OUTPUT EFFECT OF ORGANIC VEGETABLE PRODUCTION IN THE NORTHERN REGION OF GHANA

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ABSTRACT

The study examines the factors influencing the adoption of organic vegetable technology and the effect of adoption on vegetable output in the Northern Region of Ghana. Farm level data on vegetable production was collected from 400 farmers, consisting of 200 adopters (organic vegetable farmers) and 200 non-adopters (conventional vegetable farmers). Descriptive statistics were used to analyse farmers' perception about the benefits and problems associated with organic vegetable production. The Treatment Effect Model was used to analyse the socioeconomic factors that influence the adoption of organic farming technology and its effect on output of the farmers. The estimation results showed that the adoption of organic farming was significantly influenced by the farmers' characteristics (such as education, membership of farmer based organisations, and knowledge of farming business), internal inputs (farmer's ability to make their own inputs, farmers' ability and resources to cultivate throughout the year and sole ownership of farm land) and some external incentives. Organic vegetable farmers had higher output than the conventional farmers. For a sustained increase in the production of organic vegetables, farmers should be supported through education and access to extension services, membership of farmers' organisations, and affiliation with agricultural research organisations.

Keywords: Conventional vegetables; Organic vegetables; Adoption; Treatment effect model; Vegetable output; Northern Ghana

INTRODUCTION

The consumption of vegetables is widely known to have several nutritional benefits for human health (Rapley and Coulson, 2005). Current disease patterns in Ghana indicate a shift towards more chronic non-communicable diseases. In view of this, the Ministry of Health has introduced the Regenerative Health Programme which advocates deliberate consumption of organically grown vegetables (Amo-Adjei and Kumi- Kyereme, 2014). Moreover, with the increasing health awareness and concerns about the use of agrochemicals and waste water in vegetable cultivation, studies suggest that there is a growing public appetite for organic produce. Studies by the Coalition for the Advancement of Organic Farming (CAOF) (2011) and Osei-Asare (2009) show that demand for some organic products far outstrips supply in Ghana.

Challenges confronting farmers include the risk of pest infestation, especially, in relation to exotic vegetables and the use of pesticides to forestall harvest and income loss (Lund *et al*., 2010; Ntow *et al*., 2006). Although documentation on the acute and chronic exposure to risks with respect to these pesticides is limited, the practice has raised concerns about the health implication on consumers. Amoah *et al.* (2006) and Probst *et al*. (2012) found that, in Ghana, vegetables are contaminated with pesticide residues exceeding regulatory standards.

Given the above challenges, it can be contended that sustainable agricultural production practices such as organic vegetable production are devoid of the use of agrochemicals and other unhealthy practices, relying solely on organic fertilisers and bio-pesticides. Thus it requires good agricultural practices which when dully followed can lead to relatively low cost of production, the production of safer vegetables and the protection of the environment. (Probst *et al*., 2012). In other words, given that the production of organic vegetables involves local inputs and practices which are familiar, less expensive and accessible to the farmers, they (farmers) would be efficient in their production, resulting in increased output to take advantage of the huge market potential, *ceteris paribus*. Conventional farming, on the other hand, involves using synthetic fertilisers and pesticides (though farmers can also use some organic fertilisers and pesticides) which may have a lot of adverse health implications. In the study area some farmers are into conventional vegetable production while others are into organic production. The questions that bother many minds are: what socioeconomic factors distinguish organic vegetable production from conventional vegetable production? And does the production of organic vegetable production mean a higher output than the production of conventional vegetables? It is important to know the factors influencing the adoption of organic vegetable production so that stakeholders would be well informed as to the angle from which to encourage and support the production of organic vegetables. Notwithstanding its advantages, very few studies on organic farming are available in West Africa (Kristiansen *et al*., 2006; Sodjinou *et al*., 2015) and Ghana (Owusu and Anifori, 2013; Probst *et al*., 2012). It is hoped that this study would add to the limited literature to help give direction for further research and policy formulation. Specifically, the study seeks to (i) investigate the factors that influence the adoption of organic vegetables and (ii) measure the effect of adoption on output.

Meaning and Production under Organic Agriculture

Owusu and Anifori, (2013) and Setboonsarng and Markandya, (2015) defined organic vegetables as those produced without agrochemicals. Organic vegetables are produced using organic fertilisers such as compost, farmyard manure, (FYM), green manure, poultry droppings, and cow dung to improve and maintain soil fertility, whereas conventional agriculture makes extensive use of agrochemicals for cultivating vegetables (Setboonsarng and Markandya, 2015). It is similar to what Liu *et al*. (2013) and Zhang *et al*. (2002) referred to as safe food and green foods respectively because they undergo an ecological sound food-producing system whereby only slight or no harmful residue of agrochemicals are found.

Ghana's main organic export commodities comprise vegetables and fruits (IFOAM and FiBL, 2010). Motivations for venturing into organic farming include its high demand in the international market, especially, Europe and US (Osei-Asare, 2009), where there is a high market premium for organic agricultural products, estimated between 9% and 40% (Owusu and Anifori, 2013). Norman (2007) and Nouhoheflin *et al*. (2004) found that organic vegetables contribute significantly to job creation, wealth, and poverty reduction in Ghana. It serves as valuable ingredients for the local food industry, particularly, restaurants and supermarkets throughout the country. Organic crop production requires a few inputs (Dabbert, 2006; Hole *et al*., 2005; Thapa and Rattanasuteerakul, 2010) and improves soil quality. Unfortunately, in Ghana, conventional agricultural products predominate instead, thereby, rendering consumers susceptible to the health hazards associated with agrochemicals and heavy metals. This situation, however, can be counteracted by promoting organic crop production and fostering technical competence in the subject.

Organic Farming in Northern Ghana

We understand from IFOAM & FiBL (2006; 2011) that about 5,453 hectares of land were under organic cultivation in Ghana in 2003. As a result of increases in demand, the figure rose to 19,132 hectares. In 2010, this further rose to 26,000 hectares (representing 0.18% of the total land in the country). According to Osei-Asare (undated) the farming practice is mainly private sector led, even though there are also large scale organic farms with or without out growers mostly funded and or managed by external partners. Similarly, not only do local entrepreneurs also rely on external funding, most of the organic produce are exported. There is a huge market potential for fresh organic vegetables in northern Ghana (CAOF, 2011). For instance, Osei-Asare (undated) found that consumers were willing to pay a maximum of 20% premium on organic products. Also, he found that whereas there were more male producers (88%) than female producers (12%) of organic produce, female consumers (75%) outstripped male consumers (25%). Similarly, while the educational backgrounds of the respondents were generally low, that of the consumers were a bit higher. The sample size of Osei Asare's (undated) study was however, only 200 across 8 out of the 10 regions of Ghana.

