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Determinants of Willingness to Pay (WTP) for organic fertiliser: a case of smallholder potato farmers in KwaZulu-Natal, South Africa

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Abstract

The South African smallholder sector is characterised by relatively low productivity due to persistent deterioration in soil fertility owing to declining organic matter and other essential soil nutrients. Consequently, adoption of sustainable agricultural inputs like organic fertiliser is essential. Although there is sufficient advocacy in the adoption of organic fertiliser, the economic linkage between farmers' socioeconomic factors and willingness to pay (WTP) remains under-explored. This study investigated the determinants of WTP a price premium for organic fertiliser among smallholder potato farmers using primary data collected from 189 smallholder farmers in three municipal areas in KwaZulu-Natal, South Africa, through a multi-stage sampling technique. The data was analysed using the ordered logit model and results revealed that marital status, access to extension services, and knowledge of organic fertiliser usage, land ownership, livestock size and distance to the source of organic fertiliser influenced the farmers' WTP for organic fertiliser. The study found that about 83.6 % of the sampled smallholder farmers were willing to pay for organic fertiliser, while about 16.4 % of them indicated that they were not willing to pay for organic fertiliser. This result justifies the prospect of commercialisation of organic fertiliser to facilitate the availability of organic fertiliser to those that are willing to pay for it. This study recommends improved access to extension services to enhance technical information dissemination and knowledge of organic fertiliser usage among smallholder farmers. Development of policies that strive to institute security of land tenure among smallholder farmers, which will encourage smallholder farmers WTP is also essential.

Keywords: extension services, contingent valuation, adoption, land tenure, multi-stage sampling, ordered logit

1 Introduction

In South Africa, the agricultural sector is dualistic, consisting of the commercial sector which is highly capital intensive and the subsistence sector which is characterised by smallholder farmers, who are often poor and endowed with inadequate or obsolete production capitals (Baiyegunhi & Fraser, 2014). Smallholder farmers are mostly situated in rural areas or former homeland areas (Baiphethi & Jacobs, 2009), usually owning small plots of land on which they grow subsistence crops and/or one or two cash crops. They rely extensively on family labour and in their production systems, which are mostly characterised by simple technologies and low returns, women play the most important role in production (DAFF, 2012). In addition, they are mostly characterised by poor access to both input and output markets, which has a remarkable effect on their production activities. This is linked principally to their remote and rural settings which further limit their access to physical and economic infrastructures that consequently increase costs of transactions and lower profit margins (Fan *et al.*, 2013; Sinyolo & Mudhara, 2018).

The South African potato industry comprises of the commercial farmers and the smallholder farmers, however, most potatoes produced are from the commercial sector (NAMC, 2012). According to Potatoes South Africa (PSA) records, there are about 635 commercial potato producers and over 1000 active smallholder potato farmers. The South African potato production is carried out in all nine provinces. The potato industry contributes to the livelihoods of many individuals in the country by creating jobs and generating income for potato producers, subsequently contributing to poverty alleviation and ensuring food security (PSA, 2012).

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However, potato cultivation usually involves intensive soil tillage throughout the cropping season, which often results in nutrient and organic matter depletion from soils (soil degradation), erosion, and leaching of nitrates (Kenmore *et al.*, 2004; FAO, 2005). Nutrient replenishment is required to maintain soil productivity and to achieve sustainable and optimal yields of crops (Kenmore *et al.*, 2004; FAO, 2005; Adediran *et al.*, 2005).

Land degradation has become one of the world's greatest environmental threats, as it poses a severe challenge to agricultural productivity mostly in developing countries, where agriculture contributes substantially to the economy (Ketema & Bauer, 2011). As a result, the adoption of fertility or productivity improving technologies (e.g. organic manure and fertilisers) is essential in order to improve long-term soil fertility and increase crop productivity and yield (Terefe & Ahmed, 2016). Hence, enabling smallholder farmers to become self-sufficient in potato production and less-dependent on food purchases in the market. Excess production resulting from improved soil fertility could also improve household income and welfare outcomes. Therefore, soil fertility improvement for smallholder farmers is believed to be critical for mitigating the consequences of food insecurity and poverty.

However, there is a low level of inorganic fertiliser usage by smallholder farmers in South Africa which is not effective for maintaining soil fertility and crop sustainability (Sinyolo & Mudhara, 2018). The main factor constraining the use of chemical fertilisers is their high cost while smallholder farmers are characterised by low purchasing power (Cedric & Nelson, 2014). Literature recommends that it is necessary to develop and adopt mechanisms that alleviate these challenges faced by smallholder farmers (Mkhabela, 2002; Terefe & Ahmed, 2016; Sinyolo & Mudhara, 2018).

