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WELFARE EFFECTS OF LIVELIHOOD DIVERSIFICATION OF FARM HOUSEHOLDS IN NORTHERN GHANA: A QUANTITATIVE APPROACH

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Abstract
The declining trends of agricultural productivity in Northern Ghana, which could be attributed in part to climate change, is pushing farm-households to add non-farm livelihood activities to their existing on-farm livelihood activities in order to survive. The extent to which this diversification is affecting the livelihoods of farm households is not fully understood in the empirical literature. This paper therefore explores the effect of livelihood diversification on farm households' welfare. By using multistage sampling procedure, 284 farm households from 62 communities in the Northern and Upper East regions of Ghana were used for the study. The Probit model was employed to examine factors influencing farm households' decision to diversify their source of livelihoods. The Propensity Score Matching (PSM) was employed to estimate the effects of livelihood diversification on farm households' welfare. The probability of diversifying was higher for older farmers, farmers with access to extension service, male farmers, farmers who perceived that rainfall was erratic and that temperatures were high. Using household off-farm income as a proxy for welfare, the PSM results indicate that on the average, diversified farm households are better off (GH₵2,657.52 per annum) compared to non-diversified farm households (GH₵2,448.95 per annum). This study therefore recommends that farm households across Northern Ghana should diversify their sources of income to reduce liquidity constraint to enhance farm productivity via the purchase of productivity enhancing farm inputs.

Keywords*: Diversification, Welfare, Off-farm income, Probit model, PSM, Northern Ghana*

Introduction
Agriculture contributes to large proportion of farm household incomes in developing countries including Ghana. Agricultural sector employs the most of the labour force in rural and peri-urban areas of developing countries (Kassie et al., 2017). It is a major livelihood scheme in Sub-Saharan African (SSA) for most rural farm households. Agricultural contributes to economic transformation and reducing poverty gap and also offer a strong solution to food insecurity (World Bank, 2008) situation in many countries. For instance, in Ghana, the agriculture sector functions as a primary driving force of resource poor farm households' livelihood. In 2016 alone, the agricultural sector contributed about 19% to Ghana's GDP and provided employment to about 44.7% of the labour force. (MoFA, 2016). Also, agricultural output per hectare (Ha) is declining due to poor soil fertility, soil erosion and climate change. These make smallholder farmers vulnerable. Therefore, agriculture as a main source of livelihood to smallholder farm households is unable to sustainably support them over time to combat food insecurity. This has somehow pushed them to diversify their livelihoods by considering different alternatives. Even though agriculture is a major livelihood source to farm households, it has not been able to generate enough income to enhance farm households' welfare across SSA (Babatunde, 2013).

Agriculture in Ghana is primarily led by smallholder farmers, majority of whom cultivating less 2.00 Ha (MoFA, 2016). These smallholder farmers mostly cultivate basic staples such as maize, rice, millet and sorghum for household consumption, with little left to sell. However, these smallholder farmers are faced with the challenges of old conventional production practices, small farm sizes, erratic rainfall pattern, soil erosion, land degradation, and disease and insect infestations (Arega et al., 2013). These factors influence farm households to engage in extra livelihood activities to generate extra income to enhance their welfare. Low productivity and income realised from farming can drive rural and peri-urban farm households into off-farm businesses. Farm households that depend solely on agriculture might not generate more income to support their families as agricultural is prone to risk compared to off-farm businesses.

The effects of livelihood diversification could be positive or negative, as it has been well established in literature about the causes and consequences in which the evidence is somewhat mixed and ambiguous (Bezabiw et al., 2010). Livelihood diversification serves as a risk insurance mechanism and enhances farmers' resilience to climatic shocks. It also helps in reducing poverty gap among farm household (Martin & Lorenzen, 2016; Simtowe et al., 2016).

