Examining the determinants and effects of Contract Farming on Farm Income in the Northern Region of Ghana

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Abstract

The study sought to determine the factors that influence farmers' decision to participate in contract farming as well as the effect of contract farming on farm income in the Northern Region of Ghana. It involved 230 crop farmers selected through multi-stage sampling procedure. A treatment effect model was estimated to determine the factors that influenced farmers' participation in contract farming and its effect on farm income. The factors that positively influenced participation in contract farming were access to extension services and credit. However, farm size and off-farm income negatively influenced participation in contracting. In general, farmers who participated in contract farming had a higher income than their non-participating counterparts. Other factors that significantly influenced farm income positively were land, labour and fertilizers. Weedicide however impacted negatively on income, suggesting that it is being over-used. We recommend that farmers are supported to access the facilities that enable them to participate in contract farming such as credit and extension services. To increase their farm incomes, farmers also need support in increasing the levels of farm inputs such as land, labour and fertilizers. Farmers also need education on the accurate use of weedicides

Keywords: *Adoption, Contract farming, Crop output, Climate Change Coping Strategies, Northern Region, Ghana, Treatment effect model*

INTRODUCTION

Even though contract farming has been used for agricultural production for some time now, it has gained popularity in recent times. The Food and Agriculture Organisation (FAO) (2008), defined contract farming as agricultural production carried out according to an agreement between a buyer and farmers, which establishes conditions for the production and marketing of a farm produce or products. The organisation has observed that contract farming has become attractive to many farmers because the arrangement can offer them both an assured market and access to production support. Contract farming is also of interest to buyers, who seek supplies of products for sale further along the value chain or for processing. Processors constitute the main users of contracts, as the guaranteed supply enables them to maximize utilization

of their processing capacity (Charles and Shepherd, 2014). Contracts with farmers can also reduce risk from disease or weather and facilitate certification, which is being increasingly demanded by advanced markets. There are also potential benefits for national economies as contract farming leads to economies of scale, which, as Collier and Dercon (2014) argued, are bound to provide for a more dynamic agricultural sector. However, contract farming is not without problems. Farmers often complain that contracting companies often buy their produce at much lower prices than the prevailing market prices. On the other hand, the companies also complain that sometimes farmers divert inputs away from the intended purposes and also refuse to sell their produce to them (companies) contrary to what had been agreed by both parties.

Eaton and Shepherd (2011) identified five different contract farming models, namely; centralized model; nucleus estate model; multipartite model; intermediary model and informal model. Under the centralized model a company provides support to smallholder production, purchases the crop, and then processes it, closely controlling its quality. This model is used for crops such as tobacco, cotton, sugar cane, banana, tea, and rubber. Under the Nucleus Estate model, the company also manages a plantation in order to supplement smallholder production and provide minimum output for the processing plant. This approach is mainly used for tree crops such as oil palm and rubber. The Multipartite model usually involves a partnership between government bodies, private companies and farmers. At a lower level of sophistication, the Intermediary model can involve subcontracting by companies to intermediaries who have their own (informal) arrangements with farmers. Finally, the Informal model involves small and medium enterprises who make simple contracts with

farmers on a seasonal basis. Although these are usually just seasonal arrangements they are often repeated annually and usually rely for their success on the proximity of the buyer to the seller.

In the Northern Region of Ghana, the centralised and informal models of contract farming are common among crop farmers. Under the centralised model, companies such as Wienco Ghana, SAVBAN, Presbyterian Agriculture Services, BUSAKA, and Karaga Agribusiness Centres have provided and continue to provide supports to smallholder production, and then purchase the crops for onward sale to end markets that add value to these produce. This support comes in the form of inputs such as fertilizer, improved seed, herbicides and technical backstopping in good agronomic practices to produce what has come to be known as food security crops such as maize, rice, and soybeans. The farmers are assisted in groups in a form of collateralisation for these input credits to ensure accountability. Contracts are then signed by the farmers through their leadership such that their produce are sold to the companies that assisted them with their production activities. Under this legal arrangement of contracting, the farmers are assured of a stable marketing channel for their produce and acceptable economic price for their produce. This approach adopted by the companies is also said to be an informal model because simple contracts are entered into with the farmers on a seasonal basis.

