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Factors affecting farmers' participation in contract farming: The case of soybean producers in the eastern corridor of the northern region of Ghana

Abdulai Y.*, Abdulai A. M. and Abdul-Manan K.

Department of Agribusiness, Tamale Technical University, Tamale Northern Region, Ghana.

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Contract farming (CF) is gaining traction as a vital solution for improving the fortunes of Ghana's small-scale soybean farmers. Government and non-governmental organizations, such as the Savanna Farmers Marketing Company (SFMC), the Northern Development Authority (NDA), and the Adventist Development and Relief Agency (ADRA), have begun contracting farmers to cultivate soybeans in Ghana, particularly in the Northern Region's Eastern Corridor. The study sought to determine the factors that influence farmers' decisions to participate in CF in the Eastern Corridor of the Northern Region of Ghana. It involved 374 contract and non-contract soybean farmers selected through a multi-stage sampling procedure. A treatment effect model was estimated to determine the factors that influenced farmers' participation in CF and its effect on farm income. The factors that positively influenced participation in CF were gender, education, off-farm business, FBO membership, farm size, access to agricultural extension services, and distance from the farm to the market center. However, participation was negatively affected by experience in soybean production and access to production credit. CF participation, the farmer's level of education, farm size, the cost of plowing, the cost of pesticides, and the cost of seeds all had a positive effect on farm income. The cost of labor and the age of the farmer had a negative effect on farm income. The study recommends policies for greater public investment in facilitators that can enable smallholder farmer participation in CF, such as off-farm income opportunities, extension systems, and transportation infrastructure. It also advocates for measures to promote education, land consolidation, and sustainable intensification that can boost productivity and farm incomes.

Key words: Contract farming, treatment effects model, soybean producers.

INTRODUCTION

In the developing countries including Ghana, agriculture plays a significant role in leading economic development. Globalization, expanding agribusiness, and shifts in consumer tastes are changing the agricultural production pattern. Moreover, the efforts of many government policies toward more market-oriented solutions are playing a pivotal role in this shift. One of the strategies adopted by governments and non-governmental organizations in these market-oriented solutions is Contract farming (CF) (Abdulai and Al-hassan, 2016). CF is a newly developed

*Corresponding author. E-mail: yahya@tatu.edu.gh/yahyaghx@yahoo.com; Tel:+233 242710608.

modern agricultural approach that connects backward and forward markets in sub-Saharan Africa's agricultural produce (Mwambi et al., 2016). The Food and Agriculture Organization (FAO) (2008) defined CF as an agricultural market and access to production support. Buyers looking for suppliers of goods for processing or further sales down the value chain are also interested in CF.

The primary users of contracts are processors, who may make the most use of their processing capability due to the guaranteed supply (Charles and Shepherd, 2014). It is recognized as a viable method for agricultural transformation in poor countries because of its capacity to deal with the constraints of agricultural commercialization (Little and Watts, 1994). According to Mishra et al. (2018), CF not only aids in agricultural sector transformation but also acts as an institutional innovation by lowering transaction costs and addressing market shortages through farmer-to-market connectivity. According to Masakure and Henson (2005), CF can help farmers overcome market inefficiencies by connecting them to a greater range of domestic and worldwide markets through the organization of high-value agricultural crop production. Eaton and Shepherd (2014) identified five CF models: the centralized model, the nucleus estate model, the multipartite model, the intermediary model, and the informal model. A firm offers help to smallholder production, purchases the crop, and then processes it while strictly regulating its quality under the centralized model. Tobacco, cotton, sugar cane, banana, tea, and rubber are all crops that use this model. The Nucleus Estate model also includes the management of a plantation to enhance smallholder production and provide a minimum output for the processing plant. This method is mostly utilized for tree crops like oil palm and rubber. The Multipartite approach typically comprises collaboration between government agencies, commercial businesses, and farmers. The Intermediary model, at a lower level of sophistication, can entail firms subcontracting to intermediaries who have their own (informal) links with farmers.

