

Willingness to Pay for Faecal Compost by Farmers in Southern Ghana

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Abstract

The use of faecal waste for agricultural production is practiced by farmers in most parts of Ghana. However, information about farmer acceptability and willingness to pay is not widely reported. Using choice experiment, this study analyse willingness to pay for faecal compost by farmers in Ningo-Prampram and Shai-Osudoku in Southern Ghana. Data was collected from 200 randomly sampled farming households and analysed using basic and hybrid conditional logit models. Results show farmers' marginal willingness to pay values of US$ 0.51 for packaging only, US$ 0.32 for labeling only and US$ 0.82 for packaging and labeling of 50kg faecal compost. 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.

Keywords: Choice Experiment, hybrid Conditional Logit, Faecal Compost, Ghana

1. Introduction

Rapid urbanization in Low and Middle Income Countries has posed major challenges to rural–urban planning and food security as well as waste management and environmental protection (Drechsel and Kunze D 2001). Food production in Africa suffers from numerous constraints, including diminishing arable land due dwindling water resources, climate variability, unimproved planting materials, poor marketing and distribution system, and, above all, high cost of agricultural inputs, particularly fertilizer (Alfsen 1997; Crppenstedt 2003). Higher rate of soil fertility decline and consistently lower crop yields therefore necessitate increased use of inorganic fertilizer in Africa (Alfsen 1997; Xu *et al*. 2009; Larson 1993).

However, according to Yawson *et al*. (2010) the high cost of inorganic fertilizer prevents particularly small-holder farmers, who are resource-poor (predominantly within low income bracket), from using the required levels of fertilizer to boost crop production. Therefore, there is the need for cost effective alternative soil ameliorants which, in addition to increasing farmer productivity, would also provide protection and restoration of the ecosystem.

In each year, an average of 520kg of toilet waste containing 7.5kg of Nitrogen Phosphorus and Potassium and some micronutrient in a form usable by plants is produced by one person which when converted into fertilizer and applied to the soil, can organically produce 250kg of grain/cereals (Wolgast 1993). Even though the use of faecal matter for agricultural purposes is reported in some parts of Ghana (Danso *et al.,* 2005; Cofie *et al*., 2005; Owusu-Bennoah and Visker, 1994;) there is little or no evidence of an existing market for processed and packaged faecal compost.

For an immerging business to be sustainable, it is very imperative that the demand and willingness to pay for that good by its target consumers are solicited for. Whether or not the product will be accepted by the market is a crucial problem that needs to be evaluated before investment is made (Anderson *et al*. 1993). More so, the form in which consumers wants the product to appear is of great market significance. Agriculture in Ghana is dominated with small scale farmers known to be associated with poor income levels (Yawson *et al.* 2010). Meanwhile it requires some financial investment to turn raw faecal matter into a harmless organic fertilizer and to further package it for sale. Such financial investment may be done in an expectation of financial returns. Therefore farmers (predominantly peasants) may have to pay for faecal compost, if they accept its use for farming. Thus whether farmers will be willing and capable to pay for faecal compost as an alternate soil ameliorant to inorganic fertilizer, and also, the amount they will be willing to pay for market value addition to faecal compost were questions worth seeking answers to. This study uses the choice experiment to

hypothetically elicit farmer's willingness to pay for faecal compost in peri-urban Ghana.

2.0 Methodology

2.1 Study Area and sampling

The study was conducted in the Shai-Osudoku and Ningo Prampram Districts in the southern Ghana. between the months of April to October, 2012 as part of the Sustainable Sanitation (SUSA) Ghana Project. A random sample of 200 farming households was chosen using a sampling frame from the Dodowa Health Demographic Surveillance System (DHDSS 2011). Data were via a pretested questionnaire.

2.2 Economic Model

Choice experiment (CE) asks subjects to choose between scenarios that are described by attributes of the good in question. Choice experiment is therefore a combination of Lancaster (1966) characteristic theory of value and McFadden's (1974) random utility theory. According to Robert and Estelle, (2010) choice experiments (CE) has emerged as a preferred stated preference technique in recent literature for estimating the economic value of environmental goods and services.