Although most organic farms in northern Ghana are on small scale, they play significant roles in economic activities contributing to the livelihood of people, especially, farmers. Organic farming is confronted with several challenges including the non-availability of exclusive market for organic produce, the absence of premium price in the local market, not creating national recognition for organic produce, and a vague policy direction of the organic farming sub-sector. To address these challenges, there is the need to have a strong Organic Producer and Consumer Network or a coalition that will champion the course of organic agriculture. In 2007, CAOF was formed by a number of civil society organisations (CSOs) and individual organic farmers from the Northern and Upper East Regions of Ghana. The coalition's aim was to advocate the identification, development, and promotion of best organic/conservation practices as alternatives to agrochemicals in agricultural production (CAOF, 2011). The available information suggest that organic farming can have a positive impact on farmers' income. However, there is paucity of empirical evidence on its effect on the output of smallholder organic vegetable farmers in Ghana.

METHOD OF ANALYSIS

Literature Review

Considering the specific objectives of the study as indicated above, it is important that in this section we review briefly the theoretical frameworks of adoption and impact assessment. We begin with the theories of adoption and diffusion of agricultural innovations and latter impact assessment.

Theories of Adoption and Diffusion of Agricultural Innovations

The production of organic vegetables may be considered as not completely new given that our forefathers started with it until the adoption of modern or exotic technologies. However, the negative effects of the latter have meant that farmers are being encouraged and supported to go back to what they were doing before. Modern organic production is quite different from the traditional one because the technologies/ practices under the former are the improved form of the ones used under the latter. Hence the need to examine the concepts of diffusion and adoption.

Diffusion of innovations theory offers a means to evaluate farmers' decision to adopt organic cultivation. Diffusion is seen as 'the process by which an innovation is communicated through certain channels over time and among members of a social system' (Rogers, 1995). Feder and Umali (1993) expound adoption as the acceptance or use of an innovation by an individual whereas diffusion refers to a large scale adoption of the innovation by many individuals. For decades, researchers (Doss, 2006; Lee, 2005) have tried to explain agricultural technology adoption. In simple terms, adoption is the extent to which new technologies or innovations are used. Rogers (2003) defined innovation as any idea, practice, or object that is perceived as new to a potential adopter. The decision as to adopt a new technology depends on a careful evaluation of several technical, economic and social factors. Rogers (2003) and Lee (2005) further explained that adoption or non-adoption of an innovation is a decision made by an individual or group.

Some farmers perceive organic vegetable production as a new concept in farming. Ćifrić (2003) cited in Simin and Janković (2014) argued that ecological (or organic) agriculture has existed as a practice in a traditional peasant society. Nonetheless, organic agriculture is a modern agricultural practice based on up-to-date scientific knowledge integrated into the indigenous knowledge of local farming practices and circumstances. Although many of the practices involved in organic farming (manure application, crop rotation, and cultural control of insects) are not new to agriculture, organic farming is an innovation because it represents a complex system of change to most conventional agricultural producers (Padel, 2001). Hoffman and Kassouf (2005) opine that a re-invention of an already existing product is an innovation. Compost, for instance, can be considered as an innovation. This is because organic farming involves the implementation and commitment to certain production standards which may be new to potential adopters. For this reason, organic farming can be described using the concept of adoption.

Another widely-used diffusion theory propounded by Rogers (1995) is the Rate of Adoption. This theory states that innovations are diffused over time in a pattern that depicts an S-shaped curve when plotted over a period (Rogers, 1995). Bonabana-Wabbi (2002) offers an alternative definition for the rate of adoption. According to Bonabana-Wabbi (2002), the rate of adoption is the relative speed at which an innovation is used continuously and extensively by members of a society. Therefore, innovation goes through a period of slow or gradual growth before experiencing a period of relatively dramatic and rapid growth. The theory further states that, following the period of rapid growth, the rate of innovation adoption will gradually stabilise and eventually decline.

Theoretical Framework and Estimation Technique

The objective of examining the factors that influence organic farming among vegetable producers is drawn from the theory of utility maximization and for that matter, the random utility theory. Numerous reasons exist as to why the adoption of organic vegetable production may influence outcomes such as output. However, it is difficult to attribute the observed difference in the outcomes of adopters and non-adopters solely to the adoption of the technology. This introduces a sample selection bias into the process. The standard approaches for dealing with the problems of self-selection are the Heckman selection–correction approach (Heckman, 1979).

A farmer's decision to grow or not grow organic vegetables falls under the framework of choice modelling. Usually, the concept of choice is studied using the utility maximisation framework. In the production decision making process, the vegetable farmer is assumed to be a rational being with an economic objective. Given a choice among two alternative activities, such as organic and conventional vegetable production, the rational producer aims at choosing the option that yields the maximum benefit, referred to as utility. Therefore, to examine the factors that influence organic vegetable production will require the concept of utility maximisation.

Thus, a farmer is likely to produce organic vegetable if the expected utility $(\mathrm{E}(\mathrm{U_{i1}}))$ of organic production is higher than producing an alternative, a conventional vegetable, $\mathrm{E}(\mathrm{U_{i0}})$, [i.e. $\mathrm{E}(\mathrm{U_{i1}}) \geq \mathrm{E}(\mathrm{U_{i0}})$]. Because there are errors in optimisation and perception, the utility function is assumed to be random (McFadden, 1974). Note that the producer's utility is not observed and therefore it is treated as random. Therefore, what is done is to assign one (1) if a producer produces organic vegetables and assign zero) if otherwise (Greene 2008).

Thus, in the context of making a decision to produce organic vegetables, the linear random utility function may be expressed as

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (1)$$

where U_{ij} is the utility of the farmer *i* in choosing an alternative j, V_{ij} is the systematic component of U, relating to the utility of producing organically ($j = 1$) and not producing ($j = 0$), and ε_{ij} is the random error. V_{ij} becomes the explanatory part of the variance in the alternative chosen, which is used to explain and predict farmers' choices and a vector of individual farmer attributes. V_{ij} can be expressed as a linear function of *n* characteristics for a specific alternative as follows:

$$V_{ij} = \beta_1 \chi_1 + \beta_2 \chi_2 ...... + \beta_n \chi_n \qquad (2)$$

where x_n is a vector of variables representing the characteristics of the decision maker in choosing an alternative j, and β'*s* are unknown parameters associated with the characteristics. The fundamental assumption is that, an individual farmer *i* will choose an alternative *j* over another alternative *k* if only the expected utility associated with *j* is greater than the expected utility from alternative *k*, given *j*, *k* ∈ *C* where *C is* the set of alternatives, called the choice set and written as

$$U_{ij} > U_{ik} \text{ for all } j \neq k \qquad (3)$$

Substituting equation (1) into (3) and expanding yields equation (4) as follows

$$V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik} \qquad (4)$$

Rearranging equation (4) into observable and unobservable (random) components gives:

$$V_{ij} - V_{ik} > \varepsilon_{ik} - \varepsilon_{ij} \qquad (5)$$

The left-hand side of the inequality is comparing the expected levels of utility or profit of the two options. The right-hand side compares the error terms. However, in practice, it is difficult to observe$(\varepsilon_{ik} - \varepsilon_{ij})$, and hence, one cannot determine whether $V_{ij} - V_{ik} > \varepsilon_{ik} - \varepsilon_{ij}$. Since the true utility function cannot be observed, the probabilistic utility function is often used in the estimation process. Hence, the probability of choosing alternative *j* (that is if the farmer decides to produce organic vegetables) follows Verbeek (2004), given by:

$$P_r(j) = P_r(A_i = 1) = P_r(V_{ij} > V_{ik})$$

$$P_r(j) = P_r(V_{ij} - V_{ik} > \varepsilon_{ik} - \varepsilon_{ij})$$

$$P_r(j|C) = P_r(V_{ij} - V_{ik} > \varepsilon_{ik} - \varepsilon_{ij}) \qquad \forall j \neq k \in C \qquad (6)$$

