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Sustainable agricultural intensification practices and rural food security: The case of Northwestern Ghana

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The case of Northwestern Ghana

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Abstract

Purpose – The purpose of this paper is to understand the impact of participation in sustainable agricultural intensification practices (SAIPs) on household food security status in Northwestern Ghana.
Design/methodology/approach – The study utilised the Household Food Insecurity Access Scale (HFIAS) indicator for the measurement of food access data from 168 households in ten communities from the Northwestern region of Ghana for the analyses. Households were categorised into participating households (treatment) and non-participating households (control). The endogenous treatment effects model was employed to evaluate the impact of participation in SAIPs training on food insecurity access scale.
Findings – The results show that participation in SAIPs training lowers, on average, the household food insecurity access by 2.95 points, approximately an 11 per cent reduction in HFIAS score. Other significant factors found to influence household food insecurity access scale are age of household head, experience in farming, total acres owned by household, income level of the household and occupation of the head of the household.
Research limitations/implications – The training programme of participation in SAIPs has massive implications for food security, rural economy and farmers' livelihoods. However, due to the unique conditions prevailing in Northwestern Ghana, the findings of this research are limited in terms of their generalisability. Future research direction in the area of SAIPs trainings and impact study replications in all qualifying rural food production areas in Ghana, which are susceptible to household food insecurity, will provide a national picture of the efficacy of SAIPs trainings on household food insecurity.
Practical implications – A proven means to decrease natural resource degradation, increase crops yields, and increase subsistence farmers' income, and food security is an important intervention to resolve the seasonal food shortage, which last for five months in a typical year for agro-food-dependent farming communities in Northwestern Ghana.
Social implications – Ensuring household food security improvement and environmental sustainability will help improve living standards of food producers and reduce the adverse social challenges associated with food insecure communities such as health problems due to food deficiencies, social inequalities, environmental pollution and natural resource degradation in Northwestern Ghana.
Originality/value – The contribution of this paper is the novel thought and approach to examine the impact of the SAIPs trainings on household food security in Northwestern Ghana using the household food insecurity access scale indicator. The study also examined the factors that affect household food security using the endogenous treatment model, which also evaluates the impact of the training programme on the outcome variable.

Keywords Food security, Endogenous model, Northwestern Ghana,
Sustainable agricultural intensification practices
Paper type Research paper

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1. Introduction

Farmers in Northwestern Ghana practice subsistence agriculture with low soil productivity due to continuous mono-cropping with limited external farm inputs such as advanced seeds, chemical fertilizer, etc. This situation is exacerbated by the lack of access to credit market, poor physical infrastructure, underdeveloped agricultural market, and poverty. These factors hinder the subsistence farmers' access to food, which make their households food insecure. Taking a cue from the earlier failed attempt in Ghana, sustainable agricultural intensification practices (SAIPs) research has been introduced in Northwestern Ghana in 2010, in phases, as potential interventions to decrease natural resource degradation, increase crops yields, and increase subsistence farmers' income, and food security (Dalton *et al.*, 2014).

The debate as to what sustainable agriculture is among agricultural practitioners (Peterson and Snapp, 2015) is ongoing but the FAO definition is still popular with both researchers and practitioners. According to FAO (2009) sustainable agricultural intensification is defined as "the management and conservation of the natural resource base, and the orientation of technological and institutional change to ensure the attainment and continued satisfaction of human needs for present and future generations".

Food security is a growing concern in the world, particularly in developing countries. Among many definitions of food security, the World Food Summit of 1996 defines a situation "when all people at all times have access to sufficient, safe, and nutritious food to maintain a healthy and active life". This definition covers both physical and economic access to food that meet people's dietary needs and their food preferences. In general, food security is based on three pillars: food availability, food access, and food utilisation. Food availability refers to the sufficient amount of food available on a regular basis. Food access refers to having sufficient resources to receive appropriate food for a nutritious diet, whereas utilisation refers to how properly individual uses the food to which they have access. Utilisation primarily focuses on dietary quality related with inadequate intake of necessary vitamins and minerals for a healthy life (Barrett, 2010). Food insecurity affects food intake in quantity and quality, and eventually affect nutritional status and health of households (Mwaniki, 2006)[1].

More than 60 per cent of the population in sub-Saharan Africa depends on agriculture and about 30 per cent of the total population leave below the poverty line in Ghana (UNDP, 2005). The Northern, upper East and upper West regions of Ghana have been described as the home for mostly food insecure people (GLSS, 2000). The people of Northern and upper West regions experience seasonal food shortage and do not have adequate food for five months in a typical year (Quaye, 2008). Ghana living standard survey and UNDP reports have consistently shown that food insecurity is a big challenge in Ghana, particularly in Northern Ghana.