Finally, the Informal model incorporates small and medium-sized businesses that enter into seasonal contracts with farmers. Although these are often seasonal arrangements, they are frequently repeated annually and rely on the buyer's proximity to the seller for success. To ensure accountability, farmers are aided in groups in the form of collateralisation for these input credits. Contracts are subsequently signed by the farmers' leaders, and their output is sold to the firms that helped them with their production efforts. Farmers are assured of a reliable marketing channel and a satisfactory economic price for their produce under this formal contracting structure. Because basic contracts are entered into with farmers on a seasonal basis, the companies' strategy is also referred to as an informal model.

Breach of contract by farmers in diverting inputs and other resources provided to them and instances of contractors exploiting the farmers tend to be some limiting factors in contracting farmers (Abdulai and Al-hassan, 2016). In Ghana, contracting firms are often more interested in cash/industrial/commercial crops. Among these crops include cocoa and oil palm, as well as non-traditional agricultural crops such as cashew, pineapple, mangoes, and soybeans. Except for soybeans, most of these crops are farmed in the southern part of the country. Soybean (*Glycine max*) is an arable crop that has been described as a low-cost source of protein with edible vegetable oil and an optimal amino acid profile, the crop is rapidly eclipsing groundnuts as Ghana's primary cash crop, particularly in the Northern region, and was thus the subject of this research (Abdulai, 2023). Soybean is extremely important for Ghana's economy and has great potential to increase incomes and nutritional value. As such, stakeholders like the Council for Scientific and Industrial Research (CSIR) and Ministry of Food and Agriculture have collaborated to promote soybean cultivation (Mbanya, 2011). Growing soybeans is economically and nutritionally prudent, plus soybeans offer therapeutic benefits for preventing and treating cardiovascular disease (Sanful and Darko, 2010).

In 2012, the Statistics, Research and Information Directorate (SRID) of the Ministry reported over 75% of Ghana's soybean production comes from the Northern Region. Consequently, most soybean interventions, like the Agricultural Value Chain Mentorship Project (AVCMP) funded by DANIDA through AGRA, are focused there. Through programs like AVCMP, CSIR provides technologies to Northern Ghanaian soybean farmers involving certified seeds, planting techniques, integrated soil fertility management, integrated pest management, timely operations, and crop rotations. However, average yields of 1.97 Mt/Ha remain well below the 3 Mt/Ha potential yields (MoFA, 2021). Bridging this yield gap could be achieved through participation in CF (Abdulai, 2023). According to studies, participation in CF increases farmers' production, efficiency, and income (Key and Runsten, 1999; Warning and Key, 2002). Additionally, there has been evidence of farmers gaining minimally from CF (Key and Runsten, 1999; Simmons et al., 2005). CF is being considered as a strategy for increasing the efficiency of production and marketing access for small farming firms.

Several other studies on CF have also been undertaken, including that of (Abdulai and Al-hassan, 2016), Setboonsarng et al. (2008), and Cai et al. (2008). Similarly, the Asian Development Bank Institute (ADBI) in Tokyo has performed a series of case studies in various Asian nations to analyze the circumstances for which rice farmers to gain in participating in CF. In addition, a research in Lao PDR found that contracted farmers generated much better earnings than non-contracted farmers. This allowed the shift of subsistence farmers to commercial agriculture, potentially alleviating rural poverty (Setboonsarng et al., 2008).

In light of the benefits and drawbacks of CF especially in

Ghana's Northern Region, it is critical that research efforts like the ones mentioned above be carried out in order to determine (empirically) how much CF affects the welfare including the farm income of farmers. This study aimed to determine the factors that influence farmers' decisions to participate in CF and how that decision affects farm income.

Study area

The study was conducted in Ghana's Northern Region, which had a population of 2,310,943 in the 2021 census, making it the sixth most populous region in Ghana (GSS, 2021). The regional capital is Tamale. The Northern Region is divided into fourteen administrative and political districts. It is bordered by the North East Region to the north, the Oti Region to the south, the Savanna Region to the west, and the Republic of Togo to the east. The region's largest lakes are formed by the convergence of the White and Black Volta rivers. The land is relatively flat and low-lying (MoFA, 2011), which facilitates agricultural production. Approximately 68.5% of the labor force is engaged in agriculture in the Region.

The Northern Region falls within the guinea savanna agro-ecological zone, with a rainy season typically spanning March/April to October, peaking in September. Rainfall variability is 15-20% (MoFA, 2006). The region is a major producer of cereals, tubers, legumes and other foodstuffs in Ghana.