In this study, there are two categories of producers: those producing organic vegetables and those producing conventional vegetables. It is assumed that those that produce organic vegetables maximise their expected utility. On the other hand, those that are not producing organic vegetables have inherent reasons behind their choice, such as not having the resources to produce the organic fertilisers necessary for organic production.

From equation (6), the probability of choosing alternative k (producing conventional vegetables) can be derived by

$$P_r(k) = 1 - P_r(j) \tag{7}$$

Utility models are obtained by specifying a probability distribution of the two disturbances $\varepsilon_i = (\varepsilon_{ik} - \varepsilon_{ij})$. The two most commonly used forms are the normal distribution and logistic distribution. If the disturbance (ε_i) is identically and independently distributed as a Weibull distribution, then this follows the logistic distribution, resulting in the logit model (Maddala, 1983). If it is assumed that the disturbances (ε_i) are independently and identically distributed normally, then their difference $(\varepsilon_{ik} - \varepsilon_{ij} = \varepsilon_i = u)$ will also be normally distributed and the probit transformation can be used to model farmers' decision to produce organic vegetables. Both models have symmetric and bell-shaped densities, although the logistic density has heavier tails than the standard normal. The logit and probit models are both used for analysing dichotomous choice models (Greene, 2008) and since the distributions are similar, the results derived using the two models are quite similar, making it difficult to make a choice between the probit and logit on theoretical bases (see Hill, *et al.*, 2008; Stock and Watson, 2007). Thus, the probability that a given farmer is an adopter of organic vegetable production is given as

$$P_r\,(j) = P_r(A_i = 1) \;=\; F(\beta_j{}'X_j) \tag{8}$$

where A_i is a binary variable representing adoption of organic vegetable farming F (•) denotes the cumulative normal distribution, P_r the probability, β, a coefficient estimate, and X, a vector of explanatory variables. The parameters in the above equation (8) are estimated by maximum likelihood methods. This is because the dichotomous dependent variable in the probit regression (8) cannot predict a numerical value and violates the assumptions of homoscedasticity, linearity, and normality. As a result, the use of ordinary least squares (OLS) estimates for the best fit approach of minimising the sum of squared distances is inefficient (Maddala, 1983). The likelihood function for the model is given as:

$$L = \prod_{A_i=1} P_r \prod_{A_i=0} (1 - P_r) \quad \text{(Maddala, 1983)} \tag{9}$$

The goal of this research is to examine the effect of organic farming adoption on farmers' output. To determine this, the impact assessment theory has been used. The concepts and the varieties of impact assessment are described in the next section.

Theoretical Framework for Impact Assessment

Many reasons exist as to why the adoption of agricultural technology may influence outcomes such as output. However, it may be difficult to attribute the observed difference in the outcomes of adopters (organic vegetable farmer) and non-adopters (conventional vegetable farmer) solely to the adoption of the technology. Preferably, experimental data gathered through randomisation would provide information on the counterfactual situation that would solve the problem of causal inference. Since this is not the case, any attempt to attribute specific outcomes to specific agricultural technology interventions faces the fundamental problem of missing data (Blundell and Costa Dias, 2000). Consequently, many researchers are compelled to resort to drawing conclusions on the direct effects of technology adoption using the difference in outcomes across the farm households. Meanwhile, producers make adoption decision themselves; hence randomisation requirement is not fulfilled. In this case, estimation processes that does not account for self-selection may lead to biased results.

The standard approaches for dealing with the problem of self-selection are the two-step Heckman treatment model, the instrumental variable (IV), randomised designs, the double difference estimator, propensity score matching, regression discontinuity, and pipeline methods (Heckman and Vytlacil, 2007; Imbens and Wooldridge, 2009). In this study, Heckman's sample selection procedure was adopted to estimate the effects of organic farming adoption on output of vegetable producers in the study area. The choice of Heckman's estimation for this study was motivated by the fact that it is a more suitable approach that corrects self-selection and accounts for simultaneity problems.

Sample Selection Bias

Sample selection bias arises when a selection process influences the availability of data, and that process is related to the dependent variable. Sample selection induces correlation between one or more regressors and the error term, leading to bias and inconsistency of the estimator. Barnow *et al.* (1980) noted that selectivity bias arises in programme evaluation when the control (or treatment) status of the subjects is related to unobservable or unmeasured characteristics that are themselves related to the programme outcome under study. Researchers define the term 'bias' as potential mis-estimation of an effect of a treatment or programme on an outcome. In this study, sample selectivity bias can arise when organic vegetable production is related to unmeasured or unobservable characteristics like farmers' competence, managerial skills, and entrepreneurial skills which may affect organic vegetable production, but correlate with output.

Several studies (Breen, 1996; Winship and Mare, 1992) have explicated sample selection bias. According to them, there are basically two versions of the selection bias problem. The first one is when information on the dependent variable for part of the respondents is missing, and the other is when information on the dependent variable is available for all respondents. However, the common method of the sample selection that is linked to this research is where information on the dependent variable is available for all respondents, but the distribution of respondents over categories of the independent variable of interest has taken place in a selective way.

If an ordinary least squares (OLS) model is used to estimate the effect of organic farming on vegetable output as given below;

$$Y_i = \gamma X_i + \delta D_i + \varepsilon_2 \qquad (10)$$

where Y_i is annual vegetable output, D_i is a dummy (1 = organic vegetable farming; 0 = conventional vegetable production), X_i is vector of farm inputs, γ and δ are vectors of parameters to be estimated, and ε_2 are the error terms with *N* (0, σ^2v).

