dummy: 1 if household head is located in Upper East and 0 if otherwise.	+	1.62
Upper West	Dummy: 1 if household head is located in Upper West and 0 if otherwise.	-	1.54
Flood times	The total number of times a household experienced flood within the past three years.	-	1.56
Drought times	The total number of times a household experienced drought within the past three years.	-	1.32
Windstorm experience	The total number of times a household experienced windstorm within the past three years.	-	1.16
Forest times	The total number of times a household experienced forest fires within the past three years.	-	1.21
Climate perception	Dummy: 1 if household head perceives climate change wrongly and 0 if correctly.	-	1.71
Climate information	Dummy: 1 if household head had no access to climate information and 0 if otherwise.	-	1.46
LVI	The estimated vulnerability of a household without diversification.	-	1.66

On-farm	Dummy: 1 if household head engages in crop diversification and 0 if otherwise.	+	2.93
Animal	Dummy: 1 if household head engages in maize cropping-animal rearing diversification and 0 if otherwise.	+	2.84
Trading	Dummy: 1 if household head engages in maize cropping-trading diversification and 0 if otherwise.	+	1.89
Agro processing	Dummy: 1 if household head engages in maize cropping-agro processing diversification and 0 if otherwise.	+	2.27
Prof/Skilled job	Dummy: 1 if household head engages in maize cropping-prof/skilled diversification and 0 if otherwise.	+	2.34
IMRs	The predicted vector of IMRs of diversification strategies obtained from multivariate probit model (chapter 5)	-/+	
TOTAL VIF			1.94

4 RESULTS AND DISCUSSION

4.1 Gender welfare gap

Table 2 shows the mean welfare level of male and female headed households and the difference between the two households. From the result, the average male headed household spends $400.76 (equivalent of GH₵1,855.51) per annum while the average female headed household had an average welfare of 354.91$ (equivalent of GH₵1,639.67) per annum. Thus, a pooled welfare of $389.30 (equivalent of GH₵1,798.56). These average mean values are statistically significant at 1%, suggesting that they significantly represent the welfare levels of male and female household heads, respectively. The estimated mean welfare values are higher than the lower poverty line (GH₵792.05) and upper poverty line (GH₵1,314.00) of Ghana but lower than the average welfare of the country (GH₵2,926.86) [26].

Comment [A10]: GH₵1,855.51 ($400.76) ….. Follow this pattern for all the amount of money having equivalence.

From the average welfare values, the estimated gender welfare gap is $45.85 (equivalent of GH₵211.84) per annum. The welfare gap is also significant at 10%, indicating there is a statistically significant difference in the welfare levels between male heads and female heads. Thus, male headed households spend $45.85 (GH₵211.84) every year more than female headed households. This implies that to address gender welfare inequality, 11.4% (45.85/400.76*100) of the welfare of male headed households have to be redistributed between both male and female

headed households. However, after controlling for selectivity bias due to livelihood diversification, the gender welfare gap increased to $79.80 (GH₵368.69). This suggests that under the current diversification differences between male heads and female heads, the observed gender welfare gap was underestimated. Using assets as a measure of welfare in Ghana, [28] found that the gender distribution of welfare is biased in favour of males, with males having a total of 69.8% of total wealth while females had a share of 30.2% of total wealth. Although Ghana is making progress in reducing headcount poverty, inequality continuous to widen [28, 30].

Table 2: Gender welfare gap

Gender	Coef.	Std. Err	Z-Value	P-Value
Male heads	400.76***	15.984	25.07	0.000
Female heads	354.91***	18.115	19.59	0.000
Observed G	45.85*	24.159	1.90	0.058
Adjusted G	79.80**	33.214	2.40	0.016

*****, ** and * indicates significant at 1%, 5% and 10%, respectively**
Source: Computed from field data, 2017

4.2 Aggregate decomposition of gender welfare gap

The aggregate decomposition (stage two of the OB model) is the separation of gender welfare gaps into endowment and discrimination components. This is provided in Table 3. The decomposition was done using two approaches; three-way and two-way decompositions. From the three-way decomposition, the differences in characteristics of male headed and female headed households is found to be the main contributor to G. Thus, the endowment effect contributed 104.9% to the gender welfare gap while the discrimination component contributed 17.09% to G. The interaction between the two lead to a reduction of G by 21.99%. The implication is that both the differences in endowment and actual discrimination leads to an increase in welfare difference between male and female headed households. However, the interaction of these two components contributes to a reduction in the gender welfare differences. However, only the endowment effect had a statistically significant effect on the G.

