Case Study

REASONS PROMPTING THE ADOPTION OF ORGANIC FERTILIZERS IN VEGETABLE PRODUCTION IN AGOTIME-ZIOPE DISTRICT, GHANA

ABSTRACT

The objective of this research was to identify the reasons prompting the adoption of organic fertilizers in vegetable production and also to establish the factors that discourage organic fertilizer usage in vegetable production. Data from 50 purposively selected farmers based in Agotime-Ziope District was used. A binomial logistic regression analysis was fitted to a data of 50 farmers. Results show that five factors; *X4* (Easy access), *X5* (Less processing needed), *X8* (More economical), *X9* (Consumer preference of organic products), and *X11* (Enhanced healthy ecosystem) were statistically significant in the prediction of the adoption of organic fertilizers with a predicted adoption rate of 93.64%. Furthermore, respondents were unanimous on "Doubtful efficacy", "Health risk", and "Labour intensive" as the factors that discourages organic fertilizer usage in vegetable production. It was therefore suggested that entrepreneurs and investors should be incentivized by Government through tax exemptions and subsidies among others things to invest in setting up more composting sites as composting helps remove some of the constraints associated with raw manure such as the need for drying which consumes time and increases opportunity cost. Finally, there is the need for consumer sensitization by nutritionists on the potential benefits of patronizing organically grown vegetables. This could expand the demand for organically grown vegetables and the willingness of consumers to pay premium price and hence stimulate organic production by farmers.

Keywords: Organic, Fertilizer, Adoption, Logistic regression

INTRODUCTION

According to the Department for International Development (2002) sustainable agriculture connotes perpetuity and continuance in profitable production. It involves agricultural practices that can be repeated without the depletion of available vital resources that support agriculture. It also means agricultural practices that will not destroy the environment. Over 8 million tons of nutrients are mined from soils in Sub-Saharan Africa every year. In Ghana, about 5 Kg of soil nutrients per hectare is taken out by crops (Henao & Baanante, 2006). They further indicated that if Africa is to be able to feed its poor and hungry people, the use of inorganic fertilizers should be promoted by Governments and stakeholders rather than organic fertilizers which have more benefits than the nutrients that they provide (Department for International Development, 2002). In Ghana the current level of inorganic fertilizer usage is about 8 Kg per hectare (Ministry of Food and Agriculture, 2008). In its attempt to increase the use of inorganic fertilizers, the Government of Ghana introduced the fertilizer subsidy programme in 2008 (Yawson et al., 2010). However, the subsidy policy is bedeviled with problems such as shortages and high transaction costs. Small scale farmers who form about 80% of the farmers in Ghana complained that even with the subsidy, the inorganic fertilizers were still expensive (Yawson *et al*., 2010). There is a strong argument by Savci (2012) that inorganic fertilizers used are constrained by their high costs and uncertain returns under rain fed agriculture.

Furthermore, Alimi *et al*. (2006) also stated that inorganic fertilizers do not improve soil physical properties such as moisture retention capacity and bulk density among others, which organic fertilizers are capable of doing. McGuinness (1993) and Alimi *et al.* (2006) indicated that the leaching of inorganic fertilizer minerals into greater depths, contaminate ground water and bring about conditions such as water hardiness. Alimi *et al.* (2006) added further that the minerals are leached beyond the reach of plant roots. McGuiness (1993) and Heal (2004), have reported that for agriculture to be sustainable, inorganic fertilizers are not suitable because of environmental degradation caused by their usage. It can affect current production negatively as well as jeopardize the agricultural productivity levels and compromise future production which will result in poverty in the long term. Heal (2004), submits that inorganic fertilizer usage in agriculture contributes to biodiversity losses, however available literature on the quantitative estimates is scanty. Organic fertilizers on the other hand promote the living of the soil by providing conditions that are suitable for diverse living organisms to coexist in the soil environment (Heal, 2004). Savci (2012) stated that chemical fertilizers are agricultural pollutants and that they can pose health problems such as cancer. These issues raise concern of urgently finding alternatives such as organic fertilizer. However, Barnard and Nix (1979) posit that farmers will replace an existing input only when the new input will yield an incremental positive net return or that the new costs (both direct and transaction costs) per unit associated with that input is much lower than the associated benefits. Delgado (1998) also indicated that if transaction costs associated with an input are perceived to be high, farmers may be discouraged from using that input resource, hence farmers are likely to choose one input over another when the cost implications as well as the benefits are more favourable compared to the alternative being discarded. Thus, it is against this background the research seeks to identify the reasons prompting the adoption of organic fertilizers in vegetable production and also to establish the factors that discourages organic fertilizer usage in vegetable production.