The effect of adoption on the outcome (vegetable output) variable is e measured by the estimates of the parameter δ. However, if δ is to accurately measure the effect of organic farming adoption on vegetable output, then farmers should be randomly assigned to organic vegetable farming (adoption) or conventional vegetable farming (non-adoption) (Faltermeier and Abdulai, 2009; Kassie *et al*., 2011). Furthermore, the farmers themselves decide (self-selection) whether to adopt organic vegetable farming, and thus, the adoption decision is likely influenced by unobservable characteristics that may be correlated with the outcome of interest (such as annual vegetable output). For example, if organic farmers tend to be more industrious or more skilful than non-organic vegetable farmers, they would have higher vegetable output regardless of whether they participated in organic vegetable farming. In this case, the coefficient on the participation dummy variable would include the effect of these unobservable characteristics in addition to the effect of organic farming, thus overestimating the effect of organic vegetable farming. Therefore, if unobservable characteristics are correlated with either dependent variables or error terms (of annual vegetable output), then, the estimation of Equation (10) does not account for this self-selection and may lead to biased results. This selection bias can be accounted for by assuming a joint normal error distribution with the form:

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

and by recognising that the expected output of choosing organic vegetable production, is given as:

$$E\ [Y_i|A_i\ = 1] = \ Z_i\beta + \delta + E[\varepsilon_{2i}|A_i = 1] \qquad = \ Z_i\beta + \delta + \rho\sigma\lambda_i \tag{12}$$

where

$$\lambda_i = \frac{\emptyset(\rho + x_i'\beta)}{\Phi\,(\rho + x_i'\beta)} \tag{13}$$

And ∅ and Φ are the density functions of a standard normal and cumulative distribution function of a standard normal distribution respectively. Inverse Mills Ratio (IMR) is denoted by a symbol λ and describes the ratio of the ordinate of a standard normal to the tail area of the distribution (Greene, 2003). If λ_i is not statistically significant, then sample selection bias is not a problem (Heckman, 1979, 1980). If the finding of λ_i is statistically significant in the vegetable output equation, then, this would suggest that an important difference exists between the farmers that adopted organic vegetable farming and those that did not adopt. This difference needs to be taken into consideration in estimating the equations. Also, equation (12) implies that in estimating equation (10) without the IMR, the coefficients β and δ will be biased. Hence, the standard approach for dealing with the problem of self-selection is the treatment effects model (also called the Heckman selection–correction model).

The Treatment Effect Model

Heckman's sample selection procedure controls for the self-selection that normally arises when technology adoption is not randomly assigned and self-selection into adoption occurs. According to literature, (Awotide *et al.*, 2016; Siziba *et al.*, 2011), Heckman correction model is commonly used to account for this bias. This method involves, first, the estimation of the selection equation which uses the probit model (which are the factors that influence the adoption of organic farming among vegetable producers; equation (8)) and second, the estimation of the substantive equations (in this case vegetable output equation (10).

As mentioned above, the idea behind the Heckman's sample selection procedure is to estimate a probit model and use the predicted values of organic vegetable production to calculate the IMR. The IMR is then included in the vegetable output model as an additional explanatory variable. The treatment effect model is a special case in which the adoption variable appears as an additional explanatory variable. The treatment model also offers the opportunity to the researcher to estimate the adoption and output equations simultaneously. This computation corrects possible selection bias and yields unbiased and consistent estimates in the output model. Consequently, according to Maddala (1983), equation (10) takes the form;

$$lnY_i = \beta'(\Phi_i \, lnZ_i) + \delta\left(\Phi_i A_i\right) + \sigma\emptyset_i + \varepsilon_{2i} \quad (14)$$

where $\Phi_i \equiv \Phi(w_i\gamma)$, δ measures the effect of organic farming on the natural logarithm of vegetable output Y_i; ε_{2i} is also two-sided error terms. X_i is a vector of independent variables affecting vegetable output, A_i is a binary variable representing adoption of organic vegetable farming, γ, δ, and β are parameters to be estimated.

Empirical Model

The empirical model for estimating factors influencing organic vegetable production decision is given as

$$A_i = \beta_o + \beta_1 AGE + \beta_2 HSIZE + \beta_3 EDU + \beta_4 FEXP + \beta_5 FSIZE + \beta_6 AECS + \beta_7 OFFACT + \beta_8 EXT + \beta_9 FBO + \beta_{10} TRAIN + \beta_{11} AMOI + \beta_{12} ARCAY + \beta_{13} LOWN + \varepsilon_1 \quad (15)$$

where: A_i is the 0-1 outcome with 1 corresponding to farmers who produced vegetable under organic production methods for the period of 3 years and above and 0 relating to farmers who produced vegetable using conventional method. $\beta_1 - \beta_{13}$ are the parameters to be estimated, and ε_1 is the error term which is assumed to follow a standard normal distribution with mean zero and variance 1.

The second stage (outcome equation), which assesses the effect of organic farming on vegetable output is estimated empirically as

$$Y_i = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \partial_i A + \varepsilon_1 \quad (16)$$

where Y_i is vegetable output, X_i represents the inputs used in producing the vegetables, A_i is a binary variable and represents the adoption of organic farming variable, α is a parameter estimates for X_i and δ is a parameter estimate measuring the effect of organic farming on output. Table 1 presents a summary of the explanatory variables in the equations.

Description of the Variables and their *a priori* Expectations

The study considers a set of explanatory variables that relate to the theoretical framework in the vegetable production adoption decision as described earlier. These variables include farmers' characteristics, farm/production factors, economic factors, and institutional factors. Brief descriptions, measurement and *a priori* expectations of the explanatory variables used in the model are presented in Table 1.

TABLE 1: DESCRIPTION, MEASUREMENT AND A PRIORI EXPECTATIONS OF THE STUDY VARIABLES

Variable	Description	Measurement	Expected Sign
Dependent variable			
A_i	Adoption status	Dummy (1 = adopter of organic vegetable farming; 0 = non-adopter/ conventional vegetable farming)	
Y_i	Natural logarithm of vegetable output	Ghana Cedis	
Independent variables			
x_1	Natural logarithm of farm size	Hectares	+
x_2	Natural logarithm of labour costs	Cedis	+
x_3	Natural logarithm of fertilizer/manure cost	Cedis	+
x_4	Natural logarithm of seeds cost	Cedis	+
AGE	Age of the farmer	Years since birth	-/+
HSIZE	Number of household members	Number of people	+
EDU	Education level of the farmer	Schooling years	+/-
FSIZE	Farm size	Hectares	+-
EXT	Access to Extension service	Number of visits	+/-
ARCAY	Ability and resources to cultivates all year	1 if farmer's have the resources to crop all year	+

		around; 0 if farmers' do not have the ability and crop once a year	
AECS	Access to external credit support	Yes = 1; No = 1	+
OFFACT	Engagement in off- farm activities	Yes = 1; No = 0	+
FBO	Membership in farmer associations	Yes = 1; No = 0	+
AMOI	Ability and resource to make own inputs (organic fertilizers and pesticides)	Yes = 1; No = 0	+
LOWN	Sole owner of land	Yes = 1; No = 0	+

Study Area

The research was carried out in the Northern Region of Ghana (Figure 1). The region is the largest in the country, with an estimated land area of about 70,384 km^2 of which 75% is available for cultivation (Zibrilla and Salifu, 2004). The area has a very high agricultural prospect and high concentration of vegetable producers. Vegetable farmers in the research area grow a wide range of exotic and indigenous vegetable crops, including tomatoes, cucumbers, sweet and hot pepper, green beans, carrots, cabbages, spring onion, okra, *amaranthus*, *roselle* (bra), white jute (ayoyo), okra, among others. The climate of the region favours vegetable cultivation. The region experiences two major seasons, namely, the dry season and the wet season. The average annual temperature varies from 18^{o}C to 41^{o}C. The study area is characterised by a uni-modal rainfall pattern (April to November) with a mean rainfall of 1,100mm and a minimum of 670mm.