Given these disadvantages associated with chemical fertilisers, adoption of organic fertiliser by smallholder farmers seems to be a potential alternative to ensure sustainable agricultural production. The use of organic fertilisers is advantageous to smallholder farmers as compared to chemical fertilisers (Mkhabela, 2002; Cedric & Nelson, 2014; Terefe & Ahmed, 2016; Sinyolo & Mudhara, 2018; Mkhabela, 2002). The rationale behind this is because organic fertilisers are easily accessible to farmers, available on the farm or close to the farm at a relatively low or no cost besides the cost of labour, transport costs and or opportunity costs of land used for their production (Gupta & Hussain, 2014). In addition, since organic fertilisers are made up of natural materials originating from either plants or animals (livestock manures, green manures, crop residues, household waste, compost and woodland litter), they improve soil structure and organic matter, water infiltration and aeration, reduce soil erosion, enhance soil biological activity and improve crop yields (Cedric & Nelson, 2014; Gupta & Hussain, 2014).

Although there is sufficient advocacy in the adoption of sustainable agricultural inputs such as organic fertiliser, the economic linkage between farmers' socioeconomic factors and willingness to pay (WTP) has not been adequately explored. WTP is defined as "the maximum price that a buyer accepts to pay for a given quantity of goods or services" (Le Gall-Ely, 2009); while Baiyegunhi *et al.* (2018) defined WTP as the maximum additional price premium that a consumer is willing to pay for a particular commodity compared to the price charged for an alternative commodity. In marketing, the price is the most important variable, for both corporate practices and buying decisions of consumers because of its contribution to sales, margins, and product positioning and thus making it imperative to assessing consumer perceptions about prices (Le Gall-Ely, 2009; Etim & Benson, 2016). Hence, for agribusiness ventures to be sustainable, the determination of consumers' willingness to pay for a product is vital in order make inferences about consumer preferences or perceptions about prices (Etim & Benson, 2016).

There are several methods that are used to measure WTP, however, the most common ones are conjoint analysis, that assesses products profiles through their characteristics (attributes) and price; contingent valuation (CV), which involves conducting direct interviews with open-ended questions on WTP and/or closed-ended questions on the intention to buy at a proposed price and lastly, price tests which applies a simulated purchase price (Le Gall-Ely, 2009; Shee & Haile, 2020; Otoo *et al.*, 2018). These methods enable economists or analysts to elicit money values that individuals are willing to pay in order to acquire a good or service. Contingent valuation is the most broadly adopted and used method of measuring WTP and it is a general questioning technique that aims to identify how much individuals are willing to pay subject to availability of a good or service in the market (Naanwaab *et al.*, 2014; Otoo *et al.*,2018).

The aim of this study is to estimate the smallholder potato farmers' WTP a price premium for organic fertiliser in KwaZulu-Natal (KZN), in other words, to determine whether smallholder potato farmers in KZN are willing to pay for organic fertiliser and to investigate the determinants of their WTP.

2 Materials and methods

2.1 Study area description

This study was conducted at Msinga, uMshwathi and uMzumbe local municipalities of KZN Province, South Africa. In terms of population size, KZN is the second largest province, with an estimated amount of 11,3 million people (about 19,2 %) and it consists of 43 local municipalities (Stats SA, 2019). Msinga local municipality has an estimated population size of 189 578 people, living in an area of 2500 square kilometre (sq km), while uMshwathi local municipality consists of an estimated population size of 111 645 people, in an area of about 1 811 sq km (Media, 2018). On the other hand, uMzumbe local municipality has an estimated population size of 160 005 people and it covers a vast, largely rural area of about 1 182.7 sq km (Media, 2018).

These three municipal areas were chosen for this study because they comprise of a majority of rural smallholder farmers with relatively homogeneous socio-economic characteristics. They are characterised by limited formal employment and hence, they are low income and poverty-stricken communities. The majority of the population depends mainly on welfare-social grants, particularly old age pensions and child support grants, and also smallholder farming (e.g. potato production) as their primary source of livelihood. In addition, most rural households depend on the land and other natural resources like kraal manure to improve their productivity.

2.2 Data collection and sampling methods

This study employed the multi-stage random sampling technique to select respondents. The first stage involved purposive selection of smallholder farmers who are involved in potato production regardless of whether they are using or not using organic manure/fertiliser in Msinga, uMshwathi and uMzumbe local municipalities. The second stage employed a simple random sampling technique to select subsamples of 63 smallholder farmers from each of the three selected municipal areas to constitute a total sample size of 189 smallholder potato farmers. The respondents were requested to participate freely in the survey. They were assured of the privacy, anonymity, and confidentiality of the data collected from them. Ten randomly selected smallholder potato farmers from each of the three municipalities concerned were interviewed in a pilot survey to evaluate the feasibility, time, cost, adverse events and to test the structured questionnaire for any ambiguities. From their responses, ambiguous questions were modified, and possible responses that were not included in the closed-ended questions were added.

The questionnaires were administered by trained enumerators who understood data collection methods and the questionnaire content before performing the survey. The training involved a review of the questionnaire and asking the enumerators to share how they would ask questions in isiZulu since most of the respondents do not speak English language. This was done to establish a common understanding of the type of data required by each question and to ensure that the enumerators collect the right data.