The main objective of this study is to evaluate the impact of household participation in SAIPs on household food insecurity (access) in Northwestern Ghana. The SAIPs programme was introduced in the region in 2010 to increase soil productivity, increase crops yields and farmers' income. Many studies have examined the status of food security elsewhere in Africa (Poppy *et al.*, 2014; Saaka and Osman, 2013; WFP, 2012; Reardon *et al.*, 1988; Barrett and Maxwell, 2006; Barrett, 2006). Most of these studies focused on examining the impact of socioeconomic, income, and farm characteristics on food security. The contribution of this paper is the novel thought and approach to estimate the impact of participation in sustainable conservation agricultural practices on food security using the household-level survey data. This work complements those few studies that have considered the issues of food security associating with human and natural resources, health and investment factors such as the work of Rosegrant and Cline (2003), which links innovations in agro-ecological approaches and crop

breeding to improve food security. Our evidence also complements the study of Quaye (2008), which examined the coping strategies of households during food insecure periods in Ghana.

2. Literature review

This section provides background information on sustainable agriculture, food security situation in Africa, focusing mainly on Ghana. It also describes factors that influence food security including past studies in the areas of conservation agriculture and food security.

2.1 SAIPs

SAIPs involve components like direct seeding without prior ploughing with either a plough or a hoe, leaving crop residue or planting of cover crops, and inter-cropping or crop rotation with legumes. The reasons for using SAIPs are to reduce the rate of declining soil fertility, improve soil structure, prevent soil erosion, and allow for sustained soil fertility (FAO, 2009). The benefits of these practices are the significant reduction of production cost (Dalton *et al.*, 2014) and increased yields (Balota *et al.*, 2004; Bayala *et al.*, 2012).

The extant literature suggests that sustainable agricultural intensification has helped communities improve their forest resources through community management in Mali (Tappan and McGahuey, 2005). Ndiritu *et al.* (2014) found that no significant socioeconomic inequalities exist among gender difference in the adoption of the components of sustainable agricultural intensification in Kenya. According to Gadanakis *et al.* (2015), the concept of sustainable agriculture needs a holistic approach in integrating all the resource endowment of the farm household and the community as whole. This is evident as agrobiodiversity is found to support sustainable agricultural intensification (Omer *et al.*, 2010)

SAIPs are widely practiced by the USA with about 26 million hectares of land under the conservation agriculture practices followed by Latin America with about 26 million hectares (representing 16.5 per cent of total cultivable land in 2007) and China is in a position to practice SAIPs in larger hectares (FAO, 2009). However, the uptake of the technology in sub-Sahara Africa is very low with less than one million hectares, which is about 0.3 per cent of the total cultivable land (FAO, 2009). It is worth noting that SAIPs were first introduced in Ghana by GTZ and Monsanto in the early 1996 (Boahen, 2007). Constraints to SAIPs uptake in developing countries are attributed to the non-availability of cash to farmers to purchase external inputs and machines, lack of appropriate loose straw management, high cost of no-till drills and lack of adequate extension services (Singh *et al.*, 2008). Huggins and Reganold (2008) also reported that the high cost of zero-till equipment, use of residue for animal feed and fuel are some of the factors hindering the adoption of zero-till in low-income countries. In Ghana, lack of cover crop seeds, lack of appropriate tools, limited promotion and little or no institutional support were reported as challenges to no-till adoption (Boahen, 2007).

The SAMREM CRSP project introduced SAIPs through an intensive participatory research process considering the socio-economic and farm-level adaptation trial to enhance farm household knowledge in the project beneficiary communities in 2009. This was aimed at demystifying the perceptions held and to promote the use of SAIPs for sustained benefits to both household food security improvement and environmental sustainability.

The participant farmers who are part of the broader intended beneficiaries of the project were involved in the research process from the development to the implementation stages with researchers taking local content into consideration in the research design. The mother-baby trial approach was adopted to facilitate stakeholder involvement at the implementation stage of the research process. The mother trial, managed by the researcher, comprised of several

treatments of the SAIPs compared to the farmers' practice, while the baby trials, managed by the farmer, had comparative trial between the farmers practice and the three SAIPs components with nutrient management: zero-tillage, rotation and permanent soil cover on the farmers own field on maize and soybeans. The participatory approach was adopted to enhance sustainability of the conservation practices through social and human capital development and to facilitate technology impacts (Neef and Neubert, 2011).