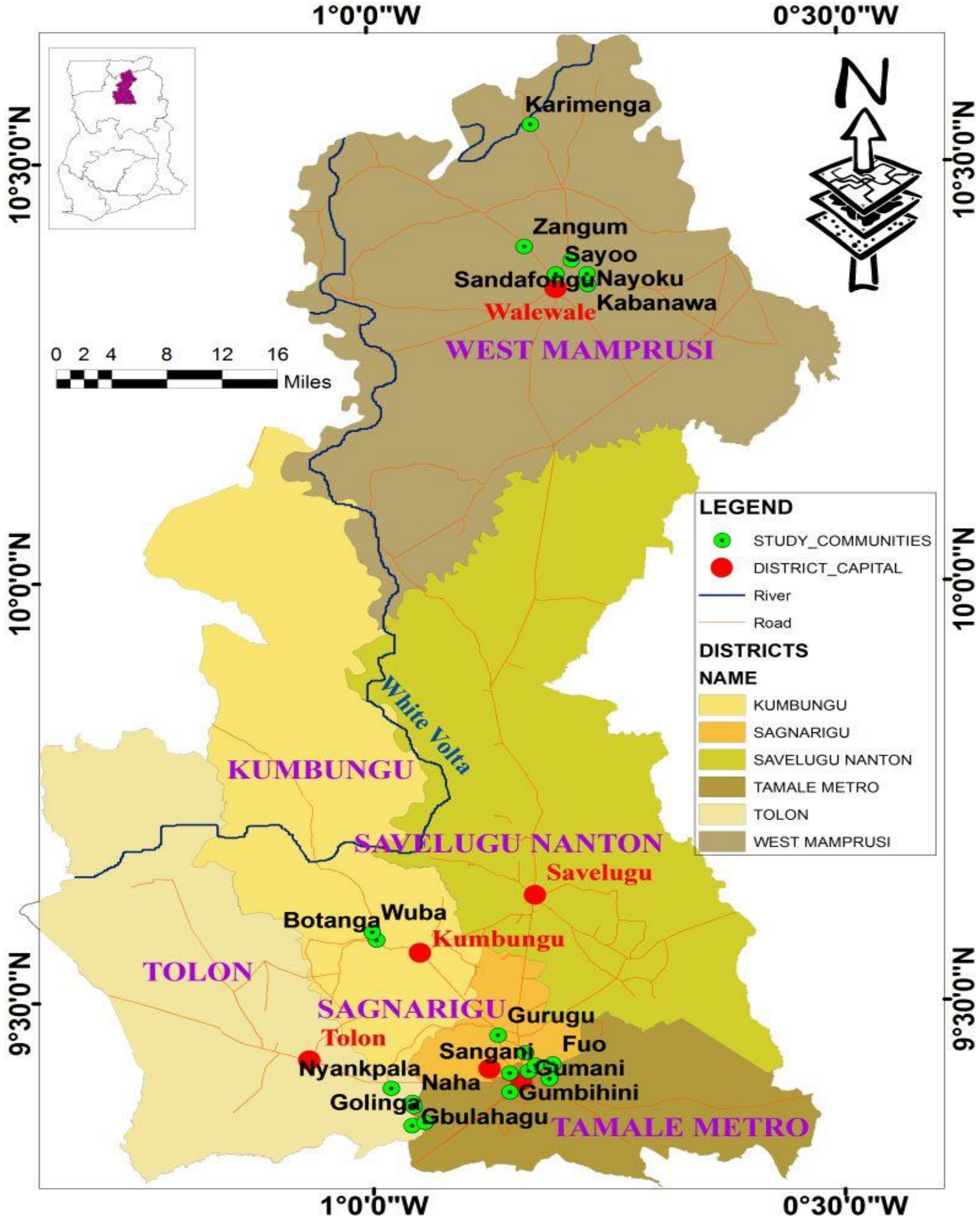

Figure 1: Map of the Northern Region showing the study area

Research Design and Data

Mainly, primary data was collected through a survey, group discussions, and key informants' interviews for the 2014/15 cropping season. Prior to the conduction of the survey, a pre-test of the questionnaire was conducted to evaluate the clarity, consistency and appropriateness of the survey questions. Based on a review of the pre-test sample, the survey questions were amended. The survey's field work lasted for a year. Both qualitative and quantitative primary data were collected from selected organic and conventional vegetable farmers. The respondents of the sampled population were interviewed using a semi-structured questionnaire, comprising both closed- and open-ended questions. The questionnaire included several categories of questions such as demographic information, information on general farming practices, and farmers' knowledge of organic farming. The questionnaire also asked for extensive information on credit access, seeds, land holding, assets, expenditure, household income sources, extension contacts, and membership with farmer based organisations. Information on average input prices was also taken from the respondents. Supplementary primary information was collected from a group discussion with the farmers and from the semi-structured interviews of three government agricultural extension agents and six officials from two NGOs.

Based on reconnaissance survey, it was observed that the farmers in the study area were cultivating several types of vegetables including cabbage, cucumber, garden eggs, carrots, green pepper, lettuce, pepper, okra, *amaranthus* (alefu), bitter leaf, onion, white jute (ayoyo), spring onion, beans leaf, and green beans. Notably, cabbage, carrots, green pepper, lettuce, cucumber, hot pepper, okra, *amaranthus*, *roselle* (bra), and white jute (ayoyo) were predominant, in terms of the farm size being cultivated.

In this study, adopters are classified as farmers who grow vegetables using only organic fertilisers and bio-pesticides, and non-adopters are those who grow vegetable using only synthetic fertilisers and pesticides or both. As the 'adoption of organic vegetables farming' is a dichotomous or binary dependent variable with the option of either 'adoption' or 'non-adoption', probit regression was the most appropriate analytical tool with which to investigate the factors determining adoption.

After obtaining the factors influencing the adoption of organic vegetable farming, the study found out whether the adoption has the potential to improve farmers' output value. Output prices were gathered from organic and conventional vegetable farms. All the vegetables produced on the sample organic and conventional vegetable farms were aggregated into one output valued in Ghana Cedis (GH¢), which was the dependent variable.