Several studies, including those of Setboonsarng et al. (2008), and Cai et al. (2008), have been conducted on contract farming, many of which are listed in FAO (2008). Similarly, the Asian Development Bank Institute (ADBI) in Tokyo has conducted a series of case studies in selected Asian countries to assess the conditions for benefits to be achieved by marginal rice

farmers. Also, in Lao PDR, a study suggested that contracted farmers earned significantly higher profits than non-contracted farmers. This facilitated the transition of subsistence farmers to commercial agriculture, offering potential to reduce rural poverty (Setboonsarng et al., 2008). Furthermore, a study in Cambodia on organic rice for export assessed the effect of contract farming on farmers' performance. This suggested that younger and more educated farmers with larger families and fewer assets were more likely to join the contract. However, farmers with access to good road communications often left the contract, indicating that contract farming had helped them to develop into independent farmers (Cai et al., 2008). Lastly, Wang et al. (2014) reviewed a large number of empirical studies of contract farming. They concluded that contract farming has had a significant impact on improving farm efficiency and productivity, and farmer incomes and that this should give governments the confidence that allocation of resources to the topic of contract farming could yield positive results (Wang et al., 2014).

Given the advantages and challenges of contract farming in the Northern Region of Ghana, it is important that studies such as the ones reviewed above are carried out to investigate (empirically) the extent to which contract farming impacts on farm income. However, to the best of the authors' knowledge there has not been any econometric study to that effect, hence this study to identify the determinants of farmers' decision to go into contract farming and the effects on farm income.

MATERIALS AND METHODS

The Study Area
The Northern Region, which occupies an area of about 70,384 square kilometres is the largest region in Ghana in terms of land mass (GSS, 2014). It shares boundaries with the Upper East and the Upper West Regions to the north, the Brong Ahafo and the Volta Regions to the south, Togo to the east, and Côte d'Ivoire to the west. The land is mostly low lying except in the north-eastern corner with the Gambaga escarpment and along the western corridor. The region is drained by the Black and White Volta Rivers and their tributaries such as the Nasia and Daka rivers. The climate of the region is relatively dry, with a single rainy season that begins in May and ends in October. The amount of rainfall recorded annually varies between 750 millimetres and 1,050 millimetres. The dry season starts in November and ends in March/April with maximum temperatures occurring towards the end of the dry season (March-April) and minimum temperatures in December and January. The majority of people in the region are engaged in agriculture. Like it is nationally, a larger percentage of the farming population are small-scale farmers. The crops that they produce include yam, maize, millet, guinea corn, rice, groundnuts, beans, soya beans and cowpea. Livestock production is also very common in the region. The northern region can also boast of the presence of a relatively large number of private sector actors such Wienco Ghana, SAVBAN, Presbyterian Agriculture Services, BUSAKA and Karaga Agribusiness Centre.

Sampling Technique and Data
The selection of the respondents involved multi-stage sampling technique. In the first stage, six districts noted for their agricultural activities were purposively selected from the Northern Region of Ghana. The choice of the

districts was based on the fact that some crop farmers in the districts have had contracts arrangements with organisations to produce for them. In the second stage, stratified sampling method was used to select 2 communities in each of the selected districts, giving a total of 12 communities. Finally, twenty (20) respondents were selected from each community, using simple random sampling method. This gave a total sample size of two hundred and forty (240) respondents. However, 230 questionnaires were completed and returned for the purpose of analysis. Primary data were basically collected directly from crop farmers using semi-structured questionnaires. Interview guide was used to collect data from MoFA, and some NGOs – including BUSAKA Agribusiness Centre, RAINS, ACDEP, EPDRA Chereponi, CARE International, Tree Aid, and Presbyterian Agricultural Services, Tamale.