In this study, respondents are assumed to make trade-offs between attributes of various sets of faecal compost options; thus the frame of reference was made explicit to respondents via the inclusion of attributes of the product, which enabled implicit prices to be estimated for attributes such as price, packaging and labeling.

The choice model (Equation 1) consists of two independent and additive parts, observable V_{ij} and unobservable (ε_{ij}) components (Verbeek 2004).

$$U_{ij} = V_{il} + \varepsilon_{ij} \qquad (3.1)$$

According to Greene (2007), in a CL model, the utility functions are conditioned on observed individual's choice invariant characteristics, Z_i and attribute of the choices which includes a price attribute necessary for the estimation of the willingness to pay for that choice X_{ij}, as well as a constant α_j known as the alternative specific constant (ASC) and so V_{ij} can be written as in Equation 3.2.

$$V_{ij} = \alpha_j + \beta' x_{ij} + \zeta_j' Z_i \qquad (3.2)$$

The error terms (ε_{ij}) of the model is 'assumed to be independently distributed across utilities', making the probability of individual *i* choosing alternative *j* as given in Equation 3.3, and their probabilities as presented in Equation 3.4 where y_i = the index of the choice made.

$$if \quad \Pr ob(U_{ij} \succ U_{iq}) \, for \, all \; q \neq j. \qquad (3.3)$$

$$then \quad P(y_i = j) = \frac{\ell^{V_{ij}}}{\sum_{q=1}^{j_i} \ell^{V_{iq}}} \qquad (3.4)$$

The model has an assumption that all (ε_{ij}) is independent across respondents. Thus the error terms of the choice sets should not relate to each other. This property is called Independence of Irrelevant Alternatives (IIA). The conditional logit specification implies that selections of an option from the choice set must obey the `independence from irrelevant alternatives' (IIA) property. This assumption places some limitations to the application of conditional logit CL model to mimic empirical choice situation because when different options of the same product is presented to a choice maker, his choice for one of the option is surely influenced by the presence or absence of other options available.

There are several possibilities for removing IIA violations and also improving the model fit. However as suggested by Rolfe et al. (2000) and McConnel and Tseng (2000), the inclusion of interactions between socio-economic characteristics of the choice maker and attributes of the product is a simple but important step for estimating more accurate models of choice to both improve model fit and relax the IIA assumption by introducing heterogeneity in the choice problem.

Another condition that forms the basis for the use of interaction terms in the CL model in this study follows the examples of Walker (2001) and (2006) where the theory of choice is extended to include the cognitive process of attitude and perception or some characteristics associated with a choice maker and his choice behaviour. According Ben- Akiva *et al*. (1999), including interaction terms in the conditional logit model allows for more realistic representation of behaviour in the choice process, with a better predictive power, producing consistent and efficient estimates of the parameter, and also fills the gap between behavioural theory and discrete choice.

Following the conditions above, two models were used for the analysis of the choice data. A basic CL model, which includes choice as a dependent variable and the attributes of the faecal compost as the independent variables (table 2), and hybrid CL model having the interaction of some choice attributes and some socio-economic characteristics of the choice maker and his experience with faecal or related organic compost use (Table 3).

The estimation of trade-off between attributes is as shown in equation (3.5), also referred to as the implicate price IP estimation. This gives an indication of the value farmers assign to an addition of a packing option or label to the specified kilograms of faecal compost under valuation.

$$IP = -\frac{B_K}{\beta_C} \tag{3.5}$$

Where B_K = the co-efficient of the attribute whose IP is to be determined and β_C = the coefficient of the price attribute

2.3 The choice Design:

To be able to efficiently solicit for farmers' willingness to pay for faecal compost, the research went through several processes. The determination of the appropriate attributes of the product and the financial value that should be attached to each of the attributes, formation of choice sets designed orthogonally with SPSS version 20, and the formation of possible choice profile that was seen to have minimal cognitive burden on respondents and finally the elicitation process.