Data were collected on smallholder potato farmers' socioeconomic characteristics and household demographic information such as gender, age, marital status, farming experience, household size, and education level. The questionnaire also included measures of WTP, livestock and asset ownership, and off-farm income and expenditure patterns. Furthermore, the questionnaire captured data on capital assets (human, natural, financial, physical, social and psychological), government support, social grants and access to credit. At the end of each interview with the respondents, questionnaires were checked to ensure that all the information was captured comprehensively and correctly. The same set of questionnaires were used across the study areas to ensure that the information collected is consistent across the sampled smallholder potato farmers.

2.3 Theoretical and conceptual framework

This study employed the contingent valuation method (CVM) to elicit the farmers WTP for organic fertiliser. CVM is a survey-based technique which assigns monetary values on environmental goods and services for which there is no real market for them (Carson, 2000). Hence, CVM is mostly used in hypothetical market scenarios. WTP for any particular commodity can be referred to as a choice issue between the consumer-stated preference framework rather than revealed preference (Owusu & Anifori, 2013).

In the stated preference valuation methods respondents provide value estimates in a survey contingent upon information previously given to them in the hypothetical market setting; hence they are referred to as CVM (Jinbaani, 2015). Whereas, the revealed preference method estimates the value of the non-market commodity through the revealed (actual) behaviour based on the closely related market (Carson, 2000; Owusu & Anifori, 2013). CVM can be used to determine WTP for a particular commodity through the use of several different elicitation methods. However, this study employed the dichotomous choice method (single bounded and double bounded). The dichotomous choice method was chosen because of its ability to solve the problems or limitations associated with other CVM elicitation formats (Lusk & Hudson, 2004; Shee & Haile, 2020).

According to Cobbinah *et al.* (2018), a consumer chooses to purchase a product which gives them a higher utility or satisfaction. Therefore, following the maximum utility framework as applied in other WTP studies (Owusu & Anifori, 2013; Njoko, 2014; Cobbinah *et al.*, 2018), a rational farmer i is presumed to make a choice of the soil ameliorant that provide high utility between organic fertiliser (γ^1) and conventional (chemical) fertiliser (γ^0). Consequently, a farmer is willing to pay more (a premium) for organic fertiliser provided that the expected utility from using an organic fertiliser $E[\Omega(\gamma^1)_i]$ is positive and is higher than the expected utility of using inorganic fertiliser $E[\Omega(\gamma^0)_i]$. The function for the farmers' WTP a premium for organic fertiliser is specified as a change in the utility arising out of choice made by the farmer: $\text{WTP} = h[\Delta\Omega(\gamma)]$. Where: $\Delta\Omega(\gamma)$ is the change in utility if $h > 0$. Therefore, the farmer chooses organic fertiliser γ^1 over conventional fertiliser γ^0, given that the difference in the utility is positive $[\Delta\Omega(\gamma^1) = \Omega(\gamma^1) - \Omega(\gamma^0) > 0]$ for all $\gamma^1 \neq \gamma^0$. Nevertheless, the utility of the farmer is unobservable. The only observable thing is whether the farmer chooses to pay a premium for organic fertiliser.

To analyse this choice behaviour of a farmer, this study employed both the single bounded dichotomous choice (SBDC) framework and the double bounded dichotomous choice (DBDC) framework (Lusk & Hudson, 2004). In establishing this, the sampled farmers were given a hypothetical scenario and the input of interest (organic fertiliser) was initially defined, the benefits of organic fertiliser and the change in the product as well as the method of payment was presented to smallholder farmers. In the SBDC question, the farmers were asked: "organic fertiliser increases yield and its free from chemicals, therefore, would you be willing to pay for organic fertiliser if it was prepared, well packaged, easily accessible and it is cheaper than chemical fertiliser?" The response generated from the SBDC question was "yes or no" which produces a categorical binary model.

Whereas, with the DBDC approach, respondents were presented with two consecutive bids with the second bid contingent upon the first bid. Initially, respondents were asked a general question about whether they are willing to pay an estimated price of R100 per 10kg of organic fertiliser. The response was a "Yes or No". The farmer who responded with "Yes" to the first bid was presented with a second higher bid. If the response to the first bid is "No", the respondent was presented with a second lower bid. The second bids were either higher or lower based on the outcome from a tossed dice containing four percentages (25 %, 50 %, 75 % and 100 %). The possible outcome combinations were no-no (n/n WTP), no-yes (n/y WTP), yes-no (y/n WTP) and yes-yes (y/y WTP). Those smallholder farmers who were not willing to pay for organic fertiliser were categorized by zero WTP. The combinations of these responses are presented in the framework modelled in Figure 1.

