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Farmers' Willingness to Pay for Fortifier Enriched Excreta Pellets for Agricultural Use in Ghana

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Abstract
Given declining soil fertility and agricultural productivity in Sub Saharan Africa, depletion of naturally occurring source of nutrients, increased cost of fertilizer and increasing levels of poverty demand that, alternative and more sustainable solutions such as fortifier fertilizer be sought to enhance agricultural productivity. However, information about farmer willingness to pay is not widely reported. This study explores farmers' determinant of willingness to pay for enriched excreta pellets in Ghana in order to inform policymakers and industry participants of some of the implications in the market. Data was collected from 400 randomly sampled farming types were conducted in Northern and Ashanti regions using a written questionnaire and an iterative bidding game contingent valuation method. Applying the logit model, results show that, age, annual household income, head of household, current land holding, positive knowledge, attitude and perception (KAP) and negative KAP are strong predictors of willingness to pay (WTP) for fortified enriched pellets for the combined regions. The information in this study can be used by probable investors, producers and marketers of fortified enriched excreta pellets to develop formidable marketing strategies in their efforts to boost demand for fortified excreta pellets in the face of rising competition in the fertilizer market.
Keywords: Willingness to Pay, Fortified Enriched Pellets, Logit model, Contingent valuation, Ghana
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1. Introduction

Developing countries especially urban and peri-urban areas are the greatest polluted and disease afflicting dwellings of the globe. A great deal of this contamination is as a result of inappropriate and inadequate urban sanitation infrastructure and services. Thus, as cities develop and urban populations' rises, the issue is deteriorating and the demand for secure, cheap and viable sanitation mechanisms is turning vital. The problem that this development shows to planners' and decision makers in meeting the needs for food, shelter and waste management is cumbersome. The waste problem can better be explained by the fact, about 50-75% of the municipal budget is utilised to harness the ever- increasing waste generation in all Ghanaian cities (Danso et al., 2003).

Research has shown that, millions of tons of human excreta are generated every day and collected as faecal sludge (FS). Nevertheless in Accra 255,000 to 366,000 tonnes of organic waste and in Kumasi, about 230,000 to 250,000 tonnes of organic waste are effectually ready for use yearly for composting (Drechsel et al., 2010).

Thus, if the gathered urban waste was treated into a composted pellet in order to be used for crop fertilization purposes, the problem could be eschewed or reduced.

However, Danso et al. (2002); Langergraber and Muellegger (2005), Danso et al. (2003) as well as Danso et al. (2006) carried out various studies on consumer willingness to pay and perception for composting municipal solid and faecal waste in Ghana. Findings showed that, most of the farmers and other compost users are willing to pay for compost. Again, consumers' characteristics incline to have an important impact on willingness to pay for the compost.

Moreover, a study was conducted by Agyekum et al. (2014) to analyse willingness to pay for faecal compost by farmers in Ningo- Prampram and Shai- 0sudoku in Ghana. Results indicate that, farmers` willingness to pay was significantly influenced by their knowledge on faecal waste re-use in agriculture and experience with use of animal manure. Product attributes such as price, packaging and labeling as well as farmer's socio-demographic characteristics, such as monthly household income, household size and age also significantly influence farmers' willingness to pay.

Other causes spelled out by compost users were: high transportation cost due to its large nature, would need engaging more farmhands when applying compost to the soil because of its bulky form, poor quality of the currently produced product, its high water requirement, and negligible market demand for organically produced crops and also complained about land insecurity (Danso et al., 2006; Danso et al., 2002; Olufunke, 2003).

To strategically address these various challenges, previous studies conducted by researchers from the University of Ibadan (Nigeria) and International Water Management Institute respectively, has developed different formulation of fortifier products such as the co-compost powder and enriched pellets in order to increase; marketability, general acceptability, ease of handling and on-farm distribution, and to improve fertilizer use efficiency and affordability (Ankrah & Owusu, 2012a, IWMI, 2012). Presently, there are limited studies on factors

that influence farmers' willingness to pay for the product in Ghana. Hence this work seeks to evaluate the characteristics that may influence farmers' willingness to pay for fortifier enriched pellets as resource. The study hypothesized that, farmers' willingness to pay for fortifier enriched excreta pellets are influenced by socio-economic characteristics.