Soybean is an important leguminous crop grown mainly in Ghana's five northern regions (MoFA, 2011). The region leads soybean production nationwide. The climate and availability of agricultural land make the region well-suited to soybean cultivation. CF (CF) initiatives by organizations such as Adventist Development and Relief Agency (ADRA), Soybean Farmers Marketing Company (SFMC), SADA and Masara N'Arziki that partner with smallholder farmers may further boost soybean productivity and farmer incomes. The Northern Region was thus selected as an appropriate study site given the prominence of soybean and CF.

METHODOLOGY

Sampling technique and data

The study utilized a multi-stage sampling technique to select soybean growers. In the first stage, Ghana's Northern Region was purposively chosen as the study area since it leads national soybean output (Ministry of Food and Agriculture Statistics, Research and Information Directorate [MoFA SRID], 2015). The three districts with the highest levels of soybean production in the Northern Region were then purposively selected based on their prominence as soybean cultivation areas with existing CF arrangements. The second stage involved Probability Proportional to Size (PPS) sampling. Ten communities were randomly chosen from each district based on the number of soybean farmers and presence of contract farmers. This yielded 30 communities total across the 3 districts.

The soybean farmers in the selected districts were divided into two strata: contract soybean producers (participants) and non-contract soybean producers (non-participants). Prior to the survey, the SFMC and Northern Development Authority (NDA) - two companies engaging farmers in soybean CF - provided a list of 655 contract farmers across the 3 districts. In determining the sample size for the study, Slovin's formula used by Visco (2006) and Rivera (2007) was adopted. It is expressed as (Equation 1):

$$n = \frac{N}{1 + Ne^2} \tag{1}$$

Where n is the sample size, e is the margin of error (0.06 for a 94% confidence level), and N is the population of contract farmers (655). This yielded a sample size (n) of 195, which was upwardly adjusted to 210 to account for potential design effects. Thus 210 contract farmers were randomly selected, representing 32% of all soybean contract farmers. An equal number (210) of non-contract soybean farmers with comparable characteristics were also randomly chosen across the communities to match the contract farmers. In total 420 respondents were interviewed, although after data cleaning this was reduced to 374 (200 contract farmers and 174 non-contract farmers).

Analytical framework

A two-stage treatment effect model was estimated to determine the impact of CF participation on crop farmers' income levels in Ghana's Northern Region. The probit model was used to examine factors influencing farmers' decisions to engage in CF.

Theoretical model specification

Estimating factors influencing participation in CF using the probit model

Farmers' decision on whether to participate in an innovation/intervention or not has been studied in a wide range of literature (Afolami et al., 2015; Kontogeorgos et al., 2008; Manda et al., 2015; Sodjinou et al., 2015). In practice, the probit or logit models are used to determine the probability that smallholder farmers will participate in a technology or not. In this study, as the participating in CF is a dichotomous or binary dependent variable with the option of either participation' or non-participation', the probit model was considered to be the most appropriate analytical tool because it allows for the estimation of marginal effects and its fitness to the data. Farmers' CF participation decision was specified as follows (Equation 2):

$$P_r(j) = P_r(Q_i = 1/X) = F(Z_i) = F(\beta' X) \tag{2}$$

A vector of explanatory variables is represented by X, where F(•) represents the cumulative normal P_r distribution probability, and β is the vector of parameters to be estimated, and $\beta' X$ is the index function that permits the estimation of the probability of participation. The parameters in the above equation (2) are estimated by maximum likelihood methods. According to Greene (2008) and Madalla (1983), in the case of the normal distribution function, the model to estimate the probability of observing a farmer participating in CF can be stated as (Equation 3):

$$P_r(Q_i = 1/X) = F(Z_i) = \int_{-\infty}^{x'\beta} \Phi(t)dt = F(\beta' X) \tag{3}$$

where, $\Phi(\cdot)$ is a the normal density function and its derivative is given as (Equation 4):

$$\Phi(t) = \frac{1}{\sqrt{2\pi}} exp^{-0.5t^2}. \quad (4)$$

Since the estimated coefficients (*β's*) do not have simple interpretation, except that they tell how the explanatory variables are related to the dependent variable (Greene, 2003; Stock and Watson, 2007), the model is best interpreted by computing the marginal effects as follows (Equations 5 and 6):

$$\frac{\partial E(Q/x_i)}{\partial x_i} = F(Z_i)\beta_j \quad (5)$$

where,

$$Z_i = \beta_o + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots\ldots\ldots \beta_k x_{ik} + \varepsilon_i \quad (6)$$