According to Diiro (2013), income generated though livelihood diversification increases farmers' purchasing power for farm inputs (i.e. improved seeds and inorganic fertilizers) and use of mechanisation methods to enhance productivity. Livelihood diversification can increase farmers' incomes and can also promote more investments in soil and water management technologies. However, diversification of livelihood of farm households can affect farm labour and agricultural productivity negatively. For instance, livelihood diversification affects negatively, the adoption of improved agricultural practices by shrinking the proportion of farm household labour-force allotted to on-farm management practices (Goodwin & Mishra, 2002). Hence, Reardon et al. (2001) suggested that policies to enhance farm households' income generation capacity should be geared towards providing credit and training in entrepreneur skill that stimulate farm households to indulge in livelihood diversification in addition to farming activities. An empirical examination of the effects of livelihood diversification on farm households' welfare will assist shape policy to enhance farm households welfare.

Livelihood diversification as an income generation approach involves a series of attempt by farm households to find alternative means to generate more cash and reduce environmental shocks associated with agriculture that make them vulnerable. Livelihood diversification is a decision of choice. Thus, a farm household can decide either to diversify or not to diversify (Ellis, 2000).

Debele & Desta (2016) has categorised livelihood diversification into on-farm and off-farm activities. On-farm activities concerns engaging in multiple crops and livestock production practices simultaneously. While off-farm diversification is an approach of generating extra income from other non-farm sources to supplement household agricultural income (Losch et al., 2010). Off-farm activities mostly engaged in by farm households include wage employment, trading in charcoal, petty trading, agri-processing and all forms of artisanal jobs among others alternatives.

In this study, livelihood diversification refers to off-farm income generation activities that farm households engage in to increase their income levels (Losch et al., 2010). Naturally, smallholder farmers diversify their sources of income to escape extreme poverty and also to improve their welfare. Therefore, the impact of livelihood diversification on the smallholder farmers' welfare need to explore. According to Abimbola and Oluwakemi (2013), knowledge on the scope of livelihood diversification practices and its contribution to farm households' income is important to governments and policy makers, as it affects policy design and implementation.

Various studies have been conducted in developing countries on the factors that influence farm households' decision to diversify their sources of livelihood. For instance, in Ethiopia Kassie et al. (2017) examined factors influencing farm household's decision to engage in livelihood diversification. The institutional factors including land ownership and being a member of a cooperative was found to influence farm households decision into livelihood diversification. It was recommended that a well design rural improvement policy that would empower rural farm households to go into other livelihood activities be given priority.

Ayantoye et al. (2017) also studied the factors that influenced rural farm households' livelihood diversification in Nigeria. Basic occupation, sex, being married, poverty status, and membership of an association were found to be driving farm households' decision into livelihood diversification. The study recommended that rural farm households should be sensitise and trained to diversify their source of income in other to enhance their well-being.

Mathenge and Tschirley (2015) studied an off-farm labour-market decisions and resilient to agricultural shocks among farm households in Kenya. The study revealed that Kenyan farmers engaged in livelihood diversification alternatives were more resilient to climatic risks and climate variability. Also, Alasia et al. (2009) opined that participation in livelihood diversification was a risk management mechanism adopted for stabilising farm household's income in Canada. Livelihood diversification empowers farm households to reduce vulnerability level and to stabilise consumption at the household level (Seng, 2015; & Reardon et al., 1992).

A study by Seng (2015) also found that household head's educational level and age as well as land holding, determined the adoption of livelihood diversification among rural farmers in Cambodia. Also, household heads with better education levels had an upper hand to engage in livelihood diversification (Akaakohol & Aye 2014). The alternative of livelihood choice and its determinants vary across farm households based on their intrinsic characteristics and location (Abdul-Kabiru & Maharjan, 2017). Understanding the livelihood diversification strategies of farmers will inform policy makers to design clear policy interventions.

All the aforementioned studies focused on factors influencing farm households' livelihood diversification without examining the effects of livelihood diversification on farm households' welfare. This study therefore sought to analyse the effects of livelihood diversification effects on rice producing households' welfare in the Northern and Upper East Regions of Ghana.