2. Materials and Methods

2.1 Survey Design, Sample Size and Sampling Method

The data used in this study was obtained through a farmer's survey conducted in Ashanti and Northern regions of Ghana in 2014. The surveyed population was all crop farmers specifically, vegetables, cereals and tree crop farmers respectively. The districts were purposively sampled Ashanti; Kumasi metropolitan (35), Mampong municipal (86), Offinso north district (79), and Northern; Tamale metropolitan (43), Tolon district (77), Kumbugu district (40), Savelugu district (50) based on it high production levels of crops, also high purchase and usage of fertilizer inputs. Respondents were proportionally and randomly sampled from the different farming types from these selected districts. Again, the targeted areas and communities were purposively sampled in which the respondents were selected. In all a total of 400 (that is, at least 200 farmers from each region) were interviewed.

2.2 Methods of Data Collection

The questionnaire comprised of three sections; the first section included questions on farmers' socio-economic characteristics such as age, income, gender, number of person's economically dependent, educational level and so forth. Also, the second section contained questions on factors influencing farmers purchasing behavior towards fertilizer, whilst the final section obtained information on farmers' willingness to pay (WTP) for fortified enriched pellets using iterative bidding game contingent valuation format. In the iterative bidding game contingent valuation part of the questionnaire, it involved a sequence of dichotomous (double bounded) choice questions followed by a final open-ended question. A scenario was presented to the respondents before the bidding game. This scenario explained the advantages of fortifier over other soil inputs, and the benefits of using fortifier.

Specifically, a segment of the scenario was that, fortifier enriched pellets offered for sale were shown to the respondents before the bidding games. Different bidding games were administered for the product with the different starting-points in the three groups. Thus, starting-points for the fortifier enriched pellets were; high (30 GH₵), medium (26 GH₵) and low (23 GH₵). The survey questionnaire was pre-tested with 20 crop farmers at Gyinase and Emena all suburbs of Kumasi metropolis to validate the logic and content of the questionnaires. The wording, content and coding of responses were modified accordingly.

2.3 Analysis of Data

Descriptive statistics such as frequency distribution tables, mean and standard deviation were used to analyze the socioeconomic characteristics of the respondents. The relationship between willingness to pay for fortifier enriched excreta pellets and respondents socioeconomic variables were analyzed using logit regression analysis. The parameters of the models were estimated with the maximum likelihood estimation technique, and the above analyses were estimated by the statistical packages such as SPSS 20 and STATA 11.

2.4 Econometric Model on Determinants of Farmer Willingness to Pay

Thus the logit model as spelled out by Amemiya (1975), was used to examine the determinants of consumer willingness to pay for fortifier enriched excreta pellets. The study used the threshold decision making theory suggested by Kau and Hill (1971), Pindyck and Rubinfeld (1998) to fortifier excreta pellets respectively by farmers. The theory points out the fact that, when the individual is faced with a situation to take a decision, in this case to pay for fortifier product or not to pay, he/she has a reaction threshold, which is dependent on a certain set of factors. As such, at a certain value of stimulus below the threshold, no reaction is observed, while at the critical threshold value, a reaction is stimulated. Such phenomena are generally modelled using the relationship

$$Y_i = \beta X_i + \mu_i \qquad (9)$$

Where

$$Y_i = \begin{cases} 1, if\ consumer\ responded\ YES-YES, or\ YES-NO\ or\ NO-YES, and\ YES \\ 0, if\ consumer\ responded\ NO-NO, and\ NO \end{cases}$$

That is, Y_i is equal to one when a choice is made to pay for fortifier products and zero otherwise; this means

$Y_i = 1$if X_i is greater than or equal to a critical value, X^* and

$Yi = 0$ if X_i is less than a critical value, X^*

Note that X^*represents the threshold value of the independent variables (X).

Equation (5) represents a binary choice model involving the estimation of the probability of willingness to pay for fortifier product (Y) as a function of independent variables (X).

Mathematically, this is represented as

$$\text{Prob}(Y_i = 1) = F(\beta' X_i) \quad (10)$$

$$\text{Prob}(Y_i = 0) = 1 - F(\beta' X_i) \quad (11)$$

Where Y_i is the observed response for the ith observation of the response variable, Y. This means that $Y_i = 1$ for a farmer who is willing to pay for fortifier pellets and $Y_i = 0$ for a farmer who is not willing to pay for fortifier pellets. X_i is a set of independent variables such as awareness and socio-economic variables associated with the ith individual, which determine the probability of willing to pay for fortifier product (P). The function F may take the form of a normal, logistic, or probability function.