2.2 Adoption of SAIPs

A number of studies have cited the adoption of SAIPs in various countries. For example, Kassie *et al.* (2015a, b) demonstrated the factors influencing SAIPS adoption and its interdependence in Ethiopia and Rural Tanzania, respectively (see also Huffman, 2001; Manda *et al.*, 2015; Teklewold *et al.*, 2013). A number of household, farm and farmer characteristics have been found to influence the adoption of SAIPs by several authors. For example older household heads, experience (years) in farming and households with both physical and social capital have been identified to influence SAIPs adoption (Kassie *et al.*, 2015b). Land ownership has also been identified to influence the adoption of SAIPs (see e.g. Manda *et al.*, 2015; Kassie *et al.*, 2015b; Teklewold *et al.*, 2013). Educated farmers have been found to influence the adoption of SAIPs (Huffman, 2001). Manda *et al.* (2015) and Doss and Morris (2000) also found that male-headed households are more likely to adopt SAIPs packages than female-headed households. Land size and lack of credit are also found to have positive effects on the likely adoption of SAIPs; the evidence can be found in Khonje *et al.* (2015). However, none of the studies cited above looked at the impact that participation in SAIPs training have on household food security.

2.3 Benefits of SAIPs

Dalton *et al.* (2014) showed significant improvement in smallholder knowledge on conservation practices among participant and non-participant farm households in the beneficiary project area since its implementation in 2009. They also showed that there were no significant differences in the yields on either plots of SAIPs and to farmer practice. SAIPs were found to have the lowest cost of production due to labour time (days) reduction (see also Ngwira *et al.*, 2012) and reduction in the cost of tractor usage in tillage. Bayala *et al.* (2012) showed mean yield increases in SAIPs of cereals in West Africa. This can lead to food security access increasing with increasing yield. The unintended benefits that were not quantified include improvement in soil organic matter (Chivenge *et al.*, 2007; Balota *et al.*, 2004) and reduction in pollution of water bodies and carbon dioxide emissions (Steiner, 2002). Despite the benefits and promotion of SAIPs and its adoption, the contribution of participation in SAIPs training to food security access in Africa and Ghana in particular is unknown. This study therefore contributes to the literature on SAIPs.

2.4 Factors influencing farmer participation

Empirical studies have been undertaken in recent years on the factors influencing farmers' participation on research and training in agricultural and natural resource innovations. Several household, individual level, farm level, economic and social capital variables have been examined as determinants of participation. Some studies have identified the age of household head to have positive impact on participation decisions (see Zbinden and Lee, 2005; Sanginga *et al.*, 2006), while others identify age to have negative impact on participation (Dolisca *et al.*, 2006). Household size and children in household have also been identified to have positive impact on household participation decision (Dalton *et al.*, 2011; Dolisca *et al.*, 2006; Sanginga *et al.*, 2006). Educational level or whether the head of the household has education or not is also identified to have positive impact on the farmers' decision to

participate (see Zbinden and Lee, 2005; Sanginga *et al.*, 2006), while Dolisca *et al.* (2006) found education to have negative impact on participation decision.

Zbinden and Lee (2005) identified that social capital which involves the membership of farmer association was found to have positively impacted participation decisions. Male household heads are identified to have positive impact on participation (Dalton *et al.*, 2011), while others found gender to have a negative impact on decision to participate in a research training (Dolisca *et al.*, 2006; Sanginga *et al.*, 2006). Income level of household has been identified to have positive impact on participation (see Zbinden and Lee, 2005; Sanginga *et al.*, 2006; Dalton *et al.*, 2011). Farm size which is the area under cultivation by the household (hectare/acres) also has positive impact on participation (Zbinden and Lee, 2005), while land ownership or tenure has been found to have negative impact on participation ((Dolisca *et al.*, 2006).

The studies on factors influencing farmers participation decision are, however, silent on the impact of farmers participation in technology development on food security access. Hence, this paper throws more light on the impact of participation decision in SAIPs on household food insecurity access scale.