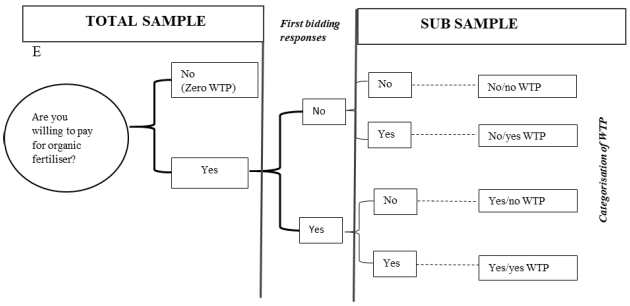

Fig. 1: *Contingent valuation method (CVM) elicitation method for willingness to pay (WTP) for organic fertiliser (Author's conceptualisation).*

The dependent variable is a categorical variable with five categories resulting from the possible outcome combinations of smallholder farmers WTP for organic fertiliser. Households' socio-economic characteristics and other institutional support variables that are included in the WTP model as explanatory variables are based on empirical evidence from literature established on factors influencing farmers WTP (Ulimwengu & Sanyal, 2011; Agyekum *et al.*, 2014; Njoko, 2014; Jinbaani, 2015; Mezgebo & Ewnetu, 2015; Etim & Benson, 2016).

These variables include details of household demographics and socio-economic characteristics such as (age, gender, educational level, etc.), wealth and asset endowment (Farm size, land ownership, livestock size, off-income etc.), access to support services (extension and credit etc.), infrastructural and/institutional support (distance to the source of organic fertiliser). The definition of these variables, their measurement and also their hypothesised sign or direction is presented in Table 1.

2.4 Empirical model

To estimate the factors influencing smallholder farmers WTP for organic fertiliser, the study employed the ordered logit regression model. This model has a continuous preference function of the unobservable (latent) decision to pay and the amount to pay. The latent continuous variable is a sum of explanatory variables and an error term, following the logistic distribution below:

$$\lambda_i^* = \sum_{i=1}^{n} X_i\beta + \varepsilon_i \tag{1}$$

The categorical observed variable contains the values that range from 0 up to m-categories, according to the following

Table 1: *Definition of variables used in the analysis and their expected direction.*

Variable	*Definition*	*Measurement*	a priori *expectation*
Dependent:			
Willingness to pay (WTP)	Dependent variable	Dummy variable with 5 categories	
Explanatory:			
AGE_OF	Age of respondent	Years	Positive
M_STATUS	Marital status	Dummy; 1 if a farmer is married; 0 if otherwise.	Positive
HH_GENDER	Gender of the household head	Dummy; 1 if a farmer is a male; 0 if otherwise.	Positive
ACC_CREDIT	Access to credit	Dummy; 1 if a farmer has access to credit; 0 if otherwise.	Positive
EDU_LEVEL	Level of education	The number of years a farmer spent in school.	Negative
ACC_EXT	Access to extension support	Dummy; 1 if a farmer has access to extension support; 0 if otherwise.	Positive
FAR_SIZE	Farm size	Hectares (ha)	Positive
KNW_UOF	Knowledge	Dummy; 1 if the farmer has knowledge of organic fertiliser usage; 0 if otherwise.	Positive
HH_SIZE	Household size	Number	Positive
LSTOCK_SIZE	Livestock size	Tropical livestock units (TLU)	Negative
OWN_LAND	Land ownership	Dummy; 1 if a farmer has land ownership rights; 0 if otherwise.	Positive
OFF_INCOME	Off-farm income	Non-farm income	Positive
DIST_FARM	Distance from farm to fertiliser market	Distance from farm to fertiliser market	Positive
SOC_GRANT	Access to social grants	Dummy; 1 if a farmer has access to social grants; 0 if otherwise.	Positive

system:

$$\lambda_i = j \Leftrightarrow \gamma_{j-1} < \lambda_i^* < \gamma_j \tag{2}$$

Where: λ_i = smallholder farmers' WTP for organic fertiliser, λ_i^* = the latent (unobserved) continuous variable, X_i = explanatory variables, β = unknown parameters to be estimated, γ = error term and threshold or cut-off values.

The double bounded dichotomous choice questions resulted in five mutually exclusive outcomes, which range from zero to four. Assuming that λ, γ_i, γ_L and γ_H and indicate the observed WTP, the initial bid, the second lower bid and the second upper bid respectively, then there were the following respondents: those who were not willing to pay for organic fertiliser; these have zero WTP. Those who responded with "No" to both bids (n/n WTP); those who responded with "No" to the first bid but said "Yes" to the second bid (n/y WTP); those who responded with "Yes") to the first bid but said "No" to the second higher bid (y/n WTP); those who answered "Yes" to both bids (y/y WTP). These can be expressed as in Equation 3.

$$\begin{aligned} \lambda_0 = 0 \; if \; \lambda_0^* \leq 0 \text{ for zero WTP} \\ \lambda_1 = 1 \; if \; 0 \; < \; \lambda_1^* \leq \gamma_1 \text{ for n/n WTP} \\ \lambda_2 = 2 \; if \gamma_1 \; < \; \lambda_1^* \leq \gamma_2 \text{ for n/y WTP} \\ \lambda_3 = 3 \; if \; \gamma_2 \; < \; \lambda_1^* \leq \gamma_3 \text{ for y/n WTP} \\ \lambda_4 = 4 \; if \; \lambda_1^* \leq \gamma_4 \text{ for y/y WTP} \end{aligned} \tag{3}$$