RESEARCH MATERIALS AND METHODS

The study area

This study was carried out among rice producing households in the Northern and Upper East regions of Ghana. Northern region is ranked the second for paddy rice output in Ghana, representing 168,407.25 Mt per annum. This is followed by the Upper East region representing 114,702.19 Mt per annum (MoFA, 2016). The total average paddy rice production in the two regions stand at 141,554.72 Mt per annum. This is still low compare to the national output in Ghana. The poverty status in the Northern and Upper East regions are 50.4% and 44.4% respectively, making the regions among the poorest in Ghana (Ghana Statistical Service (GSS), 2015). The regions generally have good vegetation cover suitable for rice production. Despite the biodiversity in vegetation cover, this is decreasing due to agricultural activities and climate change. This makes the farm households in the regions engage in other livelihood activities since land fertility and ecosystem services are declining. Most of the labour force are gainfully employ in the agricultural sector in the regions. The Northern and Upper East regions employ approximately 70% and 79% respectively of the labour force in the industry in the country (MoFA, 2016). Farm households mostly cultivate crops like maize, millet, rice, yam, sorghum, groundnut, cowpea and Bambara beans. Likewise, animals rearing by farm households include cattle, sheep, goats, guinea fowls, fowls, and donkeys (MoFA, 2016). In terms of comparative advantage in animal production, the Northern and Upper East regions are high compared to other regions in the country (Livestock Market Diagnostics Report, 2014).

Sample size and sources of data

The population of the study is rice producing households across various rice producing communities in the Northern and Upper East regions of Ghana. Most of these farm households in the regions are into livelihood diversification activities to supplement household incomes. Multistage sampling procedure was employed in the selection of rice farm households. About 296,489 rice producing households are in Guinea Savannah zone following the Ghana Living Standard Survey (GLSS) round 6 report. Based on this, simple random sampling procedure was used to select 400 farmers (which was further adjusted to 543) based on Slovin's (1960) formula for sample size calculation. Stratified sampling method was used to group the farmers into those with diversified livelihoods and those who are not using proportion sampling. In all, 62 communities were used for the study across ten (10) administrative districts in the study area. 284 data points were found in the common support region after implementing the PSM technique, and therefore, used for the analyses. The study used primary data solicited from rice farm households with the aid of a semi-structured questionnaire.

Analytical framework

Livelihood diversification was not randomly assigned to farmers. Farmers choose to venture into livelihood diversification and such a choice is often nonexperimental and therefore is subject to sample selection unfairness. If livelihood diversification was assigned randomly to farmers, a researcher could evaluate the causal effect (counterfactual effect) of livelihood diversification on farmers' welfare by matching the difference in income earned between those who are into livelihood diversification) and those who are not into livelihood diversification. But livelihood diversification was not randomly assigned. As an alternative, livelihood diversification is a process of self-selection rather than randomly assigned. Hence, a farmer engaged in livelihood diversification or not is pre-determined and determined by a set of institutional and socio-economic indicators.

Institutional and socio-economic indicators affect livelihood diversification and these can directly or indirectly affect farmers' welfare (in this case, income from livelihood diversification). Ideally, if livelihood diversification found to have a positive association with rice producing households' welfare, a research cannot conclude that it is as result of livelihood diversification. It could be that a rice producing household is already efficient in production and well endow with resource leading to enhancing welfare (Wu et al., 2010). Due to observable and unobservable characteristics of rice producing households, just concluding that livelihood diversification positive impact on farm households' welfare might offer confounding outcome. This current study uses PSM (treatment effect) method to correct for selectivity bias arising from unobserved differences between the treatment (farmers with livelihood diversification) and comparison groups (farmers with no livelihood diversification).

Treatment effect (TE) is the average differences between rice producing welfare (off-farm income) and the two states of the conditions: (i) diversified farmers, $T = 1$ and (ii) non-diversified farmers, $T = 0$ (Rosenbaum and Rubin, 1983).