Analytical Framework
A treatment effect model (explained below) was estimated at two stages – first to examine the factors influencing farmers' decision to enter into contract farming, and second to determine the effect of contract farming on the income levels of crop farmers in the Northern Region of Ghana.

Theoretical Model Specification - Treatment Effect Model
One form of the Heckman Two Stage Procedure for correcting selectivity bias is the treatment effect model (Maddala, 1983). This has been used widely in programme evaluations since the selection criteria for observations in such studies are non-random. The main objective of this study was to determine the effect of contract farming on the income level of crop farmers. By implication, we were not only interested in correcting selectivity bias but also, measuring the effect of contract farming on crop value.

Consequently, the treatment effect model is adopted. Like the Heckman two stage, the treatment effect model estimates the selection equation in the first stage to obtain the predicted values of the selection variable, which is then used to generate an Inverse Mills Ratio (IMR) also known as *lambda*. Both the predicted values of the selection variable (contracting) and the IMR are then added to the outcome equation in the second stage as an additional variable. Mathematically,

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

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 $N(0, \sigma_v^2)$. β and δ are parameters to be estimated.

From Maddala (1983), this may not provide an adequate result since C_i is endogenous. Therefore, a selection equation of C_i is first estimated as:

$$C_i^* = Z_i'\gamma + u_{2i} \qquad (2)$$

Where Z_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:

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

$$(3)$$

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

$$E[X_i \mid C_i = 1] = Z_i\beta + \delta + E[u_{2i} \mid C_i = 1] \quad (4)$$

$$= Z_i\beta + \delta + \rho\sigma\lambda_i$$

Where $\lambda_i = \dfrac{\phi(-Z_i'\gamma)}{1 - \Phi(-Z_i'\gamma)}$ is the IMR

$$(5)$$

Equation 5 implies that when we estimate equation 2 without the Inverse Mills Ratio (IMR), the coefficients β and δ will be biased.

According to Maddala (1983), when income of both contract and non-contract farmers are considered then equation 1 takes the form;

$$Y_i = \beta'(\Phi_i X_i) + \delta'(\Phi_i C_i) + \sigma\phi_i + e_{2i} \quad (13)$$

where $\Phi_i \equiv \Phi(z_i'\gamma)$

Empirical Models Specification
Following the above theoretical model, the empirical model to be estimated to determine the factors influencing farmers' decision to enter into contracting and the effect on output are as follows:

$$\begin{aligned}
contract\ farming \\
= \delta_0 + \delta_1 Age + \delta_2 Sex \\
+ \delta_3 Marital\ status \\
+ \delta_4 Education \\
+ \delta_5 Off\ farm \\
+ \delta_6 Source\ of\ land \\
+ \delta_7 Extension\ service \\
+ \delta_8 Experience \\
+ \delta_9 farm\ size + u_2
\end{aligned}$$

In the second stage:

$$\begin{aligned}
Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 \\
+ \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 \\
+ u_1
\end{aligned}$$

The definitions and the *a priori* expectations of the variables are indicated in Table 1.

RESULTS
Background information of the respondents
Majority of the respondents were male, representing 73.5% of the sampled population. Also, the highest percentage of the respondents (34.8%) was aged between 30-39 years. The average age recorded was 39.7 years, which is far below the national average age of 55 years for farmers (MoFA, 2013a). From Table 2, it can be seen that 7.8% of the respondents schooled up to primary level, while 8.3% and 5% schooled up to the JHS/Middle school level and SHS levels respectively. Only 1 respondent (0.4%) had up to the tertiary level of education. Also, about 79% of the respondents had no formal education. This is above the regional figure of 54.9% (GSS, 2012). This revelation is understandable since most of the literate population of Ghana live in urban areas (GSS, 2012). Also, 29.6% of the respondents had a household size of between 11 and 15 members. This is also above the national and regional averages of 4.4 and 7.7 respectively (GSS, 2012). Again, majority of the respondents (35.6%) had over 20 years' experience in crop farming. About 70% of them were in formal groups and had access to extension services. However, only 33% of the respondents had access to research services.