2.3.1 The Product

The product that was presented for hypothetical choice elicitation was a 50kg weight of fecal compost, well processed to eliminate all pathogens that could be harmful to human health and packaged with a label indicating the application procedures and nutrient compositions of the organic fertilizer.

This product was then redefined according to their marketing attributes such as price, packaging and labeling.

2.3.2 Choice Elicitation Process:

The questionnaire for the field survey was designed in a simplified manner so as to reduce cognitive burden to the barest minimum and to also reduce the probability of a farmer assigning a false value to an attribute or their entire willingness to pay. Thus, a sample of faecal compost produced from the Valley View University in Oyibi, Ghana was presented to respondents before they made their choices. Choice sets were obtained orthogonally using SPSS. In the implementation of the choice experiment, farmers were asked to make a choice among three sets of faecal compost options, having differences in price, packaging and labeling and their combinations including a 'no choice' option. With each of the 200 respondent making a total of nine repetitive choices, the choice experiment data had a total 1800 observation.

3.0. **Results and Discussions**

3.1 Socio-demographic Characteristics of the Respondents

Table 1 below shows some selected socioeconomic characteristics of the respondents interviewed. Some variables measured include respondent's age, household size and household monthly income. Whilst the average age of household heads was 48 years, average household size of the respondents interviewed was 6 people per household. This shows a higher average household size among farming households in the study as compared to the average household size of the two districts as 2012 (DHSS, 2012)

Percentage frequencies of gender, marital status, educational attainment, primary occupation and ethnic background were also measured. Males were 81.5% whiles females were 18.5%. This might have been so because in most rural and peri-urban homes, men are usually the decision makers and hence, unless purposively sampled, males are more likely to dominate studies in which the household decision makers are sampled. With marital status, most of the respondents interviewed were married 74% while 7% were divorced and 19% single.

Farmers' educational level was measured at four levels; no educational level, primary/ junior high school, senior high/O/A level and tertiary/post secondary education. However, none of the respondents interviewed had tertiary education. Other variables measured were the forms of labour farmers mostly used, the sanitation facility used and ethnic backgrounds. With farm labour source, most respondents (57%) use both hired and household labour equally. However, the use of household labour only is higher (25.5%) than hired labour only (17.5%). This could also be explained by the larger average household size among farming households as measured in this study.

Table 1: Summary of Socio-economic variable

Variables	Max	Mean	Min	SD
Age	75	47.75	19	1.124
Household size (number of people in the house)	20	6.43	1	3.294
Household income (GH₵)	450.00	161.9750	20.00	111.493
	Options	**Frequency**	**Percentage**	
Gender	Male	163	81.5	
	Female	37	18.5	
Marital Status	Single	38	19.0	
	Married	148	74.0	
	Widowed	14	7.0	
Educational Background	No formal Education	86	43.0	
	Primary/Junior High	80	40.0	
	Secondary	34	17.0	
Primary Occupation	Crop Production	188	94.0	
	Animal Husbandry	1	0.5	
	Others	11	5.5	
Ethnicity	Ga Dangme	187	93.5	
	Ewe	7	3.5	
	Akan	6	3.0	
Form of Labour Mostly Used	Hired Lab	35	17.5	
	Household Lab	51	25.5	
	Both Equally	114	57.0	
Sanitation Facility in Use	Pit Latrine	65	32.5	
	VIP	11	5.5	
	Open Defecation	116	58.0	
	Public Toilet	8	4.0	

***GH ₵** is the unit of currency in Ghana. At the time of the survey, GH₵ 1= US$ 1.8*

Source: Survey Data.

From table 4.1, 43% of the farmers interviewed did not have any form of formal education. While 40% had obtained some form of primary/junior high Education, only 17% of the respondents had obtained Secondary High/ some Post Secondary Education. When measured as a continuous variable, farmers average years of schooling was only 2 years.