Sampling Procedure

A multi stage sampling procedure was used to select vegetable farmers for this study. In the first stage, four (4) municipal metropolitan and district assemblies (MMDAs) of the Northern Region, namely: Tamale Metropolis and, Tolon, Kumbugu and West Mamprusi districts were purposively selected in view of the high concentration of organic and conventional vegetable production in those areas. This was followed by Probability Proportion by Size (PPS) random sampling of three (3) to seven (7) communities from each MMDA, depending on the concentration of organic vegetable farmers in the MMDA. The total communities randomly selected for the study comprised of six (6) from the Tamale Metropolis, seven (7) from the West Mamprusi, four (4) from the Tolon and three (3) from the Kumbugu districts. In all, twenty (20) communities were selected for the study.

In the second stage, vegetable farmers in each selected MMDA were stratified into two, namely organic vegetable farmers (adopters) and conventional vegetable farmers (non-adopters). Prior to the conduct of the survey, a list of vegetables farmers was obtained from private organization monitoring organic farmers (NGOs), farmers and farmer groups of the MMDA. The list indicated that there were 514 farmers from the 4 MMDAs of the region that grew organic vegetables at the time of data collection. Two hundred (200) farmers were randomly selected, accounting for about 39% of the total farmers in organic vegetable farming, spreading over the 4 MMDAs of the region. The non-adopters (conventional vegetable farmers) were also distributed throughout the selected MMDAs. Two hundred (200) conventional vegetable farmers with similar characteristics were also randomly selected to match the selected organic farmers for the study. Thus, equal numbers of organic and conventional vegetables producers were randomly selected from each stratum for the study. From each selected community, 20 respondents, made up of 10 each of organic and conventional vegetable producers were randomly sampled, giving a total of 400 sample farmers in all for the interview. Considering the fact that the non-adopters were more than the adopters we admit that we could have used proportional sampling to select proportionately more non-adopters than adopters but we also felt that by picking equal samples we could do a more effective comparison of the two vegetable farming systems pertaining in the study area.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Smallholder Vegetable Farmers

The descriptive analysis of the data collected (Table 2) shows that the average ages of organic and conventional vegetable farmers were 38.2 years and 37.8 years respectively. There is no statistically significant difference between the two mean ages though. It can then be inferred that most farmers in the study area are within their prime productive agricultural age and can produce vegetables for a long time. Majority of the farmers (81%) are male; the females form 19% of the sample. The higher number of male respondents among the farmers could be the result of males having greater access to farm resources than their female counterparts. This is in sync with Amoah *et al.* (2012), who attributed the low number of female in farming to land ownership. On the whole, the mean household size was 9 people. There was no statistically significant difference in the household size between organic and conventional vegetable farmers.

About 39% of the conventional farmers had used both organic and synthetic fertilisers to grow vegetables, and are referred to as 'conventional' farmers in this study whereas organic vegetable farmers used farm yard manure (FYM), compost and crop rotation among others for cultivation. FYM was the most common type of organic fertiliser used by nearly all organic farmers; about 32.5% of the conventional farmers used FYM. Cattle, poultry, sheep and goat were the sources of the FYM. Most of the respondents obtained FYM from their own poultry pens and kraals. However, 3% of farmers buy FYM from their fellow farmers (within the study area or from Sunyani and Kumasi). Compost was the second most popular organic fertiliser used by 98.5% and 6.5% of organic and conventional farmers respectively.

The analysis reveals significant differences in the quantity and cost of organic and synthetic fertilisers between farmers who adopted organic vegetable farming and those who still produced vegetables by conventional methods. The adopters of organic farming used significantly higher quantities of organic manure than non-adopters (conventional farmers). For instance, on average, organic farmers used 2672.9 kilograms per hectare of organic manure in 2014/15 production year compared with 561.8 kilograms/hectare for the non-adopters. The disparity between the quantity of inorganic and organic fertilisers is obviously due to the differences in nitrogen levels between the inorganic and organic fertilisers. The compound fertiliser NPK (15-15-15) used by conventional farmers contains 15% nitrogen whereas most organic fertilisers, ranging from compost to poultry manure, only have between 1- 4 % nitrogen. This means that higher amounts of the organic fertilisers are required in vegetable production as compared with inorganic fertilisers to meet crop nutrient demands (Amanullah *et al*., 2010; Gao *et al.,* 2010).

TABLE 2: SOCIOECONOMIC CHARACTERISTICS OF ORGANIC AND CONVENTIONAL FARMERS: DESCRIPTIVE STATISTICS

Variable	Conventional farmer (200)	Organic farmer (200)	Total (400)	*Stati test*
Age(year)	37.81(8.44)	38.24 (8.18)	38.02(8.30)	*-0.5*
Sex (% of male)	76	87.35	81.75	*-0.8*
Household size (numbers)	8.76 (3.17)	8.79 (3.87)	8.77(3.53)	*-0.7*
Education (year)	5.13(4.57)	6.12(5.03)	5.13(4.90)	*--5.*
Vegetable farming experience (years)	16.27(9.17)	18.67 (7.57)	17.47(8.48)	--2.
Extension service (numbers of visit)	1.12 (1.64)	2.93(3.8)	2.04(3.05)	-6.0
AMOI (% of yes)	6.5	100	53.25	-148
FBO (% of yes)	22.5	35.5	29	-12.
ARCAY (% of farmers cultivating all year around)	28.5	80.5	54.5	-93.
Off-vegetable farm activity (% of Yes)	54	53.5	53.8	0.01
AECS (% of Yes)	5.5	34.5	20	63.7
Formal Training (% of Yes)	7	52	29.5	*-97.*
Sole ownership of land (% of yes)	71.5	70	70.75	0.11
Fertiliser (cedis)	232.15(93.2)	79.18(60.4)	155.67(119.2)	16.7
Inorganic Fertiliser (kg)	211.5(164.8)	0	232.15(93.2)	
Organic Fertiliser (kg)	561.8(165.3)	2672.9(1472.7)	1617.3(1487.4)	211
Farm size (hectares)	0.688 (0.38)	0.674 (0.28)	0.681(0.33)	-0.4
Seed (cedis)	8.81(4.01)	9.10 (5.30)	8.96(4.70)	*-0.6*
Labour (cedis)	232.59(14.4)	293.27(104.1)	262.93(103.2)	-6.1
Vegetable outputs (cedis)	27,144.16	37,091.66	32316.76	*-6.4*

Figures in parenthesis are standard deviations; [(a)] Statistical test: Pearson chi-square for dummies and t-test, ***, ** and * Significant at the 1, 5 and 10 percent level, respectively. ARCAY, AMOI, FBO and AECS refer to ability and resources to cultivate all year, the ability to make own inputs, farmer based organisation, and access to external credit support respectively

Source: Field survey, 2015

The results also suggest that any policy intervention that would encourage further research into the improvement in nitrogen level of organic manure can encourage an increased interest in adoption. Although organic farmers use large quantities of organic fertiliser, the annual cost associated with the use of the organic fertiliser was GH¢79.2 per 2672.9 per hectare in 2014/15. This was relatively low compared with the GH¢232.2 per 211.5kg of synthetic fertiliser used by conventional farmers.