From the two-way decomposition also, the explained component that measures the contribution of differences in observable characteristics contributed positively (95.03%) to welfare gap

between male and female heads. Also, the unexplained component that measures the contribution by unobservable characteristics (a measure of discrimination) had a positive insignificant effect on G; contributing 4.97% to G. The results imply that in order to address welfare or poverty inequalities in the northern regions of Ghana, more efforts should be directed in improving the resource difference between male and female headed households. These resources include the socioeconomic endowment such as education and credit access, livelihood diversification as well as improve the resilience of female headed households to climate change and variability. In the subsequent sections, the contribution of the resource groups and the individual characteristics is provided. The further decompositions are based on the two-way decomposition approach.

Table 3: Aggregate decomposition of gender welfare gap

Source of G	Coef.	Std. Err	Z-Value	P-Value	% of G
Three-way decomposition					
Endowments	83.713***	32.031	2.61	0.009	104.90
Coefficients	13.638	42.041	0.32	0.746	17.09
Interaction	-17.548	34.979	-0.50	0.616	-21.99
Two-way decomposition					
Explained	75.842***	20.850	3.64	0.000	95.03
Unexplained	3.962	30.382	0.13	0.896	4.97

***** indicates significance at 1%**

Source: Computed from field data, 2017

4.3 Grouped decomposition of gender welfare gap

Table 4 shows the decomposition of G under the grouped variables (stage three of the OB model) in Table 2.The factors were grouped into socioeconomic, location, climate change/variability, and livelihood diversification sources. From the result, the socioeconomic and climate change/variability factors had significant influence on the explained component of G while climate change/variability and livelihood diversification significantly contributed to the unexplained component of G.

Table 4: Grouped decomposition of gender welfare gap

Source of G	Coef.	Std. Err	Z-Value	P-Value	G (%)
Explained component					
Socioeconomic	27.37**	10.57	2.59	0.010	59.70
Location	1.32	5.28	0.25	0.802	2.89
CCV	29.63***	10.16	2.92	0.004	64.62
Diversification	17.52	12.40	1.41	0.158	38.21
IMR	15.30	11.22	1.36	0.173	33.38
Total	91.14***	20.46	4.45	0.000	198.78
Unexplained component					
Socioeconomic	53.45	66.34	0.81	0.420	116.58
Location	8.18	24.52	0.33	0.739	17.83
CCV	-88.61*	50.82	-1.74	0.081	-193.26
Diversification	102.50**	52.34	1.96	0.050	223.55
IMR	-49.25**	23.96	-2.06	0.040	-107.42
Constant	-71.55	101.42	-0.71	0.480	-156.06
Total	-45.29**	20.70	-2.19	0.029	-98.78

*****,** and * indicates significant at 1%, 5% and 10%, respectively**

Source: Computed from field data, 2017

Socioeconomic factors had a positive effect on G through both explained and unexplained components. This means that the differences in resource endowment such as education as well as the returns from these characteristics worsens G. Thus, in addition to observed differences, the returns associated with these characteristics favour the male heads more than the female heads. In terms of percentage, socioeconomic factors contributed 59.70% and 116.58% to the observed and unobservable portions of gender welfare gap, respectively. However, the effect of socioeconomic factors on gender welfare gap is significant only through the observed differences in socioeconomic characteristics. These are reasonably high and call for improving the socioeconomic base of the female heads. Also, efforts that would ensure that women realize higher returns from an improvement in their socioeconomic status are needed to address gender welfare inequalities.

Livelihood diversification had positive effect on explained and unexplained components of G. However, the effect is significant only through the unexplained component. This means that the unobservable returns from livelihood diversification leads to an increase in gender welfare gap by as high as 223.55%. Thus, male heads have higher returns from livelihood diversification than

female heads. The inclusion of the IMR is to correct for selectivity bias in estimating the gender welfare gap. This was also significant at the unexplained component, consistent with the estimates of livelihood diversification. Empirically, [40] concluded from their study that diversification does not necessarily lead to higher welfare, but the ability of the households to attract high return sectors into their livelihood portfolio is what brings about the improvement in welfare. Also, [41] concluded that livelihood diversification in Ghana is transient and this have a significant welfare cost on the households.