The average treatment effect (ATE) was calculated following the above scenario. The ATE is the mean differences in welfare of rice producing households who diversify their source of livelihoods *p,* denoted by T (1) (treatment group) and those who did not (control group), denoted by T (0). The estimation of the ATE is illustrated in equation (1).

$$ATE = T_i(1) - T_i(0) \quad (1)$$

The ATE model compared the rice producing households' welfare who diversified their source of livelihoods to those who did not diversify but have similar characteristics. This was a nonexperimental selection process since rice producing households engaged in livelihood diversification were random but not in a selective way. Equation (1) computes ATE which could be translated as the impact of livelihood diversification on rice producing households' welfare.

Two practical situations are necessary when estimating treatment effect model by using non-experimental information. A researcher can only observe either treatment group ($T_i = 1$) or control group ($T_i = 0$) for each rice producing household i, but cannot observe the two situations simultaneously. The undetected and hidden welfare is called the counterfactual (Wu et al., 2010). Based on this, ATE can be conveniently presented in equation (2) as:

$$E(ATE_i) = P[E(Y^1|T = 1) - E(Y^0|T = 1)] + (1 - P)[E(Y^1|T = 0) - E(Y^0|T = 0)] \qquad (2)$$

P denotes the possibility of observing a diversified rice producing household. The overall ATE the weighted average of livelihood diversification (treated group) and non-livelihood diversification (untreated group) as it illustrated in equation (2).

In order to estimates the ATE, both counterfactual welfare either $E(Y^1|T = 0)$ or $E(Y^0|T = 1)$ should be created. According to Wu et al. (2010), this procedure of estimation is complex and many studies are restricted to one method of estimating the counterfactuals.

Average treatment effect on treated (ATET) is another significant parameter for estimating effects of welfare for non-experimental data apart from the ATE. The ATET parameter estimates the effect of livelihood diversification on households who actually diversified rather than across all farmers who could potentially diversify their livelihoods. ATET is computed as follows:

$$W_{ATT} = E(W|T = 1) = E[Y^1|T = 1] - E[Y^0|T = 1] \qquad (3)$$

Where T is an indicator for treatment ($T = 1$ diversified household, 0 if otherwise). The problem of selection bias is easily observed in equation (3), because the unobservable term in the right-hand side is the second term. For instance, if $E[Y^0|T = 0] = E[Y^0|T = 1]$, then households who did not diversify their livelihoods can be used as baseline for comparison. Nevertheless, as aforementioned, this method hardly ever pass when using non-experimental information.

The last parameter used for estimating livelihood diversification on households' welfare is the average treatment effect on the untreated (ATC). This measured the effect of livelihood diversification on farmers' welfare who are not into livelihood diversification at all. In this case, the model for measuring ATC can be illustrated as:

$$ATC = E[Y^1 - Y^0|T = 0] = E[Y^1|T = 0] - E[Y^0|T = 0] \qquad (4)$$

Propensity Scores Matching (PSM)

Logit and/or Probit models are mostly used for estimating limited dependent variables in research domain. According to Caliendo et al. (2005), these two models yield similar outcomes when estimating the possibility of a household to diversify or otherwise the probit model was used to estimate propensity scores for each responding household. Propensity scores are estimated using socio-economic and institutional factors that push farmers into livelihood diversification (Djido et al., 2013). Representing the possible of a farm household to venture into livelihood diversification by Y and the set of institutional and socioeconomic (X) factors that influenced this decision, then the PS regression model is illustrated as:

$$PS = Prob(Y = 1|X) = Pr(\alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 x_4 + \alpha_5 x_5 + \alpha_6 x_6 + \alpha_7 x_7 + \alpha_8 x_8 + u) > 0 \qquad (5)$$

X_1 denotes sex, X_2 denotes age, X_3 denotes mobile phone ownership, X_4 denotes member to FBO, X_5 denotes access to credit, X_6 denotes extension service, X_7 and X_8 denote rainfall and is temperature perception perceptions. The alphas $(\propto_s)$ and error term (u) are parameter to be estimated.