According to Maddala (1983) cited by Cobbinah *et al.* (2018), according to the Gaussian errors assumption, the ordered logistic probabilities for M-categories is given by the following expression:

$$\pi(\lambda_i \leq \frac{j}{X_i} = \Lambda(\gamma_j - X_i^{'}\beta) - \Lambda(\gamma j - 1 - X_i^{'}\beta) \tag{4}$$

Following the general logit framework:

$$\pi(\lambda_i \leq \frac{j}{\lambda_i} = \Lambda(\gamma_i^*) = \frac{\varepsilon^{\gamma_i^*}}{1 + \varepsilon^{\gamma_i^*}} = \frac{1}{1 + \varepsilon^{-\gamma_i^*}} \tag{5}$$

Therefore, the probabilities of each ordered outcome are given by the following:

$$\begin{aligned}\pi_0(\lambda_i = 0|X_i) &= \Lambda(-X_i\beta)\\ \pi_1(\lambda_i = 1|X_i) &= \Lambda(\gamma_1 - X_i\beta) - \Lambda(-X_i\beta)\\ \pi_2(\lambda_i = 2|X_i) &= \Lambda(\gamma_2 - X_i\beta) - \Lambda(\gamma_1 - X_i\beta)\\ \pi_3(\lambda_i = 3|X_i) &= \Lambda(\gamma_3 - X_i\beta) - \Lambda(\gamma_2 - X_i\beta)\\ \pi_4(\lambda_i = 4|X_i) &= 1 - \Lambda(\gamma_3 - X_i\beta)\end{aligned} \tag{6}$$

Given the combination of the five ordered outcomes above, the model employed the maximum likelihood (ML) criteria to estimate the model parameters, following the log-likelihood function specified below:

$$\begin{aligned}\ln l = \sum_{i=1}^{N} \Big\{ & d^{yy}\ln^{yy}(\gamma_i, \gamma_H) + d^{yn}\ln^{yn}(\gamma_i, \gamma_H)\\ & + d^{ny}\ln^{ny}(\gamma_i, \gamma_H) + d^{yy}\ln^{nn}(\gamma_i, \gamma_H) + d^{zero}\ln^{zero}(\gamma_i)\Big\}\end{aligned} \tag{7}$$

Where: d^{yy}, d^{yn}, d^{ny} and d^{nn} are binary variables presenting a value of 1 when the statement is true or 0 otherwise.

The function (equation 8) specified below represents the empirical model for analysing the factors influencing the smallholder farmers' WTP for organic fertiliser.

$$\ln\left(\frac{\pi_i}{1-\pi_i}\right) = \beta_i X_{ij} + \varepsilon_i \tag{8}$$

Where: $\ln\left(\frac{\pi_i}{1-\pi_i}\right)$ is the probability of WTP outcome; X_{ij} is the vector of coefficient estimates for household characteristics that are hypothesised to influence the smallholder farmers WTP for organic fertiliser, and ε_i is a white noise error term.

3 Results

3.1 *Descriptive statistics of smallholder farmers' WTP for organic fertiliser based on their demographics and socio-economic characteristics*

The descriptive statistics outlining the distribution of smallholder farmers WTP is summarised in Table 2. These results showed that the majority of smallholder farmers were willing to pay for organic fertiliser, while the minority indicated that they were not willing to pay for organic fertiliser.

The determinants of the WTP for organic fertiliser by smallholder potato farmers, as well as the significance level of tests of difference between means for each determinant for farmers that are willing to pay (WTP)and those that are not willing to pay (not WTP) for organic fertiliser are presented in Table 3.

Table 2: *Distribution of smallholder farmers' willingness to pay (WTP) for organic fertiliser (n=189).*

Category	*Description*	*Frequency*	*Percentage*
0	zero WTP	31	16.40
1	n/n WTP	46	24.34
2	n/y WTP	32	16.93
3	y/n WTP	25	13.23
4	y/y WTP	55	29.10

Note: n/n WTP: 'no' to both bids; n/y WTP: 'no' to the first bid, 'yes' to the second bid; y/n WTP: 'yes' to the first bid, 'no' to the second bid; y/y WTP: 'yes' to both bids.

The t-statistic results show that there are statistically significant differences between smallholder farmers who are willing to pay for organic fertiliser and those that are not willing to pay in terms of access to credit, level of education, knowledge of organic fertiliser usage, household size, livestock size, land ownership, off-farm income, access to social grants and the distance to the source of organic fertiliser.

Access to credit: The average percentage of smallholder farmers with access to credit who were willing to pay for organic fertiliser was greater than that of farmers who were not willing to pay. This implies that those farmers with access to credit are more likely to be willing to pay for organic fertiliser.

Educational level: The level of education among the sampled potato farmers is very low. The average number of years spent in school by those farmers who are willing to pay is slightly greater that of farmers with zero WTP.