Open defecation happens to be the most (58%) subscribed sanitation practice followed by pit latrine (32%). The closeness of housing to bushy environment coupled with the scattered nature of settlement in the study area may be the major contributing factor to open defecation.

3.2 Analysis of WTP and Marginal Willingness to Pay

Model 1: choice- Attributes only

Table 2 Basic Conditional Logit Estimate of Choice with Choice Attributes Only

Variables	Co-efficient	Z-values
Price	-2.964644***	-22.04
Package + Label	5.566769***	21.49
Package	3.629384 ***	16.54
LR χ^2	2921.86	
Pseudo R2	0.8040	
Log likelihood	-305.82675	

*****significant at 1%.**

Model 2: Choice attributes and Socio-economic Variables

Table 4 Hybrid Conditional Logit Estimate of Farmers Choice for Faecal Compost with Attribute*Socio-economic Variable

*****Significant at 5%, ** significant at 5%, *significant at 10%**

Table 2 shows the basic conditional logit estimates of choice against product attributes.

Form the Table price, package only and package plus label, significantly affect farmer's choice for faecal compost.

The Model 2 estimated in Table 3 is the hybrid CL model in which product attributes are interacted with individuals socio-demographic characteristics as well their knowledge of faecal and other organic compost re-use. The marginal willingness to pay values for the product attributes are also estimated in the table.

The interaction terms in the model introduces preference heterogeneity in the multinomial setting and also increase the models fit whiles relaxing the IIA assumption (Massimiliano Mazzanti 2001; Greene 2000; Long 1997; Maddala 1987).

Comparing the models 1 and 2, pseudo R^2 measure of fit values showed an improvement in the hybrid models over the basic CL model. Indicating that extended specifications in the later explain more comprehensively the choices made by respondents. The hybrid CL again has a higher level of parametric fit compared to the basic model, with improvements in log-likelihood values.

Both models had no alternative specific constants. Indicating that, in the choice experiment, all the respondents made choice of at least one of the choice packages other than the status quo.

3.2.1 Marginal Willingness to Pay (MWTP)

Table 3 shows the MWTP estimates. These values indicate how much extra a farmer is likely to pay for an addition of that attribute as an improvement to the product. Results showed that farmers will be willing to pay for an amount of US$ 0.51 for 50kg of faecal compost to be packaged and are also willing to pay additional US$ 0.32 if application instructions and nutrient composition is added to the fertilizer in a form of a label. The marginal willingness to pay for backpacking plus labeling was US$ 0.82

Model 2: choice-attributes interaction terms

Table 3. Hybrid CL model

Variables	Co-efficient	z-values	p- values	MWTP GH₵ (US$)
Choice/Willingness to pay				
Price	-3.112***	-21.82	0.000	
Package + Label	4.596 ***	4.23	0.000	1.48 (0.82)
Package	2.825 **	2.23	0.026	0.91 (0.51)
Label only [MWTP of (Package + Label) –Packaged only]				0.57 (0.32)
Packaged and Labeled *Gender	-.472	-0.96	0.336	
Packaged and Labeled*Income	.010***	4.69	0.000	
Packaged and Labeled*Household Size	.162***	2.83	0.005	
Packaged and Labeled*Education	-.320***	-2.69	0.007	
Packaged and Labeled *Age	-.037***	-3.04	0.002	
Package*Income	.004	1.29	0.196	
Package*Gender	.087	0.15	0.881	
Packaged and Labeled*Use of Cow Dung	1.097*	3.97	0.000	
Package *Age	-.029*	-1.68	0.092	
Package*Knowledge on Faecal Compost	1.097*	1.87	0.062	
Packaged and Labeled * Knowledge on Faecal Compost.	-.464	-1.10	0.273	
Log likelihood	-296.676			
Pseudo R^2	0.8321			
LR (11) χ^2	2919.47			

Source: Field Survey, 2012. *=significant @ 10%, **=significant @ 5% ***=significant@1%