Table 1: Definition of Variables and *a priori* expectations

Variable	Definition	Expected sign
Age	How old the farmer is in years	+/-
Education	Dummy (1 for received formal education, 0 otherwise)	+
Off-farm income	A measure of income from sources other than crop farming in GH₵	+
Source of land	Indicates whether the farmers' plot is rented or self-owned	+
Extension service	The number of times a farmer receives extension service in a year	+
Credit	Dummy (1 for received credit, 0 otherwise)	+/-
Farm size	Total size in acreages of a farmer's rice, maize and soybean	+
y_1	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
x_1	Natural log of farm size	+
x_2	Natural log of labour (measured in number of farm hands)	+
x_3	Natural log of inorganic fertilizer (measured in total amount in Ghana Cedis used)	+
x_4	Natural log of organic fertilizer (measured in total amount in Ghana Cedis used)	+
x_5	Natural log of seed (measured in quantity of seed used in kg)	+
x_6	Natural log of weedicide	+
Contract farming	Contract farming (dummy, 1 for contract farmer, 0 otherwise)	+

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

The Determinants of contract farming

To determine the effects of contract farming on crop output, a treatment effect model was estimated at two stages. The dependent variable in the first stage probit equation is farmers' contract farming status (Presented in Table 3). The significant variables were off-farm activities, extension service, extra credit and farm size. The insignificant variables were age, education and, land source. The Chi squared value was also significant at 5%, implying that all the variables jointly determined the dependent variable.

Table 3: Maximum likelihood estimation of the determinants of contract farming (probit)

Variable	Marginal Effect	Standard Error
Age	0.008	0.006
Education	0.027	0.019
Off-Farm	-0.525***	0.158
Land Source	0.0162	0.153
Extension	0.626***	0.172
Credit	0.266*	0.157
Farm Size	-0.013***	0.005
Constant	-0.692	0.362
Wald chi square	531***	
LR test of independent equations (rho=0): chi^2 (1) =13.93, P-value =0.0002		

* and *** indicate statistical significance at 10% and 1% respectively

The 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. The likelihood ratio (LR) test of independence shows a Chi squared value of 13.93 and is significant at 1%. This means that selectivity bias was present in the model, meaning that there were some unobserved variables that influenced both the decision to contract and output so that if we had not corrected for it the explanatory variables (especially contract farming variable) would not have measured the pure effects on the dependent variable.

Table 4: Maximum likelihood estimation results of the income model

Variable	Coefficient	Standard Error
x_1 (Farm size)	0.453***	0.076
x_2 (Labour)	0.099**	0.048
x_3 (Inorgfertilizer)	0.357***	0.072
x_4 (Org. fertilizer)	0.162**	0.078
x_5 (Seed)	0.041	0.040
x_6 (Weedicide)	-0.160**	0.074
Contract farming	0.440***	0.070
Constant	2.384	0.063

** and *** indicate statistical significance at 5% and 1% respectively

From the table, contract farming was positive as expected, and was also significant at 1%. Farm size was also positive and significant at 1%, with an estimated coefficient of 0.654. While farm size was significant at 1%, labour was significant at 5% level and also maintained its expected positive effects on output. The estimated coefficient was 0.099. Furthermore, both organic and inorganic fertilizers were significant and maintained their positive effects on crop output. Their coefficients were 0.257 and 0.162

respectively. Lastly, while seed was insignificant, weedicide was significant at 5% but had a negative sign. From the results the coefficients of the conventional inputs sum up to 0.952. This means that there is decreasing returns to crop production in the study area.

DISCUSSION
Ordinarily, well-to-do farmers are less likely to participate in contract arrangements for crop production. In the context of this study, off-farm income had the expected negative sign and was highly significant at 1%. The marginal effect means that a 1-unit decrease in off-farm income would result in 0.53 probability of a farmer going into contract farming. However, the positive marginal effect of credit means that farmers who had access to credit had a greater probability of going into contract farming. The findings show that farmers who had access to credit had about 0.3 probability of going into contract farming as opposed to those who did not have access to credit. Spio (2002) opined that agricultural finance is a major constraint that limits market access, participation and commercialization of the smallholder farmers.