The logit model uses a logistic cumulative distributive function to estimate P as follows:

$$P(Y = 1) = \frac{e^{\beta' X}}{1 + e^{\beta' X}} \quad (12)$$

Where P, is the probability that, the ith farmer will make a certain choice (answer = 'Yes"), given the observed level of farmer characteristics contained in X_i, and β is a conformable vector of parameters.

Therefore, if (12) represents the probability a farmer will answer 'Yes" to the question asking whether he or she will pay a premium for fortifier pellets, then 1 - P_i will be the probability associated with answering "No." Thus,

$$P(Y = 0) = 1 - \frac{e^{\beta' X}}{1 + e^{\beta' X}} = \frac{1}{e^{\beta' X}} \quad (13)$$

(Loureiro and Umberger, 2003, Awunyo-Vitor et al., 2013)

According to Greene (2003), the probability model is a regression of the conditional expectation of Y on X giving:

$$E\left(\frac{Y}{X}\right) = 1\left[F\left(\beta' X\right)\right] + 0\left[1 - F\left(\beta' X\right)\right] = F(\beta' X) \quad (12)$$

Since the model is nonlinear, the parameters are not necessarily the marginal effects (ME) of the various independent variables. The relative effect of each of the independent variables on the probability of a consumer willing to pay for fortifier enriched excreta pellet is obtained by differentiating (12) with respect to X_i resulting in (13) (Greene, 2003), as

$$\frac{\partial P_i}{\partial X_i} = \left[\frac{\lambda^{\beta' X}}{(1 + \lambda^{\beta' X})^2}\right] = F\left(\beta' X\right)\left[1 - F\left(\beta' X\right)\right]\beta \quad (13)$$

3. Results and Discussions

3.1 Socioeconomic Characteristics of Respondents

The descriptive statistics of the variables relating to the respondents' socioeconomic characteristics towards willingness to pay for fortifier enriched excreta pellets investigated in the study are presented in Table 1. The respondents interviewed were mostly heads of households in both regions (81 %). Again, the average age of respondents was 43 years which was closer to farmers' national average of 45 years in Ghana. This results also support the findings of Nimoh et al. (2014c) and Agyekum et al. (2014). The average numbers of dependents economically active on the respondents was eight people in the regions.

The average annual household income in log form for both regions is 3.47. The average farm size of the pooled sample is 3.36 acres, and this compares favourably with the national average of less than 2 hectares (MOFA, 2011). Most of the respondents were male; 91%. This can be linked to the tradition of the area where most women engage in non-farm activities, especially trading which is less labour intensive (Nkansah–Boadu, 2006). Farmers educational level was measured at four levels; none educational level, primary, secondary and tertiary education; 35 % have none education, 26 % attained primary education, 29 % had secondary education and 10 %, tertiary education, suggesting that the study captured less highly educated farmers. This becomes important when laying down strategies for awareness campaigns and giving information to farmers (Nkansah–Boadu, 2006).

Overall, there were more respondents who have prior awareness of faecal sludge based fertilizer (70 %) than those who did not have prior awareness. Again, there were slightly more farmers (55 %) who have ever used any organic fertilizer in the regions. Furthermore, most respondents (78.50 %) interviewed in both regions owned their current land holding for farming activities.

Table 1. Variable Definition and Sample Statistics

Variable	Definition of Variable	Mean	Standard deviation
Dependent Variables			
WILLINPAYPELLET	Willingness to pay for fortifier enriched pellet	0.82	0.38
Independent Variables			
AGE	Age of respondents in years	42.98	11.53
Gender	1 if consumer is male, 0 otherwise	.91	.29
HHOUSEHOLD	1 if household head, 0 otherwise	0.81	0.39
EDUCNONE	1 if consumer has none education, 0 otherwise	0.35	0.48
EDUCPRIMARY	1 if consumer has primary education, 0 otherwise	0.26	0.44
EDUCSECOND	1 if consumer has secondary education, 0 otherwise	0.29	0.46
EDUCTERTIARY	1 if consumer has tertiary education, 0 otherwise	0.10	0.29
DEPENDENTS	Number of individuals economically depending on the respondent	7.88	4.70
CURRENT LAND	1 if consumer owned current land holding, 0 otherwise	0.78	0.41
USEORGANICFERT	1 if consumer ever used organic fertilizer, 0 otherwise	0.55	0.49
FARMSIZEACRES	Farm size in acres	3.36	2.79
PRIORAWARENESS	1 if consumer has prior awareness of feacal sludge based fertilizer, 0 otherwise	0.70	0.46
HOUSEHOLDINCOME	Annual farm household income (both on-and off- farm income) in log form	3.47	0.57

Source: Field Survey, 2014.