From Table 4 also, climate change/variability had positive significant effect on G through the explained component and a negative significant effect through the unexplained component. Thus, while the gender differences in the resilience to drought, flood, forest fires and windstorm, access to climate information and climate perception increased G by 64.62%, the unobservable returns from these factors contributed to a reduction in gender welfare gap by 193.26%. Since addressing unobservable climate factors is limited action, there is the need to improve the climate characteristics of women. Generally, [28] hinted that climate change pose a threat to poverty reduction in northern Ghana. Also, [42] estimated that higher climate variability is associated with lower per capita consumption in Ghana.

4.4 Factors influencing households' welfare and gendered welfare gap

Table 5 shows the effect of each factor on the welfare of male and female household heads. It also shows the percentage contribution of each factor on both explained and unexplained components of G.

Empirically, one of the observed field of research is the estimation of the effects of socioeconomic factors on household's welfare. This is justifiable considering the role of these factors in shaping household's resource mobilization, production and consumption decisions. 5, the socioeconomic factors that significantly influenced the welfare of households are education of the household head, number of household members with a minimum of primary education, household size and land ownership.

Education of the household head had positive effect on household's welfare on the welfare of both male and female heads. On the other hand, household members' education had negative effect on the welfare except that is was significant for only male heads. The positive effect of education means that higher levels of education leads to improved welfare. In most occupational descriptions, particularly the formal occupations, the educational level of a person determines the qualification for higher position and higher remuneration. However, in the informal sector such as farming, higher education improves the efficiency of the farmers, obtain higher yields and also search for information on higher produce prices. Estimates from [26] shows that households headed by uneducated persons contributed 72.4% of Ghana's poverty incidence. The estimated negative effect of household members' education is unexpected. However, the survey revealed that most of the highly educated household members always want to assume some level of independence which would reduce resource contribution to the entire household. While household head's education had positive and insignificant contribution to G, the household members' education contributed negatively to the G and significant through the unexplained component. [41] estimated that having educational level above basic level have a positive effect on both consumption expenditure and composite welfare index. Similarly, studies such as [43, 44, 45, 46] estimated a rising welfare benefit from education.

Household size had a positive effect on households' welfare. Thus, an increase in the number of people (adult equivalent) in a household leads to an increase in the welfare of the households. This is contrary to the apriori expectations of the research. The result also shows that, household size contributed positively and significant to G through both explained and unexplained components. Thus, the observed difference in household size and the associated returns from household size leads to a widening G. [47] also estimated a positive significant effect of household size on asset growth in Mozambique. Contrary, [45] used Ghana Living Standard Survey panel data and found that adult equivalent household size had a negative effect on household's welfare. Also, [46] found a convex relationship between household size and welfare while [43] found a negative effect of household size on welfare.

Land ownership had a positive significant effect on the welfare of female heads but insignificant on the welfare of male heads. This was expected since land ownership or access is an important resource in farming communities. Land access and ownership by women is low and a major

source of gender discrimination in the area. Consistently also, the differences in land ownership significantly contributed 19.64% of the total G. Empirically, [44] estimated a positive effect of land ownership on welfare. But contrary to this study, [48] found that ownership of land does not necessary improve women's welfare, instead, ensuring tenure security, access to complementary inputs and market are crucial to accrue the benefits of land ownership by women.

Although the relationship between both Upper East or Upper West regions and welfare are negative, the estimate is only significant for the Upper East region. This means that households located in the Upper East region have lower welfare than those located in Northern region. Consistently, the study of [49] found that the average welfare of households in Northern region are higher than those in Upper East and Upper West regions. This is however contrary to the 2012/13 national estimates which shows that among the three northern regions, Upper East region have a higher average welfare (GH₵1,861.14) and poverty level (44.4%) than the Northern region's average welfare of GH₵1,763.60 and poverty level of 50.4%, and Upper West region's average welfare of GH₵1,390.67 and poverty level of 70.7% (26). The location variables had no significant contribution on G. Empirically, [41] used selected districts from the Eastern region (south of Ghana) and Upper East region (north of Ghana) and found that there is welfare discrimination against rural households in Upper East region. Therefore, the author argued that, there is the need for more emphasis on location specific poverty reduction policies.