LITERATURE REVIEW

Sources of Organic Fertilizers

Alimi *et al*, (2006) commercial organic fertilizers are organic fertilizers that are market oriented. Those available on the market include: Bone meal, blood/ fish/ bone, blood meal, dried manures, Epsom salts, fish meal, hoof and horn, rock phosphate, seaweed meal and wood ash (Bary, Cogger, and Sullivan, 2000). Bone meal is quite rich in phosphate to promote root growth. It is usually good to sprinkle a little in the planting hole. Blood, fish and bone for instance, is a balanced all round fertilizer. Blood meal unlike dried manure is very high in nitrogen. It can be used as a quick tonic for tired plants in the dry season.

Dried manures have all the trace elements but quite are low on NPK so more of it is needed to provide adequate amounts for crops. Epsom salts are a soluble form of magnesium. Fish meal contains nitrogen and phosphate. Hoof and horn are rich in nitrogen. It works on slow release and must be applied a week before planting. Rock phosphate promotes rooting and is a good alternative to bone meal (Jokela *et la.,* 2004).

Rock potassium is quite useful as a source of pure potash. It works as a slow release and is a good fertilizer for vegetables. Seaweed meal is also quite excellent, it is a slow releaser of nutrients, and an all-round fertilizer. It contains cytokines and hormones that promote photosynthesis and protein synthesis. Ash from wood is high in potassium and some phosphate – the quantities depend on the type of wood however (Bary *et al.,*2004 and Jokella *et al*., 2004).

Aside organic fertilizers obtained from market overt, some farmers undertake their own composting for self-usage and any excesses sold for cash or given to other farmers (Odhiambo & Mag, 2008). A recent phenomenon in the Greater Accra Region is the establishment of a number of composting plants to produce organic composts for farmers use. Most of these composting plants get raw materials from organic waste produced by the populace. Zoomlion Ghana Limited a waste management company in Ghana has established a high capacity plant at Medie in the Ga

West Municipality to process waste materials into organic fertilizers. Alimi *et al*., (2006) identified two major sources for obtaining organic fertilizers: those that go through the market exchange system i.e. commercial organic fertilizers and those that do not go through the market exchange system. Odhiambo and Magandini (2008) posits that manure for instance is obtained mainly from neighbouring farms or from farmers own livestock thus for farmers who engaged in mixed farming.

Factors Influencing the Adoption of Organic Fertilizer Technology

Boateng (2000) observed that Ghanaian farmers choose inputs based on factors such as availability, accessibility, market price, income level of farmers, previous experience of farmers with a particular type of fertilizer as well as economic factors such as labour, capital and land. Also some factors run across farmers in different areas whiles others may change from place to place depending on prevailing conditions (Bonabana-Wabbi, 2002). There are a number of factors that determine whether a farmer would adopt a given technology or not. Bonabana-Wabbi (2002) posits that these factors include Government policies towards a technology, technological change, market forces, environmental factors such as nature of the soil and soil fertility, demographic factors such as age and education, institutional factors such as access to information and the mechanisms for delivering the technology.

However, for a given technology, not all the factors may apply thus a regression analysis is a way of knowing which ones would apply in a particular scenario. These include: Market factors including availability of labour, resource requirements of the technology, size of the farm, expected benefits and the effort required to apply the technology. Social factors such as age of the farmer, social standing of the farmer, size of the farmer's household, educational level of the farmer, farming experience and the gender of the farmer, membership to farmer based organizations. Management factors like Access to credit and Institutional/ technology delivery mechanism such as the access to information and extension contacts and prior experience with using the technology, environmental health concerns (BonabanaWabbi, 2002).

Kebede *et al.* (1990) broadly categorized the factors that influence adoption of technologies into Social, Economic and physical categories. Makokha *et al.* (2001) listed factors such as extension contacts, membership in an organization, household size, hired labour for manure application, off farm income among others as being the significant factors influencing the use of inorganic fertilizer technology and manure in maize production in Kiambu district, Kenya. Waithaka, Thornton, Shepherd, and Ndiwa (2006) gave factors such as farmer characteristics, farm characteristics among others as factors that determine the adoption of fertilizer and manure by smallholder farmers in the Vihiga district of Kenya using a pair of Tobit models. They defined adoption of the two technologies in terms their continued use in production over more than a season. Bonabana-Wabbi defines adoption in terms of acceptance of the technology by the target group and ascertained the factors that influence the adoption of integrated pest management in cowpea, sorghum and groundnut cultivation in the Kumi district of Uganda by using the Probit, Logit and Tobit regression models. She found that Low levels of adoption were associated with five of the technologies and also that three technologies had high levels of adoption. She also indicated that farmers‟ participation in on-farm trial demonstrations, accessing agricultural knowledge through researchers and farmers‟ prior participation in pest management training were all associated with increased adoption of most Integrated Pest Management practices.