Choosing a matching algorithm

The estimation of PSM was based on assumptions of the matching methods employed by Imbens, (2004); Caliendo and Kopeinig (2008). After propensity scores are estimated, the appropriate algorithm is chosen to match diversified households with non-diversified household based on the familiarity of their propensity scores. The robustness of the PSM outcome was checked by using sensitivity analysis, different specifications and matching algorisms to inspect the robustness in empirical research. This study used several matching algorisms to inspect the robustness of the estimates. Examples of matching algorisms mostly used in PSM regression models include kernel-based matching (KBM) and the nearest neighbour matching (NNM) (Heckman et al, 1998). Each of these matching methods have some deficiencies. For the NNM, it matches each diversified household from the diversified households with the closest non-diversified households or those with similar propensity scores. The limitation of NNM is that it faces the risk of bad matches if the closest neighbour is far apart. KBM on the other hand uses a weighted average of all diversified households to construct a counterfactual. The advantage of this method is that it produces ATE estimates with lower variance, as it utilises greater information (Wu et al., 2010). In this study, regression adjustments method (RAM) was also estimated to compare three estimation matching algorisms methods, which served as a sensitivity check. The description and measurement of variables for the probit regression model is illustrated in Table 1.

Table 1: Description and measurement of variables and their a *priori* expectation

Variable	Description	Measurement	A prior expectation
Dependent variables			Livelihood diversification
Livelihood diversification	Farm household engage livelihood diversification activities	Dummy: 1 = yes, 0 = otherwise	N/A
Welfare	Off-farm income	GHS per annum	N/A
Independent variables			
Age	Age of farmers	Years	+/-
Sex	Respondent's sex	Dummy: 1=male, 0=otherwise	+/-
Credit	Access to credit/loan	Dummy: 1 = yes, 0 = otherwise	+
Mobile phone	A farmer owns mobile phone	Dummy: 1 = yes, 0 = otherwise	+
Extension	A farmer received extension service from MoFA extension officers	Number of visits per annum	+/-
FBO membership	A farmer belongs to Farmers Base Organization	Dummy: 1=yes, 0= otherwise	+
Temperature	Perception of temperature	Dummy: 1= increases, 0= decreases	+
rainfall	Perception of rainfall	Dummy: 1= increases, 0= decreases	--

Results and Discussion

Summary statistics of research participants

The paper considered diversified (treated) and non-diversified (untreated) households. The socioeconomic and institutional characteristics considered were sex, age, mobile phone ownership, FBO membership, credit, extension service, perception of rainfall and temperature (See Table 1). More than three-quarters (78%) of the respondents were male farmers with about a quarter (22%) being female farmers. The average age of farmers from diversified households was found to be about 40 years compared to those from non-diversified households of 39 years and the difference between the two is statistically insignificant. The average mobile phone ownership for the sampled farmers is about 74%. Farmers who had mobile phones were much more into livelihood diversification (85%) compared to those who did not participate in livelihood ventures (62%). The averages for FBO membership and access to credit were 67% and 13% respectively, and were statistically significant between treated and untreated communities. The perception factor variables (i.e. rainfall and temperature) were 84% and 25% respectively, and were also statistically significant between the treated and untreated groups. Similarly, the average off-farm income was found to be GH₵1268.88 per annum for the pooled data. This indicates that a farmer who engaged in off-farm business was earning GH₵ 105.74 per month. This was statistically significant across the two categories of farmers. It is observed from the results that, there are significantly difference between the treated and untreated categories, except for age and extension service which obviously are not significantly different across the two groups.