The marginal effect shows the effect of an increase in x_i on p_r and this effect depends on the slope of the probit function which is given by $F(Z_i)$ and the magnitude of the parameter. In order to estimate the probabilities of farmers making a decision to participate or not to participate in CF as a function observed characteristics (X_i) and unobserved characteristics
(ε_i) that is (Equations 7):

$$Q_i^* = X_i^{'}\beta + \varepsilon_i \quad (7)$$

where Q_i^* is a latent variable which is unobservable, and what is observed is the CF production decision that can be related to the observable binary variable *Q* through the expression (Equations 8):

$$\begin{matrix} 1\ if\ Q_i^* > 0 \\ 0\ if\ Q_i^* \leq 0 \end{matrix} \quad (8)$$

Equation 7 can be expanded as seen in equation 15

Treatment effect model

The model comprises two equations: a selection equation estimating the factors driving CF participation, and an outcome equation estimating income as a function of respondents' socioeconomic traits, a CF dummy variable, and the Inverse Mills Ratio (IMR). The IMR derived from the selection equation corrects the outcome equation for selection bias stemming from unobserved differences (for example entrepreneurial talent, risk tolerance) between contract and non-contract soybean farmers. The treatment effects framework assesses the effect of an endogenous binary treatment (CF participation) on a fully observed continuous variable (income), conditional on the independent variables.

As the key objective was to determine the impact of CF on soybean farmers' incomes, the analysis required going beyond merely correcting for selectivity bias, to evaluate how contracting causally affects crop revenue. Therefore, the treatment effect approach was adopted. Analogous to the Heckman two-stage, the treatment effect model estimates the selection equation initially to obtain predicted values of the selection variable (contracting), which are utilized to generate the Inverse Mills Ratio (IMR, or lambda). Both the predicted contracting values and IMR are then incorporated into the second stage outcome equation. Mathematically (Equations 9),

$$Y = X_i'\beta + \delta C_i + u_{1i} \quad (9)$$

where Y is income, $X_i'$are exogenous variables that are believed to influence income, C_i is contracting which takes the value 1 if a farmer is a contract farmer and (0) if otherwise. u_i is a two sided error term with N(0, σ_v^2), β and δ are parameters to be estimated. From Madalla (1983), this may not provide an adequate result since C_i is endogenous (Equations 10):

$$C_i^* = W_i'\gamma + u_{2i} \quad (10)$$

Where W_i' *is* a set of exogenous variables that may influence the selection variable C_i, γ is a parameter to be estimated and u_2 is also a two-sided error term with $N(0, \sigma_v^2)$. Note that we cannot simply estimate the substantive equation (without first estimating the selection equation) because the decision to contract may be influenced by unobservable variables like innovativeness that may also influence income. This implies that the two error terms (in the selection and substantive equations) are correlated, leading to biased estimates of β and δ. If we assume that u_{1i} and u_{2i} have a joint normal distribution with the form (Equations 11):

$$\frac{u_{1i}}{u_{2i}} \sim N\left(\begin{bmatrix}0\\0\end{bmatrix}, \begin{bmatrix}1 & \rho\\ \rho & \sigma^2\end{bmatrix}\right) \quad (11)$$

Then it follows that the expected output of those who contract is given as in Equations 12:

$$E[X_i \mid C_i = 1] = Z_i\beta + \delta + E[u_{2i} \mid C_i = 1] = Z_i\beta + \delta + \rho\sigma\lambda_i \quad (12)$$

$$\text{where } \lambda_i = \frac{\phi(-Z_i'\gamma)}{1-\phi(-Z_i'\gamma)} \quad (13)$$

where equation 13 is the IMR

Estimating Equation 11 without including the Inverse Mills Ratio (IMR) would result in biased coefficients β and δ, as indicated by Equation 13. As described by Maddala (1983), when analyzing the incomes of both contract and non-contract farmers, equation 9 can be formulated as (Equations 14):

$$Y = \beta'(\Phi_i X_i) + \delta'(\Phi_i C_i) + \sigma\phi_i + e_{2i} \quad (14)$$

