

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

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## Abstract

Globally, addressing poverty levels and inequality remained one of the top priorities 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 **GHC211.85 (\$45.85)**, 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**

Poverty and food insecurity reduction continues 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].

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 GHC4.62. 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.

## 2 LITERATURE REVIEW

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. Studies such as [9, 10, 11, 12] estimated that nonfarm diversification leads to increasing welfare and the smoothening of income or consumption among households. Therefore, aiming at interventions that offer opportunity for diversification would ultimately lead to improved welfare [13].

However, 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.

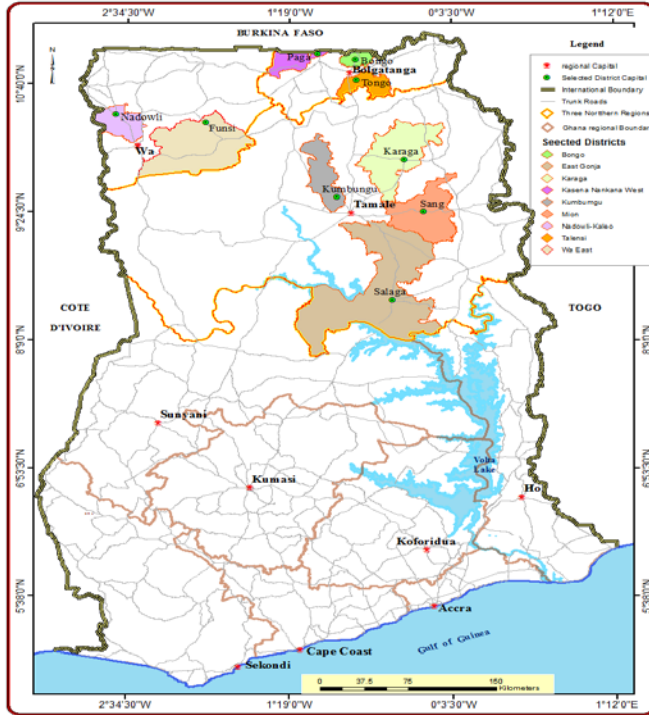
Climate change affects both the income and non-income components of welfare and the effects can be direct or indirect. In northern Ghana, climate variability has been found to negatively influence household welfare and agriculture income [12] and these impacts are worst in the north savannah zones [16]. There is increasing evidence suggesting that climate variability and change would worsen the vulnerability of the poor households, thereby worsening the 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 their adaptive capacities are less, they have a high dependence on natural resources and spend a large share of their income on food. This explains why 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.

### **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 have the highest proportion of agricultural households and far above the national average of 45.8%. The region is located farther from the equator, which means that the region is naturally warmer than the southern parts. The implications are a 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 riskier 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%) [18, 19, 20].



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

### 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 [21]. The stratum includes poor, middle class and rich districts. Three 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 put the households into male and female headed strata and the final respondents in each stratum were selected using simple random.

### 3.2 Data analysis of gender productivity and welfare gaps

One of the economic models used in inequality analysis, especially in labour economics is Oaxaca-Blinder (OB) decomposition model. The model was independently proposed by [22] and [23] and has since gained wide applications, particularly in wage gap analysis [24, 25, 26]. 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. Admittedly, this is one of the unique studies that used the OB model in analyzing households' gendered welfare. In this study, the details on the mathematical explanation of the Oaxaca Blinder model was avoid but the details on the steps are provided.

The use of the mode in this study followed five main steps. The first step was to fit the welfare function (equation 1) and estimate the gender welfare gap (G) (equation 2) from equation 1:

$$W_i = X_i\delta + u_i, E(u_i) = 0 \text{ and } i \in (A, B) \quad (1)$$

$$G = E(W_M) - E(W_F) \quad (2)$$

where  $E(.)$  is the expected value of welfare, X is a vector of predictors, including a constant,  $\beta$  is a vector of parameters including an intercept and  $u_i$  is an error term. However, X includes livelihood diversification strategies which is an endogenous variable and must be corrected. Hence, a livelihood diversification function<sup>1</sup> was estimated and the predicted values used to construct an independent variable and included in equation 1<sup>2</sup> [24, 28]. In the second stage, the estimated G was decomposed into two; the component due to differences in resources or characteristics (referred to as the endowment effect) and the component due to differences in returns associated with the resources (referred to as the coefficient or discrimination effect) [22, 23, 24, 25, 26]. This is given in equation 3 as:

$$G = \{E(X_M) - E(X_F)\}\beta_F + E(X_F)'(\beta_M - \beta_F) + \{E(X_M) - E(X_F)\}\beta_F'(\beta_M - \beta_F) \quad (3)$$

In the third stage, X is put into variables of similar category, for instance, climate variables, livelihood diversification strategies, and then, estimate their impacts on the two components in step two. This provided a measure of the extent to which these grouped factors contribute to G via the characteristics effect and also via the returns effect [24]. In the final stage, the effect of

<sup>1</sup> 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 diversification function.