Table 1: Average differences in characteristics of livelihood and non-livelihood diversifications

Variable	Livelihood diversification	Non-livelihood diversification	t-test	Pooled
Sex	0.776	0.853	1.676*	0.815
Age	40.322	38.545	1.376	39.434
Mobile phone ownership	0.853	0.622	4.581***	0.738
Farmer base organization	0.552	0.783	4.258***	0.668
Production credit	0.203	0.063	3.548***	0.133
Extension service	0.629	0.615	0.243	0.622
Rainfall perception	0.783	0.895	2.597**	0.839
Temperature perception	0.091	0.413	6.724***	0.252
Off-farm income(welfare)	2537.762	0.000	9.771***	1268.881

Note: ***, ** and * indicates statistical significance at 1%, 5% and 10% respectively
Source: Authors' Computation, 2018

Checking overlapping and common support

The PSM approach helped in checking for the observed differences in characteristics between diversified and non-diversified households. The common support region was used to check the observed differences between treated and untreated groups. The minima and maxima are used to check the validity of the common support region. According to Caliendo and Kopeinig (2005), if the propensity scores estimate points are less than the minimum and/or greater than the maximum, the opposite group is eliminated from the data points. Nevertheless, the restriction of the overlap region between the propensity scores of the two groups, could result in discarding an enormous number of observations. The trimming procedure was used to overcome this challenge by the region of common support, where P has positive density within both $T = 1$ and $T = 0$ distributions (Smith & Todd (2005).

The common support condition was used to match the region of common support for the treated and untreated groups. The counterfactual condition is met by using the common support region condition. The researchers checked for the presence of acceptable overlap between the treated and untreated groups. The matching distribution of the propensity scores after matching for treated and untreated are illustrated by the histogram in Figure 1. By inspecting the figure, the common support region is well balanced match for the entire sample. This signifies adequate overlap between the two groups and implies that the matching has produced counterfactual that are statistically related to the diversified households.