Knowledge: Knowledge of organic fertiliser usage among sampled smallholder farmers was significantly different between farmers willing to pay and those with zero WTP. On average, the percentage of farmers willing to pay for organic fertiliser who are knowledgeable about organic fertiliser usage was significantly higher than that of farmers with zero WTP.

Household size: In terms of household size, farmers who were willing to pay for organic fertiliser had families slightly bigger than those of farmers with zero WTP. This suggests that there is a strong positive association between household size and WTP.

Livestock size: In terms of livestock size, the results showed that farmers who have more livestock holding (higher TLU) were not willing to pay for organic fertiliser as compared to those with less livestock holding. Results showed that those with less livestock size were willing to pay for organic fertiliser. This suggests that there is a negative association between WTP and livestock holding.

Table 3: *Description of determinants of WTP for organic fertiliser.*

	WTP (n=158)		*Zero WTP (n=31)*		
Variable	*Mean*	*SD*	*Mean*	*SD*	*t-value*
Age	46.53	1.13	45.35	2.89	0.41
Household head gender	0.37	0.04	0.35	0.09	0.06
Marital status	0.57	0.04	0.52	0.09	0.55
Access to credit	0.55	0.04	0.26	0.08	3.04***
Educational level	4.42	0.37	2.42	0.67	2.26**
Access to extension	0.52	0.03	0.58	0.09	0.63
Farm size (ha)	0.06	0.01	0.05	0.02	0.20
Knowledge	0.88	0.03	0.71	0.08	2.46**
Household size	5.08	0.29	6.84	0.58	2.50***
Livestock size (TLU)	9.04	1.16	19.67	2.98	3.62***
Land ownership	0.72	0.04	0.26	0.07	5.15***
Off farm income (Rands)	2169.6	104.61	1487.10	213.14	2.68***
Access to social grants	0.88	0.03	0.68	0.09	2.91***
Distance	5.11	0.37	2.11	0.66	3.36***

Note: ***, ** and * indicate statistical significance at 1 %, 5 % and 10 % levels of significance, respectively. See table 1 for measurement units.

Land ownership: In terms of land ownership, the average percentage of farmers who are land owners and who were willing to pay for organic fertiliser was significantly different and greater than that of farmers who are land owners and they were not willing to pay. This implies that those farmers who have land ownership rights are more likely to be willing to pay for organic fertiliser.

Off-farm income: The descriptive results also revealed that the average off-farm income for those farmers who were willing to pay for organic fertiliser was significantly different and higher than that of farmers who were who were not willing to pay. This means that there is a strong positive association between off-farm income and WTP.

Social grants: The majority of sampled smallholder potato farmers are social grant beneficiaries, and on average, the percentage of smallholder farmers with access to social grants was significantly greater for those farmers who were willing to pay as compared to those farmers who were not willing to pay for organic fertiliser. Thus, there is a positive association between WTP and farmers access to social grants.

Distance: Lastly, the descriptive statistics results revealed that farmers who are willing to pay for organic fertiliser, on average, travel longer distances to the source of organic fertiliser as compared to those farmers who were not willing to pay. This implies that there is a negative association between the average distance travelled to access organic fertiliser and WTP among those farmers who are within close reach to organic fertiliser.

3.2 Ordered logit model results for the determinants of WTP for organic fertiliser

The estimated results of the ordered logit model, which establishes the determinants of smallholder farmers' WTP for organic fertiliser are presented in Table 4. To explain the differential impact of explanatory variables on smallholder farmers WTP, the coefficient estimates, as well as the marginal effects (which represent changes in the probability of WTP) of the ordered logit estimates, are also presented in Table 4.

The model fits the data well because the Likelihood ratio Chi-square test of the hypothesis that all the regression coefficients are jointly equal to zero is rejected at 1 % level of significance. This implies that all the explanatory variables included in the ordered logit regression analysis explain the variations in the smallholder farmers WTP for organic fertiliser. The results showed that explanatory variables such as marital status, access to extension services, and knowledge of organic fertiliser usage, land ownership, livestock size, and distance to the source of organic fertiliser were all statistically significant in predicting the farmers' WTP for organic fertiliser. The coefficient estimates have the expected signs. Marital status, access to extension services, knowledge of organic fertiliser usage, land ownership and the distance to the source of organic fertiliser have a statistically significant positive effect on the likelihood of WTP for organic fertiliser, while livestock size has a statistically significant negative effect on the probability of WTP for organic fertiliser.