<sup>2</sup> See Maddala, G. S. (1983). *Limited-dependent and qualitative variables in econometrics*. Cambridge University Press, for detailed explanation of correcting selectivity bias.

the individual factors on G as well as the welfare level of the households were estimated. Empirically, equation 1 was defined in this study as shown in equation 4. The variance inflation factor (VIF) for all the variables was less than 5 which suggested that the variables were not multicorrelated.

$$\begin{aligned}
 \text{Welfare} = & \delta_0 + \delta_1 \text{Heads' education} + \delta_2 \text{Household' s education} + \delta_3 \text{Household size} \\
 & + \delta_4 \text{Dependency} + \delta_5 \text{Credit access} + \delta_6 \text{Land ownership} + \delta_7 \text{Upper East} \\
 & + \delta_8 \text{Upper West} + \delta_9 \text{Flood} + \delta_{10} \text{Drought} + \delta_{11} \text{Windstorm} + \delta_{12} \text{Forest fire} \quad (4) \\
 & + \delta_{13} \text{C lim ate perception} + \delta_{14} \text{C lim ate inf ormation} + \delta_{15} \text{LVI} + \delta_{16} \text{On - farm} \\
 & + \delta_{17} \text{Animal} + \delta_{18} \text{Trading} + \delta_{19} \text{Agro proces sin g} + \delta_{20} \text{Pr of / Skilled job} + \delta_{21} \text{IMR}
 \end{aligned}$$

**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)	-/+	
<b>TOTAL VIF</b>			<b>1.94</b>

## 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 **GHC1,855.51 (equivalent of \$400.76)** per annum while the average female headed household had an average welfare of **GHC1,639.67 (equivalent of 354.91\$)** per annum. Thus, a pooled welfare of **GHC1,798.56 (equivalent of \$389.30)**. 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 (GHC792.05) and upper poverty line (GHC1,314.00) of Ghana but lower than the average welfare of the country (GHC2,926.86) [26].

From the average welfare values, the estimated gender welfare gap is **GHC211.84 (equivalent of \$45.85)** 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 GHC211.84 (\$45.85) every year more than female headed households. This implies that to address gender welfare inequality, 11.4% ( $211.84/1,855.51*100$ ) 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 GHC368.69 (\$79.80). 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, [20] 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 [20].

**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
<b>Three-way decomposition</b>					
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
<b>Two-way decomposition</b>					
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 (%)
<b>Explained component</b>					
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
<b>Unexplained component</b>					
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, [30] 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, [31] 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, [20] hinted that climate change pose a threat to poverty reduction in northern Ghana. Also, [32] 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 it 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 [18] 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. [31] estimated that having educational level above basic level have a positive effect on both consumption expenditure and composite welfare index. Similarly, studies such as [33, 34, 35, 36] 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. [37] also estimated a positive significant effect of household size on asset growth in Mozambique. Contrary, [35] used Ghana Living Standard Survey panel data and found that adult equivalent household size had a negative effect on household's welfare. Also, [36] found a convex relationship between household size and welfare while [33] 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, [34] estimated a positive effect of

land ownership on welfare. But contrary to this study, [38] 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 [39] 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 (GHC1,861.14) and poverty level (44.4%) than the Northern region's average welfare of GHC1,763.60 and poverty level of 50.4%, and Upper West region's average welfare of GHC1,390.67 and poverty level of 70.7% (18). The location variables had no significant contribution on G. Empirically, [31] 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. [37] found a negative effect of drought on asset growth. Contrary to this finding, [33] 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 [40].

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, [33] estimated that livestock holding leads to an improvement in household's income.



**Table 5: Determinants of welfare and detailed decomposition of G**

Variable	Male heads			Female heads			Contribution to G (%)	
	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 [38] 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 [30, 35, 36] 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.

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### **Competing interests**

Authors have declared that no competing interests exist.

### **Authors' contributions**

The manuscript was conceptualized and written by WA. AK supervised the research work. All authors read and approved the final manuscript.

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