Makhoka *et al.* (2001) identified the determinants of fertilizer and manure use for maize production in Kiambu District, Kenya by using the Logistic regression model. They defined adoption in terms of the use of the technology and found that extension and off-farm incomes were significant factors influencing the adoption of manure. The age of household head, extension, membership in an organization, and off-farm income significantly influenced the use of inorganic fertilizer. The use of both inorganic fertilizer and manure was significantly influenced by extension, membership in an organization, household size, hired labour for manure application, livestock ownership, and off-farm income. Bonabana-Wabbi (2002) gave farm size as the most important factor affecting the adoption of agricultural technologies. This was because farm size affects other factors of adoption and is subsequently affected by other factors. Farm size affects costs of adoption, risk perceptions in production, labour costs, credit requirements, labour requirements, and land tenure arrangements among others (Bonabana-Wabbi 2002). With small farms, it has been suggested that higher fixed costs become a limitation to technology adoption (Abara and Singh, 1993 cited in Bonabana-Wabbi, 2002).

According to Ajewole (2010), factors such as number of years of formal education, size of farmer's household, and the frequency of extension visits during previous cultivation season positively influence the adoption decision of organic fertilizers. According to Rogers (1983) in general, socio-economic characteristics of households strongly influence adoption of a technology. Ajewole (2010) adds further that access to a technology is key to adoption decisions about that technology. Aikins *et al.,* (1975), posit that the economic constraints affect the distribution of resource inputs such as technologies which further affects the decision to adopt the use of such input resources. Ajewole's (2010) study was mainly about farmers' response to adoption of commercially available organic fertilizers in Oyo state, Nigeria. The study employed the use of the Tobit model to look at use intensity of the commercially available organic fertilizers and also relative use of this type of fertilizers amongst the farmers in Oyo states, Federal republic of Nigeria. Ajewole found that, the number of years spent in acquiring formal education, household size, and number of extension visit received during last cropping season positively influenced adoption decisions, on the other hand farming experience, farm size, and distance from source of supply of commercial organic fertilizer negatively influenced adoption decisions.

Hooks *et al.* (1983) argue that the perceptions of an end user for which a technology is meant also defines or determines whether or not they will adopt that technology. Ajewole (2010) states that, when it comes to adoption studies, inconsistencies exist with regards to the socio-economic factors that affect adoption decisions and also on the nature of the effect. Odhiambo and Magandini (2008) added that before fertilizers can be accessed, they must be available and affordable so availability and affordability of a technology are major factors that should be considered in an adoption studies. It is very important that for an adoption study like this, the socio-economic characteristics of the respondents are considered as influencing variables. Also management and institutional factors should be included in the study as well as any other factors observed from or within the study area that could have a bearing on the adoption decision of the respondents, either directly or indirectly.

METHODOLOGY

This study used descriptive, cross-sectional study design. The setting was the Agotime-Ziope District in Volta Region, Ghana. The population for this study included sampled farmers who use organic fertilizer. A total of 50 farmers all in the district were selected for the research. The study employed a purposive sampling technique in selecting the farmers located in various parts of the district.

Data for the study was obtained using questionnaire. The questionnaire had two sections. The first section consisted of demographic information such as gender, age, and years of farming. The second section consisted of information on the reasons prompting the adoption of organic fertilizers in vegetable production and also the factors that discourages organic fertilizer usage in vegetable production.

Data for the research was analyzed using logistic regression with the help of SPSS version 23.

Definition of Variables

Below are the predictor variables considered for this study.

X1= Age
X2= Gender
X3= Farm size
X4= Easy access
X5= Less processing needed
X6= Reduce soil erosion
X7= Fertility status of soil
X8= More economical
X9= Consumer preference of organic products
X10=Premium payment of organic products
X11= Enhanced healthy ecosystem
***X12*=**Less risk of plant injury

Dependent variable construction and pre-processing

The data preparation step deals with the choice and creation of the desired variables dependent and covariates.