3.2 Factors influencing Fertilizer Purchase

The meaning of the highest significant factor was described by the number of farmers answering to the maximum (4 to 5) scale levels, that is; agree and strongly agree.

Table 2. Factors Influencing Farmers Fertilizer Purchasing Behaviour

Statements	Level of agreement (%)				
	SA	A	N	D	SD
Price is the most important characteristic	11.0	42.0	17.8	21.6	7.5
Nutrient content is the most important characteristic	38.3	48.4	6.5	6.3	0.5
Organic matter which enhances soil quality is the most important characteristic	20.3	44.4	18.5	15.3	1.5
Water holding capacity is the most important characteristics	17.0	50.4	16.5	14.5	1.5
Safety is the most important characteristic	14.5	50.6	17.3	15.8	1.8
Packaging is the most important characteristic	11.0	42.1	17.8	21.6	7.5
A label showing the fertilizer is certified by relevant authorities (MOFA) is the most important characteristic	13.5	40.1	15.3	25.1	6.0
Brand name is the most important characteristic	9.3	42.4	18.8	24.8	4.8
Suitable credit offer is the most important characteristic	10.3	31.8	18.0	33.6	6.3
A convenient location to buy the product is the most important characteristic	12.0	50.9	18.5	14.8	3.8
Volumes to apply is my main concern	5.8	51.0	21.0	16.5	5.5
Fertilizer application method is the most important	9.5	52.4	23.1	11.5	3.5
Recommended by sources I trust	10.3	51.4	16.5	17.3	4.5
I know someone who has used it	9.8	48.1	15.3	22.6	4.3
It matters that the product is made locally	2.0	24.8	24.8	38.8	9.5
It matters that the product is imported	1.5	18.8	23.6	45.6	10.5

Note: SA, strongly agree; A, agree; N, neutral; D, disagree; SD, strongly disagree

Source: Field Survey, 2014

Findings show that on average, nutrient content (86.7 percent), water holding capacity (67.4 percent), safety (65.1), Organic matter (64.7 percent), convenient location (62.9), fertilizer application method (61.9), recommended by sources trusted (61.7), known someone who has used it (57.9), volumes to apply (56.8), brand name (51.7), label (53.6), packaging (53.1), price (53) are the most important factors (Table 2), while suitable credit offer (42.1), product made locally (26.8) and product is imported (20.3) are the least.

3.3 Empirical Estimates of Willingness to Pay Fortifier Enriched Excreta Pellets with Farmer Determinants

The logit regression results of factors influencing willingness to pay for fortifier enriched pellets are presented in

Table 3. The logit regression gave a Pseudo R-square of about 0.2. The value of the log-likelihood function is -150.1582 for the unrestricted model and likelihood ratio statistic is 76.80. Thus, the null hypothesis that the variables had no effect on the willingness to pay for fortifier enriched pellet is rejected and the full model is retained. Again, additional model specification test such as stukel score or LM test was performed to evaluate if the model was correctly specified. The null hypothesis of the correct model specification was not rejected at a *p*-value of 0.5.

Table 3. Logit Regression Results of Factors Influencing Willingness to Pay for Fortifier Enriched Excreta Pellet

Variable	Coefficient	Standard error	Z	P>|z|	Average Marginal effect
CONSTANT	5.488	1.672	3.28	0.001	
GENDER	.6914	.5126	1.35	0.177	.0807
AGE	-.0485	.0179	-2.70	0.007*	-.0057
HHOUSEHOLD	.8327	.4599	1.81	0.070***	.0972
EDUCNONE	-.0794	.6094	-0.13	0.896	-.0093
EDUCPRIMARY	-.2277	.6224	-0.37	0.714	-.0266
EDUCSECOND	-1.021	.6018	-1.70	0.090***	-.1191
EDUCTERTIARY					
DEPENDENTS	.0583	.0417	1.40	0.162	.0068
CURRENTLAND	.7542	.3449	2.19	0.029**	.0880
USEORGANICFERT	.0378	.3006	0.13	0.900	.0044
FARMSIZEACRES	.1151	.0754	1.53	0.127	.0134
PRIORAWARENESS	.1872	.3342	0.56	0.575	.0218
HOUSEHOLDINCOME	-1.134	.3635	-3.12	0.002*	-.1323