Empirical models specification

Building on the theoretical framework outlined above, the following empirical model was estimated to determine the drivers of farmers' contract participation decisions as well as the effects on output (Equations 15):

$$CF = \beta_0 + \beta_1 SEX + \beta_2 AGE + \beta_3 EDUC + \beta_4 EXP + \beta_5 CD + \beta_6 OFFBUS + \beta_7 FSIZE + \beta_8 CRE + \beta_9 EXT + \beta_{10} FMDIS + u_2 \quad (15)$$

In the second stage (Equations 16):

$$Y = \beta_o + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + u_1 \quad (16)$$

Where: *CF* is the 0-1 outcome with 1 corresponding to farmers who produced soybean under CF and 0 relating to farmers who produced soybean independently □□□□□□□□ are the parameters to be estimated, and is the u_2 error term which is assumed to follow a standard normal distribution with mean zero and variance 1. Table 1 presents a summary of the explanatory variables in the equation 15. The definitions and the *a priori* expectations of the variables are indicated below in Table 1.

Table 1. Definition of variables and *a priori* expectations.

Variable	Definition	Expected sign
SEX	The sex or gender of the farmers (male/female)	+/-
AGE	How old the farmer is in years	+/-
EDUC	Dummy (1 for received formal education, 0 otherwise)	+
EXP	Experience of the farmers measured in years	+
CD	Crop diversification (No./types of crops cultivated)	+/-
OFFBUS	Off farm business (Dummy, 1 for engaging in any off-farm business, 0 otherwise)	+/-
FSIZE	Farm size measured in total size in acreages of a farmer's, soybean farm.	+/-
CRE	Access to credit (cash/kind) (Dummy, 1 for credit receipt, 0 otherwise	+/-
EXT	Extension, the number of times a farmer receives extension service in a year	+
FMDIS	Farm-market-Distance, Distance travelled by farmer from farm to market centre to sell produce. This is measured in kilometres	+/-
Y	Natural log of output (where output is the market value of the total output for the farming season). Thus, this variable can also be referred to as farm income.	N/A
CF	Contract Farming (Dummy, 1 for contract farmer, 0 Non-contract farmer)	+/-
x_1	Natural log of farm size measured in hectares	+/-
x_2	Natural log of labour (measured in number of farm hands)	+
x_3	Natural log of fertilizer (measured in total amount in Ghana Cedis)	+
x_4	Natural log of seed (measured in quantity of seed used in kg)	+
x_5	Extension service (Measured in number of visits)	+
x_6	Education (measured in of years in sch)	+/-
x_7	Natural log of Pesticides (measured in total amount in Ghana cedis)	+/-
x_8	House hold size (No. of people engaged in soybean production	

+ means the variable has a positive effect on the dependent variables and – means it has a negative effect.

RESULTS AND DISCUSSION

Descriptive statistics

Several farm, household and socioeconomic characteristics have been found to drive farmers' CF participation decisions (Eaton and Shepherd, 2014; Bogetoft and Olesen, 2002; Masakure and Henson, 2005; Saenger et al., 2013; Schipmann and Qaim, 2011; Prowse 2012). To address the first objective of identifying factors influencing soybean farmers' adoption of CF arrangements, the following variables were utilized: farm size (hectares), sex, crop diversification, education, farm-market-distance, experience, extension services, off-farm business, age, and credit access. With the sample bifurcated into contract and non-contract farmers, descriptive statistics and t-tests comparing mean values were conducted. Table 2 presents summary statistics for key model variables, indicating the distribution across contract and non-contract soybean producers. Significant differences emerged between the two groups in terms of farm size, respondent education level, distance from farm to nearest market, soybean cultivation experience, and extension service access. The data indicates that contract farmers had larger average farm sizes (2.2 ha) compared to non-contract farmers (1.8 ha). Educational attainment also differed notably - contracted soybean farmers attained approximately 4 years of formal schooling versus 3 years among non-contracted counterparts. This suggests generally low formal education levels, as a complete basic education in Ghana entails only 4 years schooling (including Arabic education). Indeed, Ghana Statistical Service (2014) figures show the Northern Region underperforms on education, with just 55.7% of 15-year-olds ever having attended school compared to 85.3% nationally. Average travel distance from farm to market was slightly higher for contract (12 km) than non-contract (10 km) soybean growers. Non-contract farmers had approximately 6 years average soybean farming experience - on par with contract growers - although focus groups suggested that familiarity with soybean cultivation deters some more seasoned growers from perceiving a need for CF. Just 5% of non-contracted farmers accessed extension services, compared to 52% of contractees. Ghana's agricultural extension system is generally weak, attributed in part to insufficient government investment, with a national ratio of 1 extension worker per 3000 farmers (Ghana Statistical Service, 2014). Automatic deployment of new graduates from agriculture colleges is also lacking. The findings overall indicate significant educational disadvantages and extension service gaps for non- contract smallholder soybean producers in Ghana's Northern Region. Addressing these structural **constraints** could promote more inclusive agricultural transformation.