In this study a binary dependent variable adoption (Y) was created.

$$Y_i = \begin{cases} 1 \text{ adoption; farmers who use organic fertilizer} \\ 0 \text{ non} - \text{adoption; faarmers wo do not use organic fertilizer} \end{cases}$$

This criterion is consistent with general definition of adoption. Since including all variables will make the model unnecessarily large, the principle of parsimony will justify small model. The researcher employed statistical procedures such as forward and backward selection processes to verify consistency of variables selected in the model.

Analytical Tools

The study makes use of the logistic regression model. Logistic regression is based on binomial probability theory. It is a mathematical modeling approach used in describing the relationship of several independent variables to a dichotomous dependent variable or a limited dependent variable. The logit function is employed because the dependent variable default" is dichotomous, whereas the proposed covariates were mixture of continuous and categorical random variables. Thus the model was chosen over others due to the data structure and purpose. Also the independent variables need not be interval, nor normally distributed, nor linearly related, nor equal variance within each group. The logit model is a derivative of the odds function. The odd of a function is the ratio of the probability of success to that of failure. Thus

$$Odds(Y = 1) = \frac{P(Y = 1/\ X = x)}{P(Y = 0/\ X = x)}$$

where $Odds(Y = 1)$is the odds of adoption; $P(Y = 1)$ is the probability that adoption occurs given a set of explanatory variables and $P(Y = 0)$ is the probability of non-adoption given set of explanatory variables.

If the odds of adoption are greater than one, it means there is a higher probability of adoption compared to that of non-adoption. A value less than one indicate a higher probability of non-adoption than that of adoption.

RESULTS AND DISCUSSION

This subsection looks at the summary statistics of the respondents. A total of 50 farmers completed the questionnaire on the reasons prompting the adoption of organic fertilizers in vegetable production. Table 1 summarizes the socio-demographic information of the respondents.

Table 1: Demographic information of the participants (n=50)

Variables	Frequency	Percentages
Gender		
Male	39	78.0
Female	11	22.0
Age		
29 - 38	11	22.0
39 - 48	31	62.0
49 - 58	8	16.0
Years of farming		
Less than 5	7	14.0
6 - 10	14	28.0
11 and above	29	58.0

From table 1 above; out of the 50 respondents 78% of them were male, whiles 22% were females. Also, 22% of the respondent were between the ages of 29 and 38; 62% of them are between 39 and 48 age group; and finally the rest 16% were in the age group of 49 and 58 years' age group. The analysis further revealed that about 14% of the respondents have been cultivating vegetables for about less than 5 years; 28% have been cultivating between 6 to 10 years; and finally, 58% of them have been cultivating between 11 years and above.

Table 2: Logistics Regression Estimates of Reasons Prompting the Adoption of Organic Fertilizers in Vegetable Production

							95.0% C.I.for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
X1	0.171	0.218	0.616	1	0.433	1.187	0.774	1.821
X2	-0.274	0.170	2.601	1	0.107	0.760	0.545	1.061
X3	0.036	0.239	0.023	1	0.880	1.037	1.098	3.535
X4	**-0.843**	0.200	17.693	1	**0.000**	**0.430**	0.291	0.638
X5	**0.737**	0.242	9.293	1	**0.002**	**2.091**	1.301	3.359
X6	0.293	0.223	1.727	1	0.189	1.341	0.866	2.076
X7	0.008	0.167	0.002	1	0.963	1.008	0.727	1.398
X8	**0.952**	0.214	19.861	1	**0.000**	**2.591**	1.704	3.937
X9	**0.678**	0.298	5.174	1	**0.023**	**1.971**	0.649	1.657
X10	0.149	0.270	0.307	1	0.580	1.161	0.685	1.969
X11	**0.871**	0.151	1.652	1	**0.000**	**2.389**	0.613	1.107
X12	0.146	0.140	1.096	1	0.295	1.158	0.880	1.523
Constant	0.294	1.688	0.030	1	0.862	1.342		

Table 2 shows the result of logistic regression estimates of the various reasons prompting the adoption of organic fertilizers in vegetable production. The significance value of the Wald statistics for each independent variable indicates the contribution or importance of each of predictor variables (P<0.05).

From the table, column six (6) determines the variables that contribute significantly to the predictive ability of the model at 0.05 level of significant. These variables are, *X4* (Easy access), *X5* (Less processing needed), *X8* (More economical), *X9* (Consumer preference of organic products), and *X11* (Enhanced healthy ecosystem).