2.5 Food security in Africa

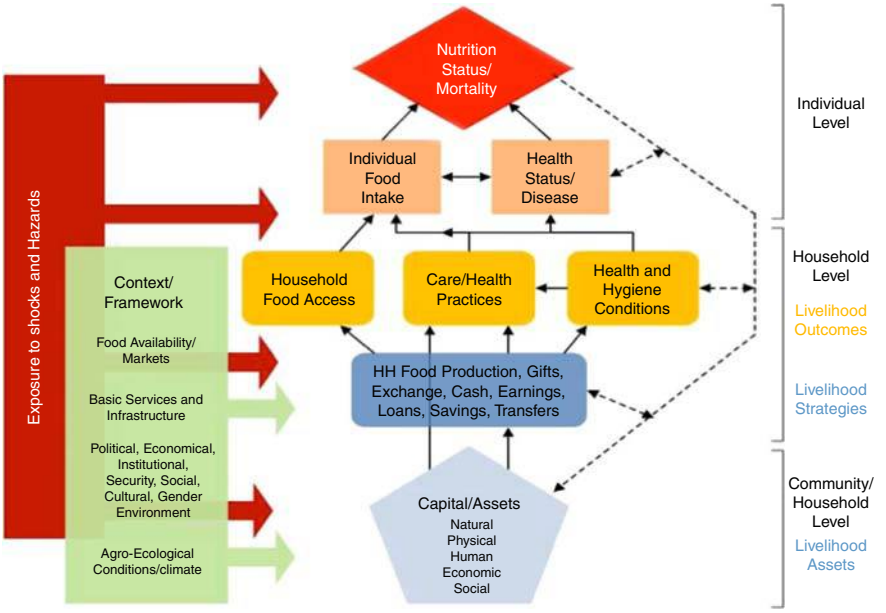
Food security is a big challenge in developing countries, especially in Africa due to an underdeveloped agricultural sector, lack of market access, disease and infection in crops, lack of physical infrastructure and so forth. Food insecurity is amplified in rural areas by seasonality, especially for perishable goods. Food security has worsened in Africa since 1970 and about 33-35 per cent of the population in sub-Saharan Africa have the problem of malnutrition (Mwaniki, 2006). Nearly, 240 million people in sub-Saharan Africa (about 25 per cent of the total population) do not have adequate food for healthy and active life (Bremner, 2012). In spite of some advances, most of the regions are not on the right path to achieve the Millennium Development Goals (MDGs). Food security is one of the primary objectives of MDGs with the aim of eradicating extreme poverty and hunger (UNDP, 2015). Some of the key factors that affect food security in Africa are explained following the following sections.

3. Conceptual and empirical approaches

The conceptual framework for food security follows multiple levels (individual, households and community) and it associates food security to political, institutional and environmental dynamics of the analysis. Food security is often an outcome of livelihood strategies. These strategies are based on available assets (e.g. human, social, natural, physical and capital resources) to households. Livelihood strategies help cope with and recover from stresses and shocks, maintaining the use of resources both now and in the future. For example, the livelihood strategies in Ghana are crop production, livestock keeping and trade (WFP, 2012). The conceptual framework for food security is presented in Figure 1.

Since food security is a multidimensional and complex issue, estimating food security has been a big challenge for researchers and practitioners. In general, analysts use proxy measures for different aspects of food security. For example, the coping strategies index, food expenditure index and dietary diversity measures are used to examine two or three pillars of food security (Barrett, 2010)[2].

Over the past 50 years, food access accounts for most food insecurity, which has focused on individual-specific hunger and underweight data[3]. This concept is based on poverty reduction, food price and social protection policies. Different data and methods may give different estimates. For example, individual or household data give higher estimates of food insecurity than those obtained from aggregate level data. The reasons for the different



Source: Adopted from WFP (2012)

Figure 1.
Food and nutrition security conceptual framework

estimates are intra, inter-households distribution of nutrient and nutritional availability. The estimates of food insecurity derived from survey data are highly correlated with poverty estimates (Barrett, 2010). Likewise, caloric adequacy has been used as a household measure of food access, but it is technically difficult, data intensive and expensive to collect (Coates *et al.*, 2007).

USAID developed the HFIAS to estimate the prevalence of food insecurity in the USA annually. The HFIAS indicator is useful to measure food access because it is relatively simple, but methodologically rigorous (Coates *et al.*, 2007). The HFIAS indicator of the access factor of household food insecurity (henceforth, household food insecurity (access) can be used to monitor and evaluate programme intervention (Coates *et al.*, 2007). The method is based on the assumption that experience of food insecurity (access) causes predictable reactions and responses that can be measured and quantified through a survey and summarised in scale.

This study follows the USAID HFIAS measure to examine the prevalence of food insecurity of farmers in Northwestern Ghana. The HFIAS indicator includes many domains – behaviours and attributes that relate to various aspects of food insecurity. The USAID of Food and Nutrition Technical project suggests adhering to follow the following steps to evaluate the impact of a programme on food security.