Table 4: *Description of determinants of WTP for organic fertiliser.*

	Coefficient		*Marginal effects (dy/dx)*				
Variable	*Value*	*SE*	*zero WTP*	*n/n WTP*	*n/y WTP*	*y/n WTP*	*y/y WTP*
AGE_OF	-0.0156	0.0140	0.00092	0.00266	-0.00005	-0.00121	-0.00232
M_STATUS	0.6236*	0.3699	-0.03659	-0.10616*	0.00191	0.04816	0.09268*
HH_GENDER	0.1154	0.2994	-0.00677	-0.01964	0.00035	0.00891	0.01715
ACC_CREDIT	0.3833	0.3510	-0.02249	-0.06524	0 .00117	0.02960	0.05697
EDU_LEVEL	0.0295	0.0359	-0.00173	-0.00502	0.00009	0.00228	0.00439
ACC_EXT	0.7844**	0.3773	-0.04603**	-0.13353**	0.00239	0.06058**	0.11658**
FAR_SIZE	0.4593	1.3545	-0.02695	-0.07818	0.00140	0.03547	0.06826
KNW_UOF	1.0646**	0.4779	-0.06247**	-0.1812**	0.00325	0.08222**	0.15822**
HH_SIZE	-0.0442	0.0503	0.00259	0.00752	-0.00014	-0.00341	-0.00657
LSTOCK_SIZE	-0.0441***	0.0121	0.00258***	0.00750***	-0.00014	-0.00340***	-0.00655***
OWN_LAND	1.8532***	0.3751	-0.10874***	-0.31548***	0.00566	0.14312***	0.27542***
OFF_INCOME	0.0002	0.0001	-0.00001	-0.00003	5.95e-07	0.00002	0.00003
DIST_FARM	0.1100***	0.0396	-0.00646**	-0.01873***	0.00034	0.00849**	0.01635***
SOC_GRANT	0.5023	0.5119	-0.02948	-0.08551	0.00154	0.03879	0.07466
/cut1	0.4301	0.7396					
/cut2	2.5384	0.7739					
/cut3	3.7792	0.7980					
/cut4	4.6419	0.8131					
n	= 189						
LR $Chi^2(14)$	= 130.26						
Prob > chi^2	= 0.0000						

Note: ***, ** and * indicate statistical significance at 1 %, 5 % and 10 % levels of significance, respectively.

4 Discussion

The results presented in Table 4 showed a statistically significant positive relationship between marital status (M_STATUS) and WTP. The probability of smallholder farmers' WTP increases with marital status. The marginal effect results showed that the likelihood of a married farmer's WTP both proposed bids (y/y WTP) increases, while the probability of not willing to pay both proposed bid (n/n WTP) decreases. This implies that smallholder farmers who are married are more willing to pay for organic fertiliser to enhance the soil fertility of their farm plots. This finding is consistent with the a priori expectations and the results obtained by other WTP related studies (Kamri, 2013; Mezgebo & Ewnetu, 2015; Etim & Benson, 2016), who found that there is a positive association between marital status and WTP. A possible explanation for this finding might be that married farmers may have more dependents in their households. For this reason, farmers' may be more likely to be willing to pay for organic fertiliser in attempt to invest in long term soil fertility improvement and increase their farm output.

As expected, farmers with access to extension services (ACC_EXT) were more likely to be willing to pay for organic fertiliser. This study found that access to extension services decreases the likelihood of a farmer choosing zero WTP and refusing to accept both proposed bids (n/n WTP), respectively. In addition, access to extension services increases the likelihood of accepting the first bid and rejecting the second higher bid (y/n WTP), and the likelihood of accepting both proposed bids (y/y WTP), respectively. This result is consistent with the a priori expectations and findings obtained by Njoko (2014), and Shee & Haile (2020) who reported that there is a positive correlation between smallholder farmers WTP and access to extension services. Extension service officers are an important source of information to farmers, as well as advice and training, which empowers and encourages farmers to seek relevant agricultural technologies that will enhance their agricultural productivity (Gelgo *et al*., 2016). Consequently, smallholder farmers who have access to extension services have a high likelihood of WTP compared to their counterparts who do not have access to extension services as they might be aware of the benefits of organic fertiliser and they might have been exposed

to necessary training as well as advice on organic fertiliser application.

This study also found that farmers with sufficient knowledge of using organic fertiliser (KNW_UOF) are more likely to be willing to pay for organic fertiliser. Marginal effects show that the probability of a smallholder farmer with sufficient knowledge of organic fertiliser usage not willing to pay (zero WTP) and refusing to accept both proposed bids (n/n WTP) decreases. While, the probability of WTP the first proposed bid and rejecting the second higher bid (y/n WTP), and the likelihood of accepting both bids (y/y WTP) increases. This result is in line with the a priori expectations and findings obtained by Agyekum *et al*. (2014), who studied farmers' WTP for faecal compost and found that there was a positive correlation between farmers knowledge and WTP. According to Mustafa-Msukwa *et al*. (2011), knowledge is essential to any technology adoption; hence, WTP and knowledge of organic fertiliser usage was expected to have a direct association.

On the other hand, this study found that smallholder farmers with larger livestock holdings (LSTOCK_SIZE) are less likely to be willing to pay for organic fertiliser. This implies that those farmers with low livestock holding have high WTP probability as compared to those with high livestock holding. The marginal effects show that the probability of not willing to pay (zero WTP) and refusing to accept both proposed bids (n/n WTP) increases respectively, with one TLU increase in livestock size. While the probability of WTP of the first proposed bid and rejecting the second higher bid (y/n WTP), and the likelihood of accepting both bids (y/y WTP) decreases. This finding is consistent with the a priori expectations because smallholder farmers with large livestock size are assumed to have better access to kraal manure which is a major source of organic fertiliser; as a result, they will not be willing to pay for organic fertiliser even if it were to be made available to them for sale as they already have the necessary material for organic fertiliser preparation.