Thus the logistic function is given by the equation (2) below:

$$P(Adoption) \quad = \frac{1}{1 + e^{-(0.294X4+0.737X50.952X8+0.678X9+0.871X11)}}$$

Furthermore, the odd ratio $(Exp(\beta))$ for the significant factors, shows the increase (or decrease if the ratio is less than one) in odds of being in one outcome category (adoption or no adoption) when the value of the predictor increases by one unit. From table 2, the odds or risk of a farmer adopting the organic fertilizer, is 0.430 for *X4* (Easy access). This indicates that, the risk of a farmer adopting organic fertilizer is 0.430 times higher for a farmer when there is an easy access to the organic fertilizer, all other factors being equal. For *X5* (Less processing needed), the odd ratio indicates that risk of a farmer adopting the fertilizer is 2.091 times more likely to adopt if the perceive the processing needs to be less, all other factors being equal. For *X8* (More economical), the odd ratio of 2.591 indicates that the risk of a farmer adopting the fertilizer is 2.591 times higher for a farmer who perceive the organic fertilizer to be more economical than for a farmer who does not perceive the organic fertilizer to be more economical, all other factors being equal.

Also for *X9* (Consumer preference of organic products) the odd ratio is 1.971 which means that for any preference of organic products by consumer, the risk of adopting the organic fertilizer increases by 1.971, all other factors being equal. Finally, the odd ratio of 2.389 for *X11*

(Enhanced healthy ecosystem) indicates that, for any perceive enhanced healthy ecosystem by farmers, the risk of adopting increases by a factor of 2.389, all other factors being equal.

Response to Factors that Discourages Organic Fertilizer Usage in Vegetable Production

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
Doubtful efficacy	Group 1	<= 2	2	0.04	0.50	0.000
	Group 2	> 2	48	0.96		
	Total		50	1.00		
Offensive odour	Group 1	<= 2	28	0.56	0.50	0.480
	Group 2	> 2	22	0.44		
	Total		50	1.00		
Health risk	Group 1	<= 2	10	0.20	0.50	0.000
	Group 2	> 2	40	0.80		
	Total		50	1.00		
Bulkiness	Group 1	<= 2	31	0.56	0.50	0.127
	Group 2	> 2	19	0.44		
	Total		50	1.00		
Inadequate storage	Group 1	<= 2	21	0.20	0.50	0.213
	Group 2	> 2	29	0.80		
	Total		50	1.00		
Labour intensive	Group 1	<= 2	12	0.24	0.50	0.000
	Group 2	> 2	38	0.76		
	Total		50	1.00		

The variables above are indicators of the factors that discourages organic fertilizer usage in vegetable production. From the table above, group 1 (<= 2) are those who strongly disagree or disagreed to the variables indicating the factors that discourages organic fertilizer usage in vegetable production; group 2 (> 2) are those who strongly agreed and agreed. At a significant value of 0.05; it appears that three exact significant values except three are less than 0.05, suggesting that the respondents are unanimous on them as the factors that discourages organic fertilizer usage in vegetable production. The significant variables are “Doubtful efficacy”, “Health risk”, and “Labour intensive” with 87%, 88% and 82% agreement respectively.

However, those that has a significant value greater than 0.05 are “Offensive odour”, “Bulkiness” and “Inadequate storage”. The implication of this is that the respondents are divided on the effectiveness of that statement as factors that discourages organic fertilizer usage in vegetable production.

CONCLUSION AND RECOMMENDATION

The study revealed that five (5) factors; *X4* (Easy access), *X5* (Less processing needed), *X8* (More economical), *X9* (Consumer preference of organic products), and *X11* (Enhanced healthy ecosystem) were statistically significant in the prediction of the adoption of organic fertilizers with a predicted adoption rate of 93.64%. This indicates that there is probability that 93.64% of farmers, with the given characteristics are likely to adopt organic fertilizer. Also, respondents were unanimous on “Doubtful efficacy”, “Health risk”, and “Labour intensive” as the factors that discourages organic fertilizer usage in vegetable production.

Therefore, entrepreneurs and investors should be incentivized by Government through tax exemptions and subsidies among others things to invest in setting up more composting sites as composting helps remove some of the constraints associated with raw manure such as the need for drying which consumes time and increases opportunity cost.

Finally, there is the need for consumer sensitization by nutritionists on the potential benefits of patronizing organically grown vegetables. This could expand the demand for organically grown vegetables and the willingness of consumers to pay premium price and hence stimulate organic production by farmers.

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