Number of observations = 400
Log- likelihood = -150.1582
LR chi2(14)76.80
Prob > chi-square = 0.0000
Pseudo R^2 = 0.2036
LM Chi-square(1)0.58 = 0.4467

* Significant at 1%, ** Significant at 5%, *** Significant at 10%
Source: Field Survey, 2014

Age, head of household, secondary educational status, current land holding for farming activities, annual household income were the significant factors that influenced farmers willingness to pay for fortifier enriched pellet for the pooled sample whilst the rest of the independent variables were statistically insignificant.

The age variable was negative and statistically significant in the WTP model for fortifier enriched pellet for the pooled sample at 1 percent level. The average marginal effect revealed that; younger respondents had on average 6 percent more farmers' willingness to pay for the fertilizer input than the older respondents after controlling for other variables. This result gives a good indication of a sustainable fortifier enriched pellet demand; as users may have more farming years ahead. These empirical findings confirm the hypothesis that the probability to pay higher premium for fortifier enriched pellets, thus confirming what Agyekum et al. (2014) found for Shai-Osudoku and Ningo Prampram Districts crop farmers; Danso et al. (2006) for Greater Accra and Northern region farmers but in contrary to Ashanti region farmers.

Head of household variable showed positive and significant relationship with willingness to pay for fortifier enriched pellet at 5 percent significant level. Farmers who were head of household at the time of the interview had on average, more farmers' willingness to pay for the product by 10 percent as compare to those who were not, after holding the other independent variables constant. This is particularly so because households' heads are mainly responsible for taken major farming decisions.

The coefficient of secondary education status was negative and statistically significant in the WTP model for fortifier enriched pellet. Respondents with some secondary schooling had on average 12 percent less willing to pay than the base variable (tertiary education) implying that, respondents with the highest level of education were more willing to pay for the fertilizer input after holding other variables constant. It also implies that higher educated individuals are more informed of the benefits of excreta reuse as a fertilizer and would be willing to pay extra for the product. This concurs to the findings by Danso et al. (2006) for Ashanti region consumers but incoherent with the results of Agyekum et al. (2014) for Shai-Osudoku and Ningo Prampram Districts farmers.

Furthermore, current land holding for farming activities variable was positive and statistically significant at 5 percent level. It was further revealed that, farmers who owned current land holding for farming activities had on average increased the probability of the choice to buy fortifier enriched excreta pellets by 9 per cent than those who did not own their current land holding for farming activities after controlling for other variables. This is so

because farmers are secured with their farmlands and thus will want to venture into a long-term soil improvement (Danso et al., 2006).

The annual household income variable had a negative sign and was statistically significant at 1 percent significant level. Farmers with lower income levels had on average 13 percent, more farmers' willingness to pay for fortifier enriched pellet than farmers with higher income levels. However, in order to agree with economy theory, income is estimated to have a positive relationship with willingness to pay (Alebel, 2002; Asafu- Adjaye, 2000; Oladele, 2008). This is particularly not so because it might be possible that higher income farmers have the purchasing power to patronize the inorganic fertilizer which they are familiar with it usage. Again, high income farmers might be skeptical of fortifier enriched pellet effectiveness since they have not seen field demonstration trials of the input. These empirical results concur with the findings by Danso et al. (2006) for farmers in Ghana but inconsistent with other related willingness to pay study (Agyekum et al., 2014).

4. Conclusions

The study found out that, factors such as Head of Household, current land holding, age, and annual household income significantly influence farmers' WTP premium for fortifier enriched excreta pellets in Ghana. Since, head of household, current land holding, age, secondary education, and household income significantly influence farmers WTP a premium for fortifier enriched excreta pellets in both regions, the marketing of these products should be tailored towards the head of household farmers and farmers who own their current land holdings. Also marketing fortifier enriched excreta pellets should focus on farmers with low income, younger farmers and farmers with higher educational status. Farmers sometimes attach more importance to organic fertilizers because of the potential benefits on the soil and crops. Some policy measures therefore need to be put in place by Non-Governmental Organizations and other stakeholders to promote patronage of organic fertilizers. Thus, through efficient marketing and educational drives, awareness is generated on the significance of applying organic fertilizer products.

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