From the result, the climate variables that had significant effect on household's welfare include drought, windstorm, climate perception, climate information access and LVI. Although flood had no significant effect on the welfare of both males and females, it significantly contributed 55.10% to G through the unexplained component.

Drought had a positive significant effect on the welfare of both male and female headed households. Although this is contrary to the research expectations, it can be explained that households that experience frequent droughts may have to spend more, especially on non-food commodities in order to maintain the living conditions of the households. While the observed difference in drought experience significantly contributed positively (25.09%) to G, the unobservable effects significantly contributed negatively (-78.88) to G. [47] found a negative effect of drought on asset growth. Contrary to this finding, [43] estimated that, households that

experienced drought within five years had lower welfare outcomes such as consumption expenditure.

Expectedly, windstorm had a negative effect on the welfare of both males and female headed households but significant for only the latter. This means that female headed households that experience frequent windstorm over the past three years had lower welfare than those that experience few or no windstorm. Windstorm contributed to a reduction in welfare gap through both explained (-12.42%) and unexplained (-93.97%) components but the reduction is significant only in the explained component. This is consistent with the findings of [24].

Climate perception had a positive effect on male headed household's welfare while a negative effect on female headed household's welfare. The negative effect means that households who perceived climate change appropriately have a higher welfare than those who predicted climate change wrongly. Climate perception however had no significant contribution to the gender welfare gap among households.

LVI had a negative significant effect on the welfare of female headed households. This means that the higher the LVI, the lower the welfare. This can be explained by the fact that the severely vulnerable households do not have enough resources to improve their consumption expenditure. This also indicate that there is an inverse relationship between LVI and welfare, therefore, if LVI is not strategically addressed, it can lead to total welfare loss. However, LVI contributes to a reduction in gender welfare gap, and this is significant through the unobservable component.

The livelihood strategies that had significant effect on the welfare of households are animal, agro processing and profession/skilled employment. Although trading had no significant effect on the welfare of households, it contributed significantly, 86.76%, to G.

Animal rearing in addition to crop production had a positive significant effect on the welfare of both male and female headed households. This means that households who engaged in this diversification strategy have higher welfare than their counterparts who do not engage in crop-animal diversification. Animal rearing is one of the recommended strategies to adapt to climate change. In terms of gender welfare gap, animal diversification significantly contributed 58.66% of the gender welfare gap. Consistently, [43] estimated that livestock holding leads to an improvement in household's income.

Table 5: Determinants of welfare and detailed decomposition of G

	Male heads			Female heads			Contribution to G (%)	
Variable	Coef.	Std. Err	Z-Value	Coef.	Std. Err	Z-Value	Explained (%)	Unexplained (%)
Education	0.009*	0.005	1.74	0.008	0.010	0.84	6.30	-10.56
Household education	-0.056***	0.017	-3.23	-0.035	0.023	-1.50	-1.30	-86.07*
Household size	0.051***	0.009	5.42	0.035*	0.018	1.94	33.88*	250.08**
Dependency	0.027	0.036	0.74	-0.025	0.030	-0.83	-0.64	-12.20
Credit access	-0.010	0.068	-0.14	-0.078	0.112	-0.69	1.81	2.61
Land ownership	-0.003	0.060	-0.05	0.293***	0.094	3.12	19.64*	-27.31
Upper East	-0.137*	0.072	-1.89	-0.287***	0.095	-3.02	2.89	22.21
Upper West	-0.079	0.081	-0.97	-0.055	0.114	-0.48	0.00	-4.38
Flood times	0.017	0.029	0.58	-0.039	0.044	-0.89	11.67	55.10**
Drought times	0.061***	0.019	3.24	0.126***	0.038	3.35	25.09*	-78.88**
Windstorm experience	-0.111*	0.059	-1.87	-0.004	0.087	-0.04	12.42*	-93.97
Forest times	-0.024	0.023	-1.02	-0.033	0.033	-0.99	4.07	14.43
Climate perception	0.102	0.084	1.22	-0.211**	0.102	-2.06	-0.39	-44.45
Climate information	-0.236***	0.063	-3.72	-0.224**	0.099	-2.25	12.94	10.10
LVI	-0.050	0.063	-0.80	-0.141*	0.082	-1.73	-1.20	-55.57*
On-farm	0.055	0.137	0.40	-0.035	0.228	-0.15	7.88	87.28
Animal	0.361***	0.100	3.62	0.345**	0.168	2.05	58.66***	-98.59
Trading	0.093	0.077	1.21	-0.227	0.147	-1.54	1.31	86.76*
Agro processing	0.187**	0.087	2.14	0.099	0.141	0.71	-32.67**	18.36
Prof/Skilled job	0.023	0.091	0.25	-0.444***	0.153	-2.90	3.02	129.71***
IMR-on farm	0.245	0.289	0.85	0.135	0.430	0.31	-1.86	10.77
IMR-Animal	-0.804***	0.275	-2.92	-0.643*	0.374	-1.72	-0.08	15.20
IMR-Trading	0.052	0.265	0.20	0.271	0.362	0.75	-7.80	-36.29
IMR-Agro processing	-0.365	0.275	-1.33	-0.284	0.299	-0.95	51.79**	-15.67