3.1 Study region and data

Data were obtained from 168 households in ten communities from the Northwestern region of Ghana. Households were categorised into participating (treatment) and non-participating households (control). The participating households were those households who were trained using on-farm demonstrations of various SAIPs described above. The participating communities were purposively sampled based on the fact that training on SAIPs took place at those communities. The non-participating communities were also purposively sampled

by virtue of the fact that they were within a radius of ten kilometres from the participating communities. The households were selected based on a prior random sample during a baseline study in 2010 and a mid-term study in 2012. The control households were sub-divided into households within the participating communities but are not actually treated and without households who are within ten kilometres from the participating community. The study region and the status of food availability of the sample size are shown in Figures 2 and 3, respectively. The summary statistics of the sample size households by gender and community is presented in Table I.

4. Empirical method and results

To evaluate food insecurity from the perspective of food access for each household, occurrence and frequency of occurrence questions are adopted from the USAID's FANTA project (Coates *et al.*, 2007). The nine occurrence questions (represent generally increasing level of severity of food insecurity (access)) and the nine frequency of occurrence questions are used. The frequency of occurrence questions work as follow-up questions to each occurrence question. The FANTA project suggests to use the complete sets of questions to examine food insecurity issues.

4.1 The causal model

The intuition behind the Rubin causal model is that each agent has two potential outcomes: with treatment (participating in SAIPs training) and without treatment (non-participants).