The average cost of seeds per hectare for organic farms was higher than that of conventional farms. This is because 81% of organic farmers have the capacity and resources to grow vegetables throughout the year, as result, they incur more cost on seeds (as reported in Table 2). However, the difference between the two groups was not significant at 10% level. Labour costs (family plus hired labour) in organic farms are higher as compared with conventional farms (Table 2). This means that organic vegetable farmers use more labour than non-adopters. The analysis indicates that all the organic vegetable growers have the capacity and the resource to prepare almost all their inputs as compared with only 6.5% of conventional vegetable farmers. Membership with farmer based organisation (FBO) is more pronounced among organic vegetable farmers (17.8%) than conventional vegetable farmers (11.3%). It was also observed that organic vegetable farmers engaged in off-farm activities more than the conventional farmers.

Almost all the farmers in this study financed their farming operations through personal savings. However, approximately 20% of the sampled farmers had received agricultural credit support to finance their production. A good proportion of the organic vegetable farmers (80.5%) in the study area have the ability and resources to cultivate vegetables throughout the year as compared with 28.5% of the conventional farmers. The organic farmers attributed their ability to farm throughout the year to the presence of organic matter in the soil. According to them, the organic matter in the soil retains enough moisture to support plant growth, even in the dry season. This afforded them the opportunity to invest in simple irrigation systems that cost less while assuring them the ability to produce, even in the dry season. A significant percentage (26%) of the organic farmers received formal training on their farming businesses, compared with 3.5% of conventional vegetable growers. Similarly, 71.5% and 70% of the respective adopters and non-adopters own their farmland. This suggests that access to farmland is not a constraint to vegetable production and adoption of organic farming in the study area.

Factors Influencing Farmers' Choice of Vegetable Production

The results for the adoption model, capturing the factors affecting the probability of adopting organic vegetable farming are presented in Table 3. The diagnostics tests, such as likelihood ratio (LR) chi-square statistics, the probability of chi-square, and pseudo R-square values are also reported at the bottom of Table 3; the magnitudes indicate that the researcher's specification provides a reasonably good fit to the data.

From the result, the marginal effect of the education variable implies that a year more in school increases the probability of a farmer adopting organic vegetables by 0.02. Organic farming is relatively knowledge intensive, and thus, management skills are vital in its implementation. Beshir *et al. (*2012) and Mignouna *et al.* (2011) reported similar findings that education increases a farmer's ability to acquire and use information that encourages the adoption of technology.

Farming experience had a positive and significant influence on adoption of organic farming among vegetable producers in the study area. A year increase in farming experience tends to increase the probability of adoption by approximately 13%. This result corresponds with the findings of Afolami *et al.* (2015) and Lapple (2010) who found the years of farming experience as an important determinant in adoption. Organic farmers were more experienced because they might have tried both methods of production (organic and conventional vegetable) in the past and learnt the benefits of organic farming and the need to adopt organic farming methods for a change. Furthermore, access to agricultural extension services was positive, and influenced the adoption of organic vegetable farming significantly. From the results, those who had access to extension services had 0.038 higher probability of adopting organic vegetable production than those who did not have access. This is in sync with the view that farmers with access to extension services are better informed on organic farming or sustainable agricultural production and are guided by improved inputs and other organic vegetable husbandry practices as well as market information which go a long way to increase their output (Langyintuo and Mekuria, 2005). Asfaw *et al*. (2012) and Mariano *et al*. (2012) also contended that access to extension services is critical in promoting the adoption of modern agricultural production technologies. This is because it can counterbalance the negative effect of lack of formal education in the overall decision to adopt new technologies.

TABLE 3: MAXIMUM LIKELIHOOD ESTIMATION OF FACTORS INFLUENCING ORGANIC VEGETABLE PRODUCTION

Variables	Coefficients	Standard Error	Marginal Effects	Standard Error
Age	0.016	0.012	0.005	0.005
Household size	-0.025	0.029	-007	0.012
Education	0.060***	0.021	0.024***	0.008
Off- farm activity	0.0604	0.198	0.009	0.079
Farming Experience	0.026***	0.014	0.013***	0.005
Farm size	-0.100	0.320	-0.019	0.127
ARCAY	1.190***	0.216	0.468***	0.066
FBO	0.418*	0.232	0.179**	0.096
Extension	0.099**	0.049	0.038**	0.017
AECS	1.77***	0.424	0.569***	0.06
AMOI	2.640***	0.428	0.727***	0.04
Training	1.498***	0.277	0.510***	0.071
Land ownership	0.371**	0.202	0.146**	0.078
Constant	-4.971***	0.836		
Log likelihood function	-109.069			
Number of observation	400			
Wald $chi^2(13)$	152.50***			
Pseudo R^2	0.61			

Note: ***, ** and * Significant at the 1, 5 and 10 percent level, respectively. ARCAY, AMOI, FBO and AECS refer to ability and resources to cultivate all year, the ability to make own inputs, farmer base organisation, and access to external credit support respectively.

Source: Field Survey, 2015

The results also show that farmers who belonged to FBOs had about 0.18 greater probability of adopting organic farming than those who did not belong to FBOs. These findings are supported by studies such as Hattam and Holloway (2006) and Uaiene *et al*. (2009). They suggest that the normal channels of information flow (via the extension agent) are sometimes not suitable for producers. However, if farmers are associated with FBO groups, they learn more, gain a better understanding, and make informed decisions. This is because FBO groups offer platforms for the farmers to learn and share knowledge among themselves for the promotion of agricultural innovations such as organic farming. In developing countries like Ghana, where extension services have not been very effective due to low extension-farmer ratio, FBOs can play a key role in promoting the adoption of agricultural innovation (Bewket, 2007).

The farmers with the ability and resources to farm throughout the year (ARCAY) had a greater probability (0.47) to adopt organic vegetable production than their resource constrained counterparts. The farmers explained that the organic matter in the soil retains enough moisture to support plant growth, even in the dry season. As a result, relatively resource endowed farmers have invested in simple irrigation systems that support vegetable production throughout the year. A related variable is 'farmer's ability to make their own inputs' (AMOI) which was found to give a greater probability of 0.73 to organic farmers. Such inputs include compost and locally made insecticides which are used in spraying the vegetables against insect attacks. For sustainable production of vegetables in Ghana it is important, from this finding that efforts are made to empower farmers to make their own inputs from local resources. Hattam and Holloway (2006) had a similar finding.