IMR-Prof/Skilled	-0.222	0.311	-0.72	0.998***	0.372	2.69	-8.68	-81.41**
Constant	5.317	0.168	31.70	5.524	0.225	24.54		-156.03
N	324			108				
F	7.62			3.34				
R Squared	38.99%			50.44%				
Adj. R-Squared	33.87%			35.33%				

*****,** and * indicates significant at 1%, 5% and 10%, respectively**

Source: Computed from field data, 2017

From the result, agro-processing had positive effect on the welfare of both male and female headed households, however, this is significant for only the male headed households. This means that engaging in agro-processing tends to increase the welfare of such households. This justified the need to improve agro-processing in the country and reduce post-harvest loses. Relatedly, the study of [47] revealed that nonfarm employment is important to offset the effects of droughts on asset wealth.

Professional and skilled employments were found to increase welfare for male headed households but decrease welfare for female headed households. In terms of contribution to G, observed differences in engaging in professional and skilled employment leads to an increase in the welfare gap, although insignificant. Nonetheless, the unobserved characteristics of profession and skilled employment leads to a positive and significant effect on G. This is consistent with the findings of [40, 45, 46] who estimated that households who diversify into salaried jobs have higher welfare.

5 CONCLUSIONS AND RECOMMENDATION

This study analysed gendered welfare inequality among farming households in the northern regions of Ghana. It specifically examined the sources of gender welfare gap, the effect of climate change/variability and diversification on gender welfare gaps and the determinants of welfare among farming households. The correction of selectivity bias in the OB model was justified. It is concluded that there is a significant difference of 11.4% in the welfare between male and female headed households. This study conclude that climate change does not only lead to welfare reduction but also, leads to increased welfare inequality. While the effect of livelihood diversification on household's welfare is established, it is concluded that the unobservable returns from livelihood diversification are male favoured, thereby, leading to a worsening gender welfare gap. Generally, the factors that influence the welfare of households include education of the household head, education by household members, household size, land ownership, Upper East location, drought, windstorm, climate perception, climate information, LVI, crop-animal diversification, crop-agro processing and crop-professional/skilled employment. In addition to most of these variables, flood and trading also had a significant contribution on the estimated

gender welfare gap. There is the need to improve the socioeconomic status of female headed households. This can be achieved by improving access to credit by the households. Promotional efforts on girl child education must be stepped-up to avert educational gaps and its impact in the future. Although livelihood diversification is a necessary condition, policies that would ensure that females also have higher returns from such strategies are sufficient to address gender welfare gaps. For instance, training and education of females on livelihood diversification portfolios is crucial to improve their abilities to obtain higher returns from such ventures. To improve the welfare of farmers in the midst of climate change, animal rearing should be promoted among maize crop farmers. Integrated farming systems are recommended. Similarly, government's policy of one district one factory should keenly consider agro-processing opportunities in the region and develop them into more commercial activities.