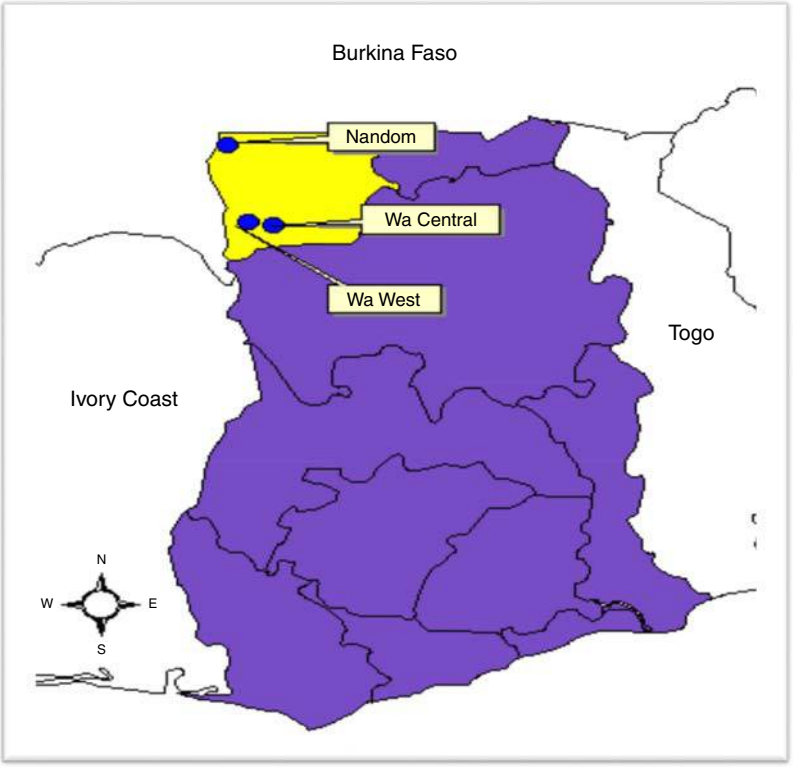


Figure 2.
Study region

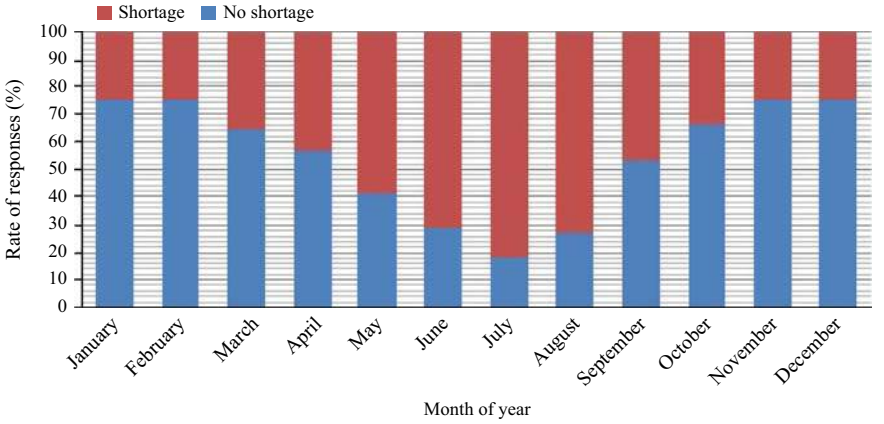


Figure 3.
Household food availability status in Northwestern Ghana

Variable	Definition	Total sample Mean	Total sample SD	Participant Mean	Participant SD	Non-participant Mean	Non-participant SD
Gender	Gender of the household head. Dummy variable (male = 1, female = 0)	0.94	0.24	0.89	0.32	0.96	0.19
Educat	Education of household head. Dummy variable (some education = 1, otherwise = 0)	0.36	0.48	0.51	0.50	0.29	0.46
Age	Age of household head(in years)	44.80	14.10	41.20	11.71	46.60	14.86
Exper	Number of years household head has been in crop production	23.57	14.55	20.32	12.44	25.18	15.29
Hhn	Total number of household members	7.69	2.76	6.89	2.36	8.09	2.86
Chn	Number of children in the household	3.00	1.99	2.85	1.73	3.09	2.12
Tenure	Household ownership of plot (s) under cultivation. A dummy variable (owner = 1, otherwise = 0)	0.94	0.24	0.95	0.23	0.94	0.24
Hfias	Household food insecurity access scale (scale: 0-27) with 0 being food secured (dependent variable for the outcome equation)	8.74	5.87	7.78	5.62	9.20	5.96
Totacres	Total household land holding in acres	8.30	7.45	6.80	4.08	9.05	8.54
Famldy	Total number of family labour days spent during previous season (days/season)	20.63	22.40	17.29	23.46	22.26	21.78
Ttime	Average walking time to the plot (s) (in minutes)	45.97	36.88	55.20	42.33	41.48	33.19
Credit	Access to credit. Dummy variable (credit access = 1, otherwise = 0)	0.21	0.41	0.24	0.43	0.20	0.40
Org.	Household head affiliation to farmer organisation. Dummy variable (member of farmer organisation = 1 and otherwise = 0)	0.50	0.50	0.95	0.23	0.28	0.44

Table I.
Summary statistics of variables used in the model

The treatment effect on an individual is the difference between the individual's state with the treatment and the state without the treatment. Mathematically, if $D_i = \{0, 1\}$ represents a binary treatment (participating in SAIPs or not), and Y_i be the outcome (food insecurity access scale) of interest from the treatment, then the potential outcome can be obtained as follows:

$$\text{Potential outcome} = \begin{cases} Y_{1i} & \text{if } D_i = 1 \\ Y_{0i} & \text{if } D_i = 0 \end{cases} \quad (1)$$

The observed outcome Y_i can be written in terms of the potential outcome as:

$$Y_i = Y_{0i} + (Y_{1i} - Y_{0i})D_i, \tag{2}$$

where $Y_{1i} - Y_{0i}$ is the causal effect of treatment (participating in SAIPs training) on an individual farmer.

However, in practice, we never get to observe both potential outcomes for an individual farmer. So, in order to observe the effect of treatment, we have to compare the average outcome of those who took part in the treatment with that of those who did not take part in the treatment. Naively comparing the averages by treatment status gives an indication of potential outcomes, although not necessarily what we are interested in. This comparison of average outcomes conditional on participating in SAIPs can be linked to the average treatment effect through the following equation:

$$E\left[Y_i \middle| D_i = 1\right] - E\left[Y_i \middle| D_i = 0\right] \tag{3}$$

Equation (3) can be re-written as:

$$\left\{\left[Y_{1i} \middle| D_i = 1\right] - E\left[Y_{0i} \middle| D_i = 1\right]\right\} + \left\{E\left[Y_{0i} \middle| D_i = 1\right] - E\left[Y_{0i} \middle| D_i = 0\right]\right\} \tag{4}$$

The term $\{[Y_{1i}|D_i = 1] - E[Y_{0i}|D_i = 1]\}$ is the average effect of participating in SAIPs training. This is known as average treatment effect of the treated (ATET). It represents the average difference between the observed outcomes of the treated and what would their observed outcomes be if they had not been treated. However, the ATET comes along with $E[Y_{0i}|D_i = 1] - E[Y_{0i}|D_i = 0]$, which is the difference in average expected food insecurity access between those who were treated and those not treated. This difference is the "self- selection bias", which must be corrected in order to estimate the actual effect of the treatment. As Angrist and Pischke (2008) puts it, the goal of most empirical economic research is to overcome selection bias, and therefore to find the true causal effect of the treatment variable. In this study, we employed the endogenous treatment regression model to correct for the selection bias. The next section explains in detail the endogenous treatment effects model (ETEM).