Table 2. Summary of variables used for the analysis.

Variable	Non-contract farmers		Contract farmers		Pooled		t-test value
	Mean	SD	Mean	SD	Mean	SD	
Farm size (hectares)	1.855	3.620	2.230	1.054	2.057	1.021	-2.661***
Crop diversification	2.919	8.541	3.060	4.257	2.995	1.254	-1.277
Education	3.450	5.142	4.034	5.051	4.103	2.581	-2.839***
Farm– market-distance	10.174	8.164	12.445	8.212	11.401	6.001	-3.343***
Experience	5.953	2.651	5.639	3.895	5.783	2.870	1.147
Extension	0.052	0.501	0.528	0.023	0.147	0.014	-4.912***
Off-farm business	0.081	0.147	0.218	0.042	0.155	0.042	-3.689***
Age	38.762	11.920	40.446	42.124	39.671	35.147	-1.405
Credit	0.308	0.415	0.361	0.654	0.337	0.114	-1.085

Table 3. Maximum likelihood estimation of the determinants of soybean contract farming.

Variable	Coefficient	Std. Err.	Z	Marginal effects	Std. Err.
Sex	0.131**	0.348	0.38	0.013**	0.102
Age	-0.006	0.014	-0.44	-0.001	0.001
Education	0.023**	0.090	0.24	0.316**	0.100
Experience	-0.048***	0.677	-0.71	-0.005***	0.012
Crop diversification	-0.065	0.214	-0.30	-0.006	0.032
Off-farm business	0.125	0.656	0.22	0.012	0.012
Farm size	0.137*	0.186	0.74.	0.013*	0.023
Production credit	-0.603*	1.804	-0.33	-0.059*	0.011
Extension	0.366***	0.584	063	0.036***	0.053
Distance; farm to market	0.054**	0.020	2.67	0.005**	0.003
Credit_residual	-0.747	1.232	-0.61	-0.075	
Extension_residual	-0.072	0116	-0.63	-0.036	
Constant	-2.005***	1.235.	-1.62		
Number of obs.				374	
LR chi2(11)				382.15***	
Prob > chi2				0.0000	
Log likelihood				-66.09	
Pseudo R2				0.7405	

***, **, and * denote a 1, 5, and 10% level of significance, respectively. Sexes, education, farm size, access to agricultural extension service and distance from farm to market center were found to have a positive and significant effect on soybean CF participation in the study. Similarly, the study discovered that soybean production experience and credit access had a negative and significant effect.

Determinants of CF among soybean producers

The probit model was estimated to study socioeconomic factors impacting farmers' participation in soybean CF in the Northern Region. Table 3 summarizes the findings. The LR chi-square of 382.15 is statistically significant at 1% and shows that the selected explanatory variables in the model contribute to explaining the variation in the probability of participation in CF. In other words, the explanatory variables in the probit model together explain the probability of CF participation. The variables *credit access and extension service* were considered potentially endogenous because they are part of the terms of the contract with the firms. The Wooldridge's (2015) control function approach was used to address the potential endogeneity of access to credit and extension service in this context. In the control function approach, the credit and extension variables are expressed as function of the rest of the variables together with an instrument. The generalized residual in the auxiliary probit regression is retrieved. The *credit* and *extension* variables and their residuals are then included as explanatory variables in the probit model. The variable *Land tenure* was used as an instrument in the first-stage regression. The validity of the instrument was tested using a simple falsification test by Di Falco (2014). The results of the endogeneity test are shown in the appendix. Marginal effects were also estimated after the regression of the probit model. The marginal effects help to explain the coefficients of the explanatory variables as probability value.