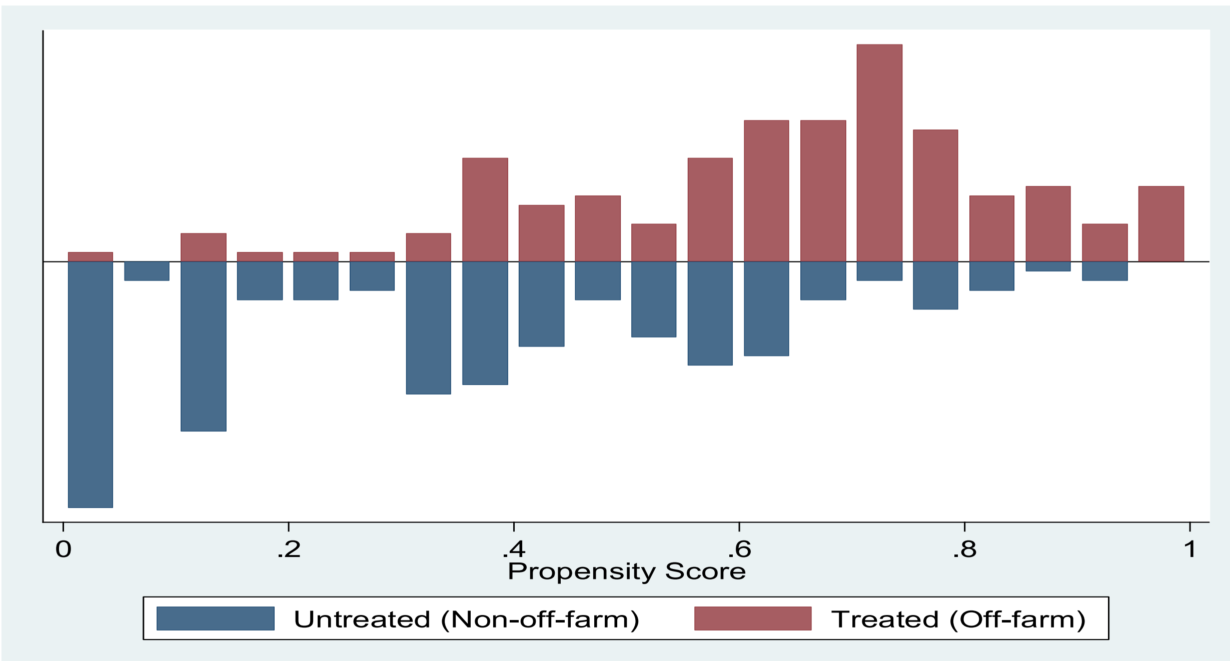

Figure 1: Propensity score distribution

Determinants of livelihood diversification

The results of the probit model is presented in Table 2, after the PSM estimation. The estimated results show that seven out of the eight variables significantly influenced livelihood diversification among the farmers (See Table 2). More specifically, sex had negative and significant effect on livelihood, implying that females had a higher probability to diversify their livelihoods to support the household responsibilities as compared to their male counterparts. This finding corroborates with Yizengaw et al. (2015) who found that male headed households had higher probability of involving in on-farm activities compared to female headed households. However, this is dissimilar to Amare & Belaineh (2013) who found that male headed households have higher possibility of going into off-farm wage activities than their counterpart female headed households.

Age was positive and statistically significant, meaning that younger farm household heads were less into livelihood diversification compared to relatively older farm household heads. This is proxy for experience in livelihood diversification, which increases with age, and therefore, experienced farm household heads had more projections of diversifying livelihood strategies. This corroborates with Debele and Desta (2016) who found that the age of the household head influenced livelihood diversification. The fact is that relatively older farm household-heads may have had more resource endowment, saved over a period of time, compared to younger counterparts, giving them the upper hand to engage in high return livelihood activities in addition to their main occupation of farming. This results however, is inconsistent with Zerai and Gebreezghiabher (2011) who suggested that younger farm household heads have more diversified livelihoods compared to older household heads.

Mobile phone ownership had positive and statistically significant relationship with livelihood diversification. The implication is that farm household heads who owned mobile phones had higher probability of diversifying their livelihoods than those who did not own mobile phones. This may be as a result of the fact that mobile phones allow for sharing and exchange of information among the farmers and between farmers and business agents. This also means that farmers need to be trained on how to use mobile phones as ICT tools to explore business opportunities (Al-Rimawi et al., 2016). Mobile phones play a very significant role in business in this 21st century. For instance, through communication, mobile phones help farmers to have access to production credit for both on-farm and off-farm employment.

Membership of FBOs is statistically significant at 1% and exerted a negative influence on livelihood diversification. Thus, belonging to farmer associations reduced the likelihood of the farmers diversifying their livelihoods. Membership of FBO is a social capital that offers farmers the opportunities for mutual support and also sharing of knowledge and skills in the agricultural value chain (Zakaria et al., 2016). However, when it comes to income generation strategies, not all farmers want to be part of social organisations due to either past experiences or other reasons known to the farmer. Ayantoye et al. (2017) found that membership to farmers' organisation reduces the probability of the farmers' participation in livelihood diversification. However, this contradicts Kassie et al., (2017) who posited that becoming a member of a farmer organisation increases the likelihood of farmers participating in livelihood diversification activities.

Extension service had a statistically significant and positive influence on livelihood diversification among farm households. Implying that farm households that had access to extension services had a higher probability of diversifying their sources of livelihoods compared to farm households that did not have access to extension services. This confirms the finding of Kassie et al. (2017) that agricultural extension services significantly influence farm household's decision to diversify their source of livelihoods.

The perception indicators of climate change for both rainfall and temperature are significant and negatively influenced livelihood diversification among the farmers. These met the *a priori* expectation since climate change can force farmers into looking for another source of income in addition to their farming business. The negative coefficients of rainfall and temperature mean that farmers who perceive rainfall to be reducing while temperatures increased had a higher probability of diversifying their livelihoods than their counterparts who thought otherwise. Fadina and Barjolle (2018), found that farmers' perception about rainfall and temperature patterns influence the probability of the farmers to diversify their source of income.