3.2.2 The factors that influence farmers' choice/ willingness to pay

The parameters of the model 2 in Table 3 show that all the choice attributes (price, packaging and packaging plus label) were significant determinants of farmers` choice and willingness to pay. The parameter estimates show that, farmers' choice and willingness to pay for faecal compost is likely to decrease as the price of faecal compost increases. This is consistent with basic economic principle of price and quantity of a product demanded and finding from many studies like Yusuf *et al*. (2007), Alagbe (2006) and Oni *et al*. (2005) that increase in price reduces the willingness of consumers to pay. Meanwhile, an addition of a package as well as a label indicating application procedures and nutrient content has a likelihood of increasing farmers' choice and willingness to pay.

Other variables explaining farmers' willingness to pay variable are the interaction of the product attributes and some choice invariant characteristics (knowledge of faecal compost as organic fertilizer and experience of use of related organic fertilizer and farmers' socio-economic characteristics).

The Hybrid CL model estimates show a positive and significant relationship between farmers' knowledge on faecal compost, experience with the use of cow dung with farmers' choice and WTP. However, in the latter, the farmers having experience with the use of cow dung are more sensitive to packaging and labeling attributes of faecal compost whilst farmers having knowledge on the use of faecal compost are sensitive to packaging only. These relationships could be due to the fact that farmers already perceive bulkiness and labour intensiveness as

characteristics of faecal compost (Agyekum 2013; Agyarko 2007) Therefore the packing and label may reduce the burden on application hence increasing farmers' assumed utility from the use of packaged and labeled faecal compost. Farmers who have some knowledge on faecal waste re-use were also likely to have a higher willingness to pay but only for packed faecal compost and not necessarily with labeling.

Farmer's household income measured in disposable monthly income positively influence farmers willingness to pay for a packaged and labeled faecal compost. Indicating that farmers with higher household income will more likely have a higher willingness to pay for packed and labeled faecal compost than those with lower income. Many studies on willingness to pay like that of Oladele (2008); Adepoju and Omonona (2009); Shen (2012), among many other studies verify this relationship.

Household size was positively influencing WTP for faecal compost through interaction with package plus label. This association could mean that households with higher number of people to feed will be willing to pay for a new farming input resource/technology that is said to have the capacity to boost the yield of crops and thereby increasing the food security of the household.

Education and age were both significant determinants of choice. As expected, age of farmers have a negative relationship with farmers WTP for faecal compost. This implies that, younger farmers have higher interest in alternation soil ameliorant to chemical fertilizer than elderly farmers. This result gives a good indication of a sustainable faecal compost demand; as its users may have more farming years ahead.

Meanwhile, the apriori expectation that one's educational level could positively influence his appreciation of value was not satisfied in this study. The results from the study rather show a negative relationship between farmers` level of education and their willingness to pay.

4.0 Conclusion

In the basic CL model, choice/WTP was estimated against the attributes of choice including price, package and package plus label. The model showed that farmers' willingness to pay for faecal compost is higher when the product is packaged and labeled. Meanwhile, the higher the price of faecal compost, the lesser farmers will be willing to pay for it. Further analyses on the factors that determine the willingness to pay were explained in terms of their interactive effect with some attributes of the product.

Results showed that household monthly income, household sizes and farmers experience with use of faecal compost were all significant and positively related to choice and the willingness to pay. Interaction of education and age with packaging and labeling however showed an inverse relationship. Thus whilst farmers` willingness to pay for a packaged and labeled faecal compost increases among young farmers, farmers level of education have a negative relationship with choice and willingness to pay. In light of the findings from this study, it is recommended that, further studies should be conducted in the cost of producing faecal compost through the different types of faecal compost technologies. In soliciting for people's willingness to pay among rural farmers who have lower education level, the information load in choice experiment should be minimal to avoid cognitive complexities. Also to ensure sustainability in waste management, studies in sanitation values chain should be encouraged to better improve the end use of faecal waste.

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