4.2 The ETEM

The study used the ETEM proposed by Heckman (1978). This is a linear model that allows for correlation structure between unobservables affecting the household participation decisions and those affecting the household food insecurity access. The household food insecurity access (HFIAS) is a scale measure with 0 meaning food access and a maximum of 27 meaning food insecurity access. The idea is to model the treatment effect of household participation on sustainable agricultural intensification training programme on food insecurity access scale. The endogenous treatment effects model is used to assess the effectiveness of the household participation on food insecurity access scale measure (HFIAS) as in Greene (2002). The outcome model can be specified as follows:

$$\text{HFIAS}_i = X_i'\beta + \delta\text{Part}_i + \varepsilon_i \tag{5}$$

The effect of participation (binary) on HFIAS_i is not captured by the δ, because this is the case of whether household i participates in the sustainable agriculture intensification training programme or not (the case of self-selection). Hence, neglecting the potential

endogeneity of participation produces wrong estimates of the treatment effect and also overstates the effect of participation on household food insecurity access scale. Household participation decisions (treatment) are based on the household, individual and farm characteristics W_i, and it is modelled as:

$$\text{Part}_i^* = W_i'\Delta + \mu_i \tag{6}$$

$$\text{Part}_i = \begin{cases} 1 & \text{if Part}_i^* > 0 \\ 0 & \text{Otherwise} \end{cases}$$

where X_i and W_i are covariates that are unrelated to the error terms. The assumption is that ε_i and μ_i are jointly normally distributed with mean zero and variance covariance matrix Σ, which is given as:

$$\boldsymbol{\Sigma} = \begin{pmatrix} \sigma_1^2 & \rho\sigma_1 \\ \rho\sigma_1 & 1 \end{pmatrix}$$

The model above can be estimated using the two-step approach or the maximum likelihood approach. Therefore, this is simultaneously modelled as a participation decision model as in Equation (6) and the outcome model as in Equation (5). Consistent estimates of household participation decision on their food insecurity access are obtained by accounting for the endogenous participation. Thus, the selection bias as observed in the causal model is corrected.

5. Results

5.1 Summary statistics

Table II presents the variables used in both the outcome and treatment models. The summary statistics of the variables used are also presented in the table. Our sample included about 65 per cent of the participant households with the about 35 per cent representing the non-participant households. The participant and non-participant households represent the treatment variable. The data with less non-participant households are due to high non-response rate among them.

5.2 Empirical estimates of ETEM

The maximum likelihood estimates of the model are presented in Table II. The results of the Wald test justify the use of endogenous treatment regression model as the test statistic of 10.89 is statistically significant at 0.001 level. This indicates that the null hypothesis of the no correlation between the treatment and the outcome errors is rejected. The negative sign of the correlation coefficient indicates the unobservable factors that tend to increase household participation decisions in training programme lower their food insecurity access scale. The implication is that unobservable factors influencing household participation increase household food access. The treatment variable (participation) is positive and statistically significant. This represents the ATET and it is 2.95 points. This implies that participation in SAIPs training lowers, on average, the household food insecurity access by about 2.95 points. This shows that households participating in SAIPs training programme are relatively likely to increase household food access.

5.3 Factors influencing household training participation

Factors affecting household participation in the SAIPs training programme include gender, land ownership, total land, etc. The coefficient of gender variable has negative

Variables	Treatment Coef.	SE	Outcome Coef.	SE
Constant			12.825***	2.669
Gender	−2.651***	0.695	−1.559	2.772
Age	−0.015	0.014	−0.076*	0.044
Education	0.027	0.096	0.195	0.309
Experience	−0.016	0.017	0.103**	0.047
Tenure	2.488***	0.680	−1.870	3.331
Total acres	−0.095***	0.029	0.115***	0.047
Total time	0.005*	0.003		
Organisation	2.501***	0.386		
Credit	0.403	0.334		
Family labour (days)	0.007	0.009		
Income			−0.001***	0.001
Occupation			−1.086***	0.263
Participation			−2.945**	1.314
ρ			−0.709***	0.133
σ			5.292***	0.308
λ			−3.754***	0.801
χ^2_9			109.27***	
Wald test ($\rho = 0$)			10.89***	
Log likelihood			−604.531	

Table II. Maximum likelihood estimates of ETEM

Notes: *,**,***Significant at 0.10, 0.05 and 0.01 levels, respectively

sign and is significant. It implies that female headed households are more likely to participate in the training programme than male headed households which corroborates the findings by Dolisca *et al.* (2006) and Sanginga *et al.* (2006). The expected positive and significant effect of land ownership (tenure) in the treatment model indicates that household heads who own their land are more likely to participate in the training programme; this is, however, contrary to findings by Dolisca *et al.* (2006). This makes sense since the SAIPs programme is a long-term investment and non-land owners are not interested in investing in their parcels of land because they may easily lose the plot of land at any time. The expected negative and significant effect of total land allocated to production on training shows that households with smaller land size are more likely to take part in the training programme than those with bigger plot sizes.