Table 2: Results of Probit estimation of PSM

Policy Variable	Coeff.	Marginal effect	Std. Error	P >|Z|
Sex	-0.776	-0.297***	0.084	0.000
Age	0.013	0.005*	0.003	0.075
Mobile phone ownership	0.648	0.250 ***	0.081	0.002
Farmer base organization	-0.719	-0.280 ***	0.071	0.000
Credit service	0.340	0.135	0.093	0.150
Extension service	0.327	0.129*	0.076	0.089
Rainfall perception	-0.466	-0.183**	0.087	0.035
Temperature perception	-0.876	-0.326***	0.075	0.000
Constant	0.423		0.448	0.345
Log likelihood	157.555			
Observations	284			
LR chi2 (8)	78.60***			
Pseudo R^2	0.1996			
Predicted value	0.480			

Note: ***, ** and * indicates statistical significance at 1%, 5% and 10% respectively

Source: Authors' Computation, 2018

Welfare effects of livelihood diversification: matching estimates

The results of the average treatment effect (ATE), the average treatment effect on the treated (ATET) and average treatment effect of the control (ATC) of livelihood diversification effects on farm households' welfare were estimated as contained in Table 3. ATE which measures the average effect of livelihood diversification for the whole farm household is given much attention in this study. The estimated ATE value indicates that livelihood diversification had significant and positive effect on farm households' welfare. The ATE of the livelihood diversification led to a significant increase in amount from GH₵ 2,448.95 to GH₵ 2,657.52 per annum among the farmers. This means that other things being equal, farm household's welfare will increase if they diversify their sources of income. Similarly, the ATET value was GH₵2,571.13 per annum and statistically significant at 1% with similar results obtained for the NNM and RA. This confirms that farm households who diversified their sources of income are better off than households who did not. Moreover, the ATC was statistically significant at 1%, meaning that future programmes on livelihood diversification are likely to help improve farm households' welfare. Kowornu et al. (2018) found that farm households in Ghana who engaged in off-farm business are far better-off than their counterparts. On the contrary, Diiro (2013) found that farm households without off-farm income generating activities were better-off than those with off-farm income options.

Table 3: The effect of livelihood diversification on farmers' welfare

	Nearest-neighbour matching		PSM		Regression adjustment	
	Coefficient	Std. Err.	Coefficient	Std. Err.	Coefficient.	Std. Err.
ATE	2448.95***	379.95	2657.52***	329.84	2272.31***	289.38
ATET	2571.13***	261.46	2571.13***	260.76	2571.13***	261.46
ATC	2326.77***	618.72	2743.92***	572.64		

Note: ***Indicate statistical significance at 1%; Std. Err. denotes standard error.
Source: Authors' Computation, 2018

Conclusions and Policy Implications

This paper employed probit regression to estimate the determinants of livelihood diversification while PSM was used to assess the livelihood diversification effects on farm households' welfare in Northern Ghana. Estimates from the probit model show that age, mobile phone ownership and access to extension services had positive and significant effect on livelihood diversification, implying that as these variables increased, the probability of farm households to diversify their source of income increases. Sex, FBO membership, perception of rainfall and temperature had negative and significant effects on livelihood diversification. On the average, income levels as proxy for welfare among the farmers significantly increased from GH₵ 2,448.95 to GH₵ 2,657.52 per annum. Livelihood diversification had the potential to improve farmers' welfare, and so could increase economic growth and development in the study area if interventions are designed to increase off-farm participation. Therefore, this paper recommends governments and development stakeholders to target their efforts at improving income diversification via creation of small-scale enterprises among smallholder farmers in the agricultural value chain, as this will enhance their welfare and build their capacities to be resilient to economic shocks and financial constraints. Also, there should be a comprehensive rural development policy targeting farm household by providing credit and capacity building programmes to empower women to diversify their source of income to support their households. Perception of farmers about rainfall and temperature has increased and this contributes to the probability of diversifying their sources of income to support household welfare. It therefore behoves on governments, stakeholders and policymakers to incorporate climate change coping and adaptation strategies in their development agenda and agricultural policies.

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