The insignificance of the estimates of the residuals credit-residual and extension residual indicates an absence of simultaneity bias, and consistent estimation of the credit access and extension variables (Wooldridge, 2015). To begin with, sex of respondents has a positive link to participation in soybean CF and it is significant at 5% level. It implies that males were more likely than females to engage in CF. In the research area, men had access to resources and control. Men also have more access to information in the study area than women, which allows them to look for ways to boost productivity. This is consistent with the findings of Zoundji et al. (2015) which concluded that, soybean cultivation is dominated by males. Saïdou et al. (2007) argued that males are normally landowners; they also inherit land from their parents much more than their female counterparts. The small number of females involved in soybean cultivation accessed land from their husbands, relatives, borrowed or lease.

The likelihood of farmers participating in soybean CF was shown to be positively correlated with their educational attainment. It was also strongly and statistically significant at the 1% level. The implication is that adding one year to a farmer's education enhances his or her chances of participating in soybean CF by 31.6%. This is not a mirage since educational attainment enhances farmers’ ability to seek more information on agricultural production techniques as well as exploring other marketing channels to increase profit margin. Also, farmers who attend school are also equipped with planning and record keeping skills as well as adopting storage techniques to reduce post-harvest losses.

Furthermore, soybean farming experience was found to have a negative impact on soybean CF participation, which was significant at the 1% level. This means that as a farmer's years of soybean cultivation increase by one year, the likelihood of him or her participating in CF decreases by 5.4%. At the 10% level, the marginal effect of respondents' farm size was also positive and marginally significant. This means that whenever a farmer's average farm size increases by 1ha his or her likelihood of participating in soybean CF improves by 1.3%. This is in conformity with our a *priori* expectation. Farmers with huge farm sizes are anticipated to join in the soybean CF to get the help they need for their farming businesses.

It was discovered that the availability of production credit has a negative and significant impact on soybean CF. Farmers with access to production credit were less likely to participate into CF, as evidenced by the negative marginal effect of production credit access. This suggests that farmers with access to production credit are 6% less likely to enter into CF. The implication is that, with an access to production credit (cash or kind) from other sources, a farmer will not be motivated to join CF again since joining the scheme will only increase his/her indebtedness. This finding is consistent with Saigenji (2010), who found an inverse relationship between credit access and CF participation amongst tea farmers in Vietnam.

Access to agricultural extension services was determined to have a positive marginal effect (0.036), which is highly significant at the 1% level. This means that people who have access to extension services have almost 4% higher chance of going into CF than those who do not. The positive significance of extension services in determining farmer's years of soybean cultivation increase by one year, farmer decisions to participate in programmes have been well discussed in literature (Doss and Morris, 2001; Ransom et al., 2003).

Having access to extension services enhances a farmer's chances of engaging in soybean CF by roughly 4%, according to this study. Farmers who had access to agricultural extension officers had a higher likelihood of participating in CF than those who did not. The distance from the farm to the market shows a positive marginal effect (0.005) and is statistically significant at the 5% level. The result is that if a farmer's walking distance from farm to market center increases by 1 km his or her chances of contracting increases by 0.5%. Distance farmers cover to market centers play a greater role in participating in CF. If a farmer’s distance from farm to market center is longer, it increases his/her transportation cost, thereby increasing his production costs hence the need to contract to cushion him/her.

Effects of contract farming on farm income

Table 4 shows the second stage result of the treatment effect model. The table presents the maximum likelihood estimates of the output equation. In other words, the model explained factors influencing smallholder soybean farmers’ income. CF had a positive effect on income as expected and significant at 1%, as shown on Table 4. This finding collaborates with many other findings (Little and Watts, 1994; Key and Runsten, 1999; Singh, 2002; Warning and Key, 2002; Miyata et al., 2009). It however contradicts the findings of Abdulai and Al-hassan (2016) who had CF having a negative effect on income. The positive coefficient of the contract variable also indicates that, on average, contract farmers earned more than non-contracting farmers. Contractors, as previously said, provide credit to farmers in the form of inputs as part of their contractual agreements to assist them in the production processes. The farmers would then repay these contractors in kind or sell all of their output to them. These agreements make scarce inputs or resources available to farmers, such as improved seeds and fertilizers etc. resulting in high yields. Wang et al. (2014)

Table 4. Maximum likelihood estimation results of the income model.