In making their own inputs, access to credit and training of farmers are very vital. From the results, farmers who had received training in vegetable production had 0.51 greater probability of adopting organic vegetable production than those who did not receive any training. Also, farmers who had external support such as credit had a 0.57 greater probability of investing in organic production compared to those who had no support. Organic farmers who have access to external support such as credit were capable of investing in simple irrigation systems as well as transporting and hiring more labour to spread the organic material on their farms This finding concurs with the findings of Awotide *et al*. (2016) and Abayneh and Tefera (2013) in Nigeria and Ethiopia respectively, but contrasts that of Ogada *et al* (2014) and Afolami *et al*. (2015) who found a negative relationship between access to credit and the diffusion of improved agricultural technology.

The marginal effect of land ownership also shows a positive significant effect on vegetables production, showing that farmers who owned their land had 0.15 greater probability of going into organic vegetable production than those who rented or borrowed it from relatives. This is plausible because organic farming requires permanent development of farmland for sustainable production. Therefore, a farmer who does not own his/her land permanently or rents may be unwilling to spend a lot to improving its long term fertility. To ensure sustainable organic vegetable production, it is important that the present land tenure arrangements are re-structured in favour of willing and committed organic farmers with longer term visions.

The Effect of Adoption of Organic Farming on Vegetable Output

The study explores the effects of organic farming adoption on farmers' vegetable output (measured in Ghana Cedis). The empirical results of the effect of organic vegetable production on farmers' vegetable output are presented in Table 4. The parameter 'lambda (λ)' is equivalent to the IMR which measures the correlation between the error terms in the selection equation and the outcome equation. The fact that this parameter(λ) was negative and statistically significant suggests that there was selectivity bias and that if the bias had not been corrected, the estimated coefficients, including the adoption variable, would have been bias, meaning that the true effects of the explanatory variables on vegetable output could not be measured. The adoption of organic vegetable farming had the expected positive sign and statistically significant effect on vegetable output. The empirical results show that adoption of organic vegetable farming had increased vegetable output levels. The findings are consistent with Bruce *et al*. (2014) who indicated that the adoption of improved variety had a positive and significant effect on farmers' output in rice production in Ghana.

Increased organic vegetable output by farmers in the study area can be attributed to the benefits that came along with organic farming such as better access to technical advice that influenced their decision making positively, thus improving the quality of their production.

Also, since most of the organic vegetable farmers in the study area had access to a ready market for their produce, it reduced post-harvest losses. Almost all the organic vegetable farmers (98.5%) reported that they had a ready market for their vegetables whenever they produced. Under the organic farming system, the organic matter in the soil retains enough water for plant growth, even under dry conditions and therefore it does not require any cost in irrigation input (Pimentel *et al*, 2005; Ramesh, 2005). This allows the farmers to produce throughout the year, thereby, giving them higher output per annum than those farming under conventional system. Developing mechanisms to help promote organic farming among poorer households is thus a reasonable policy instrument to generating higher income. The expenditure on seed and labour had positive and negative effects on vegetable output respectively. However, these effects were statistically insignificant.

TABLE 4: MAXIMUM LIKELIHOOD ESTIMATES OF HECKMAN TREATMENT EFFECT OF ORGANIC VEGETABLE PRODUCTION ON OUTPUT

Variables	Coefficient	Standard Error	P>[Z]
Constant	11.02***	0.513	0.000
Ln seeds	0.056	0.135	0.671
Ln Farm size	0.275**	0.156	0.075
Ln labour	-0.038	0.040	0.333
Ln manure	-0.138**	0.067	0.039
Adoption	0.774***	0.192	0.000
$\boldsymbol{\lambda}$ (IMR)	-0.264**	0.137	0.053

Note: ***, ** and * Significant at the 1, 5 and 10 percent level, respectively. Number of observation = 400, likelihood = -7776.886, Wald Chi^2 (5) = 51.03***

Source: Authors' estimation based on field survey data, 2015.

From the results, the area under vegetable production (0.486) was statistically significant at 5% and positive. Hence, the more farmland a farmer allocated to vegetable farming, the higher the output obtained—which is consistent with similar findings by Bruce *et al*. (2014) and Randela *et al*. (2008). This might partly be due to effective utilisation of farmland by farmers to enhance production, leading to higher output. Results in Table 2 provide some evidence for this linkage. The coefficient of manure with respect to vegetable output was negative and statistically significant at 5%. A hundred percent increase in the cost of manure used in vegetable production would be associated with about 15% decrease in vegetable output. As reported in Table 2, farmers used larger quantities of manure (2672.9kg/hectare). The manure preparation, transportation, and use are laborious, suggesting more labour particularly, hired labour which increases the cost of production. Thus, the additional cost associated with the use of larger quantities of manure in vegetable production most likely outweighed the marginal value, leading to the observed negative relationship between increased cost of manure use and vegetable output.

CONCLUSIONS AND POLICY RECOMMENDATIONS

This study focused on investigating the adoption effects of organic vegetable production on output. Organic farming has a long history with good implications on human health and the environment. However, the lack of appropriate technology and tools to enhance production in a sustainable manner to feed the growing population, led to the introduction of exotic technologies and techniques (conventional production) which has resulted in unhealthy lifestyle and the pollution of the environment. Thus, the introduction of improved forms of organic production is needed to compensate for the negative effects of conventional production as well as the lower level of productivity associated with traditional organic production. Results of the current study indicate that modern organic vegetable production goes with some important farmer-specific characteristics and institutional factors such as formal education, training, experience, farmers' capacity and resources to cultivate all year, farmers' ability to make their own inputs, access to external credit support, farmer-based organisation membership, extension services and land ownership. The adoption of organic production increases farm output/income more than conventional production. Among the inputs that determine the level of organic output, farm land and manure are most crucial.

Government and NGOs (such as Ghana Organic Agriculture Network, Mennonite Economics Development Associates, among others) should play lead roles in providing training programmes and lucrative incentives to the farmers with no formal education. Government's Planting for Food and Jobs Policy and Youth in Agriculture Programme could also support and motivate the youth to go into organic vegetable production. The government should establish certification processes which would promote premium prices for organic vegetable produce. The NGOs can also play an important role in the establishment of award schemes and the provision of inputs among others for domestic organic farmers.

It is also recommended that Ministry of Food and Agriculture sensitizes farmers on the importance of adopting sustainable agricultural production practices such as organic farming technologies to enhance retention of soil fertility. There should also be improved quality and access to extension services by, designing innovative tools such as videos and mobile phone technology to improve access to extension services. Assisting and equipping the farmers with the necessary resources to produce throughout the year would significantly improve their interest in organic vegetable farming. The professional skills of organic farmers should be enhanced through training to produce their own organic fertilizers. Households should also be sensitized to separate agricultural waste from non-agricultural waste for sale to interested organic farmers.

Lastly, the benefits of organic farming investments are reaped in the long term, reinforcing the strong relationship between security of land ownership and adoption of organic farming practices, hence there is a need for government to encourage land owners to change the land tenure regarding leasing and renting arrangements to accommodate serious-minded farmers who seek to stay long in the profession.

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