References

1. FAO. The State of Food and Agriculture 2015 (SOFA): Social Protection and Agriculture: Breaking the Cycle of Rural Poverty [Internet]. Rome; 2015. Available from: http://www.fao.org/publications/sofa/en/
2. Mersha AA, Laerhoven F Van. A gender approach to understanding the differentiated impact of barriers to adaptation : responses to climate change in rural. Reg Environ Chang. 2016;16(6):1701–13.
3. Berrang-ford L, Ford JD, Paterson J. Are we adapting to climate change? Glob Environ Chang. 2011;21(1):25–33.
4. Antwi-agyei P, Stringer LC, Dougill AJ. Livelihood adaptations to climate variability: insights from farming households in Ghana. Reg Environ Chang. 2014;
5. Olsson LM, Opondo P, Tschakert A, Agrawal SH, Eriksen SM, Perch LN, et al. Livelihoods and poverty. In: Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, White LL, editors. Climate Change 2014: Impacts, Adaptation, and Vulnerability Part A: Global and Sectoral Aspects Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA; 2014. p. 793–832.
6. Ellis F. The determinants of rural livelihood diversification i n developing countries. J Agric Econ. 2000;51(2):289–302.

7. Lama S. Livelihood diversification and its determinants: Evidence from the household survey in backward district of West Bengal. GALAXY Int Interdiscip Res J. 2014;2(3):68–80.

8. Ellis F. Household strategies and rural livelihood diversification. J Dev Stud. 1998;35(1):1–38.

9. Osarfo D, Senadza B, Nketiah-amponsah E. The impact of nonfarm activities on rural farm household income and food security in the Upper East and Upper West Regions of Ghana. Theor Econ leters. 2016;6:388–400.

10. Zereyesus YA, Embaye WT, Tsiboe F, Amanor-boadu V. Implications of non-farm work to vulnerability to food poverty-recent evidence from Northern Ghana. World Dev [Internet]. 2017;91:113–24. Available from: http://dx.doi.org/10.1016/j.worlddev.2016.10.015

11. Birthal PS, Roy D, Negi DS. Assessing the impact of crop diversification on farm poverty in India. World Dev [Internet]. 2015;72:70–92. Available from: http://dx.doi.org/10.1016/j.worlddev.2015.02.015

12. Nkegbe PK, Kuunibe N. Climate variability and household welfare in northern Ghana. United Nations University-World Institute for Development research; 2014. (WIDER Working Paper 2014 / 027).

13. Asmah EE. Rural livelihood diversification and agricultural household welfare in Ghana. J Dev Agric Econ. 2011;3(7):325–34.

14. Perz SGL. The importance of household asset diversity for livelihood diversity and welfare among small farm colonists in the Amazon. J Dev Stud. 2005;41(7):1193–220.

15. Asfaw S, Mccarthy N, Paolantonio A, Amare M, Lipper L, John C. Diversification , Climate Risk and Vulnerability to Poverty in Rural Malawi. Working paper series. Abidjan, Cote d'Ivoire; 2016.

16. Arndt C, Asante F, Thurlow J. Implications of climate change for Ghana's economy. Sustainability. 2015;7:7214–31.

17. Skoufias E, Rabassa M, Olivieri S. The poverty impacts of climate change : A review of the evidence the poverty impacts of climate change a review of the evidence. 2011. (Policy Research Working Paper, WPS5622).

18. Jayachandran S. The Roots of Gender Inequality in Developing Countries. Annu Rev Econom. 2015;7:63–88.

19. Kabeer N, Natali L. Gender Equality and Economic Growth : Is there a Win-Win ? 2013. (IDS working paper). Report No.: 417.

20. Cuberes D, Teignier M. Gender inequality and economic growth: A critical review. J Int Dev. 2014;276:260–76.

21. Cavalcanti T, Tavares J. The output cost of gender discrimination: A model-based macroeconomics estimate. Econ J. 2015;126:109–34.

22. FAO. The state of food and agriculture. Women in agriculture, closing the gender gap for development. Rome; 2011.

23. Oaxaca RL, Ransom MR. On discrimination and the decomposition of wage differentials. J Econom. 1994;61(5-21).

24. Arouri M, Nguyen C, Youssef A Ben. Natural disasters, household welfare, and resilience : evidence from rural Vietnam. World Dev. 2015;70:59–77.

25. CARE. Tackling the Double Injustice of Climate Change and Gender Inequality. By Agnes Otzelberger, CARE International; 2014.