Distance to plot has positive and significant effect on training. The implication is that households with distant plots are more likely to participate in the training programme than those with plots nearer their households. Farmer organisational affiliation has positive and significant effect on participation (see also Zbinden and Lee, 2005). The implication is that households with farmer organisational ties are more likely to take part in the training programme compared with those who have no ties. This might be due to peer learning and the fact that it allows for innovations and reduces individual conservativeness. Education, credit and family labour days have the expected positive sign, but they are insignificant.

5.4 Factors influencing household food insecurity access scale (HFIAS = outcome)

The results show that age has a negative and significant effect on household food insecurity access scale. The implication is that younger households' heads are likely to have more food access compared to their older counterparts. This result confirms the

findings that younger households' heads will participate in SAIPs training compared to older ones. The younger households are more interested in learning and, hence, are more likely to adopt innovations. The results indicate that experience has positive and significant impact on household food insecurity access scale. The implication is that farmers who have experience in farming have more food access than less experience ones. This can loosely be related to being in the system for some time and by default are older which is corroborated by the finding of the age variable.

Total acres allocated to agricultural production has positive and significant effect on food insecurity access scale. It implies that households with large acreage in agricultural production have high food insecurity access compared to small holders. This can be attributed to the fact that small holder households were more involved in the training programme and it confirms the impact of the training on households. Household total income has negative and significant effect on household food (insecurity) access scale. The food (insecurity) access increases with increasing income. This is unexpected but can be attributed to the fact that the SAIPs training targeted small holder resource-poor households. The negative and significant effect of occupation implies that households whose occupation is mainly crop production are likely to have more food access. The implication is that food producers who took part in the training programme will have access to food compared to non-food crop producers.

The most important variable in this study is participation. When farmers participate in the SAIPs programme, the predicted value of HFIAS score is 2.95 points lower than the non-participating farmers, holding other things constant. The significant reduction of the HFIAS score shows that the participating households are likely to have higher food access than the non-participating farmers. The results further showed that the study has been able to change farmers' perceptions and knowledge on SAIPs and affirms the earlier study of Dalton *et al.* (2014).

6. Conclusion

SAIPs trainings are in a research phase in Northwestern Ghana. Past research has shown that agricultural intensification trainings and communications among farmers are the effective tools to increase agricultural and crop management practices, which help to increase yields. This research investigated the impact of the SAIPs trainings on household food security in Northwestern Ghana using the household food insecurity access scale indicator. We also examined the factors that affect household food security using the endogenous treatment model, which also evaluates the impact of a project on the outcome variable. The results of the endogenous treatment model indicated that the HFIAS score decreased by 2.95 points, which is approximately an 11 per cent reduction in HFIAS score. The reduction in the HFIAS score indicates that the participating households are more likely to have higher food access than the non-participating farmers. In other words, the training programme helps to increase food security (access) in Northwestern Ghana. However, we may not generalise the results beyond the study area to other rural communities due to the unique conditions prevailing in Northwestern Ghana. Instead, SAIPs trainings can be replicated in other rural settings susceptible to household food insecurity, to be followed by respective impact study. Government of Ghana and other developing partners can therefore take up SAIPs training in food insecure agrarian households which have been proven as a worthy contributor toward alleviating food insecurity. A follow-up study to gauge behaviour change in term of farm practices beyond change of perception and knowledge acquisition on SAIP post-training is also important.

Notes

1. Note that adequate availability of food is necessary, but it does not ensure access to sufficient, safe and nutritional food. For further explanation see Barrett (2010) and UNDP (2005). Income, prevailing prices and formal or informal safety net arrangements through which people can have access to available food affect food security.
2. Three pillars of food security are availability, access and use. For detail explanation including advantages and disadvantage of each method, please see Maxwell (1996) and Barrett (2010).
3. Hunger is defined as the physical discomfort or weakness caused by the lack of food and can only be measured at the individual level.

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