Variable	Coefficient	Standard error
CF	0.2136***	0.0299
x_1(Farm size)	0.0494*	0.0402
x_2 (Labour)	-0.086***	0.041
x_3 (Fertilizer)	0.237**	0.032
x_4 (Seed)	0.1050	0.2092
x_5(Extension)	0.254	0.017
x_6(Education)	0.0149*	0.2990
x_7(Pesticides)	0.0422*	0.1794
x_8(House hold size)	0.1226***	0.0437
Constant	1.1647	0.2270

Farm size corresponds to our a priori expectation because it has a positive effect on income. This means that increasing the area under cultivation by one acre will result in a 10% increase in income. This is consistent with a large number of studies, including Arumugam et al. (2011), Wang et al. (2011), Bellemare (2012), Freguin-Gresh (2012), Hu (2012), and Wang et al. (2013). Similarly, the cost of labour, which is the cost of hiring labour for soybean production is notably negative, suggesting that adding one worker to the labour force reduces income by percentage. Many persons involved in the production process may result in role duplication, especially when diminishing returns set in; this may lead to a rise in production costs, resulting in lesser income. A 100% increase in fertilizer usage resulted in a 24% increase in farm income. This finding is consistent with that of Abdulai et al. (2013) and Bruce et al. (2014). Ainika et al. (2012) study, on the other hand, emphasizes the importance of having an organic - inorganic fertilizer mix for improved output.

The farmer's level of education has a positive effect on his or her income in CF, but only at the 10% level. The results reveal that increasing the number of years of education by one year increases the farmer's income by 1%. The cost of pesticides is significantly positive, implying that a farmer who invests in an additional bottle of pesticide to combat diseases and pests on his or her farm will see a 4% increase in income. Also, household size is positive and significant; its coefficient is 0.12, implying that increasing household size by one person providing labor for soybean production increases income by 12%. This also implies that the larger the household size, the greater the potential income from soybean cultivation. This can be linked to more active farm members, as it shows a decrease in the quantity of hired labour employed by the household.

Conclusion

This study investigated the factors influencing soybean farmers' participation in Contract Farming (CF) and whether such participation leads to higher farm incomes in the Eastern Corridor of the Northern Region of Ghana. The findings revealed that participation in CF is influenced by the respondent's gender, education, farm size, access to agricultural extension services, distance from the farm to the market center, soybean production experience, and access to credit. Additionally, farm income was significantly and positively influenced by participation in CF, farm size, fertilizer usage, education, pesticide application, and household size. Conversely, labor had a negative effect on income.

Recommendations

The study revealed a positive correlation between CF participation and farm income we therefore recommend that, the government should create an enabling environment and establish supportive regulations to facilitate CF partnerships between NGOs, private sector companies and smallholder farmers. This includes measures such as improving infrastructure, designing policies and programs to upgrade farmer skills, ensuring clear contractual guidelines, and providing access to credit for CF sponsors. Fostering public-private collaboration is key to unlocking the potential of CF to drive agricultural commercialization and rural economic growth in a sustainable and socially responsible manner.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Appendix. First-stage regression results of determinants of credit access and extension.

Variable	Credit	Extension
Sex|	-0.238 (0.165)	-0.146 (0.156)
Household size	-0.005 (0.019)	-0.037* (0.174)
Age	0.010 (0.007)	0.012 (0.121)
Experience	-0.071* (0.029)	-0.006 (0.033)
Crop diversification	0.287*** (0.082)	0.101 (0.124)
Off farm activity	0.746* (0.221)	0.515 (0.331)
Farm size	0.133 (0.147)	0.127 (0.160)
Education	0.316*(0.161)	0.094 (0232)
Training |	0.990**(0.424)	0.732* (0.744)
_cons |	-1.510**(0.347)	-0.241 (0.569)

***, **,* represent 1, 5, and 10% significance level, respectively. Values in parentheses are standard errors