26. GSS. Ghana living standard suyrvey round 6 (GLSS6): Labour force report. Accra; 2014.

27. Lu W, Horlu SGA. Economic well-being of rural farm households in Ghana : A perspective of inequality and polarisation. J Rural Stud. 2017;55:248–62.

28. Osei-Assibey E. Nature and Dynamics of Inequalities in Ghana. Development [Internet]. 2015;57(3-4):521–30. Available from: http://dx.doi.org/10.1057/dev.2015.25

29. GSS. Ghana poverty mapping report. Accra, Ghana; 2015.

30. Cochran WG. Sampling Techniques. third edit. New York: John Wiley and Sons; 1977.

31. Tessema RA. Assessment of the implementation of community-led total sanitation , hygiene , and associated factors in Diretiyara district , Eastern Ethiopia. PLoS One. 2017;12(4):1–11.

32. Oaxaca R. Male-female wage differentials in urban labour markets. Int Econ Rev (Philadelphia). 1973;14(3):693–709.

33. Blinder AS. Wage discrimination : Reduced form and structural estimates. J Hum Resour. 1973;8(4):436–55.

34. Madden D. Gender Differences in Mental Well- Being : A Decomposition Analysis Gender Differences in Mental Well- Being : A Decomposition Analysis. HEDG Work Pap 08/08 Gend [Internet]. 2008;(May). Available from: https://www.york.ac.uk/media/economics/documents/herc/wp/08_08.pdf

35. Lee MJ. Reference parameters in Blinder-Oaxaca decomposition: Pooled-sample versus intercept-shift approaches. J Econ Inequal. 2014;13(1):69–82.

36. Kaiser B. Detailed decompositions in nonlinear models. Appl Econ Lett. 2015;22(1):25–9.

37. Heckman J. Sample selection bias as a specification error. Econometrica. 1979;47:153–61.

38. Choe C, Oaxaca RL. Wage Decompositions Using Panel Data Sample Selection Correction. Bonn; 2016. (10157).

39. Cooke E, Hague S, McKay A. The Ghana Poverty and Inequality Report: Using the 6th Ghana Living Standards Survey, 2016. 2016.

40. Gautam Y, Andersen P. Rural livelihood diversi fi cation and household well-being : Insights from Humla , Nepal. J Rural Stud [Internet]. 2016;44:239–49. Available from: http://dx.doi.org/10.1016/j.jrurstud.2016.02.001

41. Dzanku FM. Transient rural livelihoods and poverty in Ghana. J Rural Stud [Internet]. 2015;40:102–10. Available from: http://dx.doi.org/10.1016/j.jrurstud.2015.06.009

42. Asravor RK. Livelihood diversification strategies to climate change among smallholder farmers in northern Ghana. J Int Dev. 2017;

43. Tambo JA, Wünscher T. Farmer-led innovations and rural household welfare : Evidence from Ghana. J Rural Stud [Internet]. 2017;55:263–74. Available from: http://dx.doi.org/10.1016/j.jrurstud.2017.08.018

44. Donkoh SA, Alhassan H, Nkegbe PK. Food expenditure and household welfare in Ghana. African J Food Sci. 2014;8(3):164–75.

45. Rolleston C. Educational access and poverty reduction : The case of Ghana 1991 – 2006. Int J Educ Dev [Internet]. 2011;31(4):338–49. Available from: http://dx.doi.org/10.1016/j.ijedudev.2011.01.002

46. Tamvada JP. Entrepreneurship and welfare. Small Bus Econ. 2010;34:65–79.

47. Giesbert L, Schindler K. Assets , Shocks , and Poverty Traps in Rural Mozambique. World Dev [Internet]. 2012;40(8):1594–609. Available from: http://dx.doi.org/10.1016/j.worlddev.2012.04.002

48. Bhaumik BSK, Dimova R, Gang IN. Is women ' s ownership of land a panacea in developing countries ? Evidence from land-owning farm households in Malawi. 2013. Report No.: 1055.

49. Adzawla W, Donkoh S, Nyarko G, O'Reilly PJ, Olayide O, Mayes S, et al. Adoption of Bambara groundnut production and its effects on farmers ' welfare in Northern Ghana. African J Agric Res. 2016;11(7):583–94.