The contrasting signs of the coefficient and marginal effect of off-farm activities and credit is quite surprising because our argument is that the farmer who has other sources of income may not want to participate in contract farming, given its associated difficulties such as contracting companies offering lower prices for farmers' output. However, the present results imply that even though off-farm income and credit are both extra incomes their associated factors relative to contract farming may be different. The significance of extension services in determining farmer decisions have been discussed in many studies including those of Doss and Morris (2001), and Ransom et al. (2003). By the present finding, if the number of times a farmer had access to extension service increases by one,

the probability of contract participation would increase by about 0.466. In effect, farmers who had more contacts with agricultural extension officers had a higher probability of engaging in contract farming than those who had no or less extension service contact. In a situation where the extension officer to farmer ratio is high (such as 1:1800 in Ghana) (GSS, 2012), the extension officers preferred contacting farmers that were operating in groups to contacting individual farmers. In other words, extension officers encouraged farmers to form groups which were a prerequisite to engaging in contracting farming.

The coefficient of farm size (-0.013) means that if farm size is increased by 1 unit holding all other inputs constant, the probability of a farmer participating in contract farming would reduce by 0.013unit. This did not also meet our *a priori* expectation in the sense that one would have thought that relatively large scale-farmers would have gone into contracting because they are normally commercially oriented.

Farm size negatively influenced contract farming but maintained its expected positive effects on farm income. As per the estimation results, if a farmer was to increase his/her farm holding by 100%, farm income would increase by about 65%, other things being equal. Similarly, a 100% increase in the labour supply would result in 10% increase in income. In the case of organic and inorganic fertilizers, a 100% increase in their usage resulted in about 26% and 16% increase in farm income respectively. These findings are consistent with that of Abdulai et al (2013) and Bruce et al (2014). Ainika et al.'s (2012) study however, specifically conveys the importance of having an organic – inorganic fertilizer mix for improved output.
Furthermore, the coefficient of weedicide implies that a 100% increase in the amount

spent on weedicide would result in a 16% decrease in revenue. This could mean that weedicide is over-used to the extent that output is adversely affected.

Lastly, the positive coefficient of the contract variable means that, in general, farmers who participated in contract farming had a greater income level than non-contracting farmers. As indicated earlier, contractors give credit to farmers in the form of inputs as part of their contractual arrangements to support them in the production processes. The farmers would in turn pay back in kind or sell out all their output to these contractors. These arrangements make available scarce inputs or resources such as improved seeds and fertilizers to farmers, hence resulting in good yields. Wang et al. (2014) reviewed a large number of empirical studies of contract farming and concluded that contract farming has had a significant impact on improving farm efficiency and productivity, and farmer incomes due to the resources that the farmers are assisted with.

CONCLUSION
This paper examined the determinants of contract farming as well as the effect of contract farming on the income levels of crop farmers in the Northern Region of Ghana. The probability of farmers going into contract farming was greater for the following: farmers who had access to extension services; farmers who had access to extra credit facilities; full time farmers; and small-scale farmers. Participation in contract farming led to higher farm income than non-participation. This means that notwithstanding the anecdotal evidences that contracting farmers are often cheated; contracting farming is still relevant as it has the potential of making farmers richer. Farm income was also significantly and positively influenced by contract farming,

farm size, labour and fertilizers. Weedicides however had a negative effect on income.

RECOMMENDATIONS
By way of recommendation, government must provide the favourable environment and regulation for NGOs and the private sector in general to go into contracting with farmers. At the same time farmers must be supported in the things that facilitate participation in contract farming such as access to credit and extension services so that they would participate in it. Furthermore, to increase yield the issue of land tenure that does not encourage private ownership of farmland should be looked into seriously, so that hardworking farmers can obtain enough farm plots to expand their farming activities. A re-introduction of the fertilizer subsidisation programme could also go a long way to increase farmers' access to fertilizers to enable them increase yield. Lastly there is the need for education on the use of weedicide so that they are not overused, since this could lead to low yields.

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