As expected, smallholder farmers with land ownership (OWN_LAND) rights were more likely to be willing to pay for organic fertiliser. The results showed that the probability of a smallholder farmer with land ownership choosing zero WTP and refusing to accept both proposed bids (n/n WTP) decreases; while the probability of accepting the first bid and rejecting the second higher bid (y/n WTP), and the likelihood of accepting both proposed bids (y/y WTP) increases, respectively. This result is consistent with the a priori expectations because farmers are expected to be more willing to pay for technology improvements in their land where the benefits will accrue to them, and they will not share it with anyone. This finding is also consistent with the results obtained by Ulimwengu & Sanyal (2011) who concluded that land ownership guarantees the security of tenure for farmers and hence, increases the WTP for agricultural services. In addition, Otoo *et al*. (2018) also found that there is a positive and statistically significant relationship between land ownership and WTP for organic fertilisation. According to Hailu *et al*. (2014), farmers are rational decision-makers, and hence, they may be willing to pay for organic fertiliser in attempt to invest in long-term soil fertility in their potato production, because the benefits of their investment will accrue to them and not to be used by someone else in case they cannot continue to crop that specific land.

Finally, this study found that there is a positive correlation between the distance from the farm to the source of organic fertiliser (DIST_FARM) and WTP. Marginal effect results showed that the likelihood of choosing zero WTP and refusing to accept both proposed bids (n/n WTP) decreases, as the distance to the source of organic fertiliser increases. While the probability of WTP of the first proposed bid and rejecting the second higher bid (y/n WTP), and the likelihood of accepting both bids (y/y WTP) increases. A possible reason for this result might be that smallholder farmers who are within close proximity to the source of organic fertiliser are expected to be less willing to pay for organic fertiliser because it is easily accessible to them at low cost, therefore, they are less likely to be willing to pay more for organic fertiliser. This finding implies that those farmers who travel long distances to get organic fertiliser to their farms are more likely to be willing to pay for improvements (packaging and accessibility) of organic fertiliser. This outcome is consistent with *a priori* expectations and findings obtained by Mezgebo & Ewnetu (2015) on their WTP study; who found that there was a positive association between farmers WTP and the distance travelled.

5 Conclusion and policy recommendations

This study analysed the factors determining the WTP for organic fertiliser by smallholder potato farmers using the ordered logit regression model. Useful findings have emerged that offer insight for appropriate policy recommendations and pathways for improvement in WTP for organic fertiliser towards improving the productivity of smallholder potato farmers in KwaZulu-Natal and South Africa.

This study found that the majority of smallholder potato farmers were willing to pay for organic fertiliser, as organic fertiliser is the most popular soil ameliorant among smallholder potato farmers, and as such they are more willing to pay for improvements in organic fertiliser in order to enhance their farm productivity. It can therefore be concluded

that smallholder farmers' value organic fertiliser highly and they constantly seek ways of improving their crop productivity, and to reduce the costs of farm production by using organic fertiliser that is well suited for their socio-economic status.

Since, there is a positive statistically significant association between WTP, access to extension services and land ownership; strengthening extension services and enforcing land tenure security among smallholder farmers could be a suitable policy intervention to improve farmers WTP for organic fertiliser. This means that there is a need for policy makers and other development partners to initiate programs that improve smallholder farmers' access to extension services and land ownership. Improved access to extension services could provide agricultural knowledge to smallholder farmers about essential advocated agricultural technologies like organic fertiliser. This can be achieved through improved technical information dissemination among smallholder farmers through extension advisory services, education, and training. In turn, this will increase their WTP for organic fertiliser in attempt to enhance their crop productivity. Improving farmers' land ownership rights can also greatly enhance their WTP for organic fertiliser. The positive association between land ownership and WTP necessitates the improvement and development of programs that improve security of tenure among smallholder farmers. Facilitating the process of land restitution as well as land distribution could be a better way to achieving this, as it could increase farmers' WTP for agricultural technologies that improve their crop productivity.

The findings that smallholder farmers with low livestock holding were willing to pay more for organic fertiliser suggests the development of appropriate options for farmers with small livestock holding, which will enhance availability and access to organic manure. Considering the high rate of WTP for organic fertiliser as a soil ameliorant reflects the potential for commercialisation of organic fertiliser. Therefore, this study recommends that policymakers and other development partners should initiate programmes for production of organic fertiliser at the farm level, either by smallholder farmer cooperative groups or individual farmers through building organic fertiliser plants (composting facilities) at farm level. Liaising with traditional leadership, farmer cooperatives, department of agriculture (government extension officers), and non-governmental organisations (NGOs) can play a major role in promoting and marketing of organic fertiliser as well as enhancing farmers WTP. Such initiatives can achieve the latter through social group support, encouragement, training, and knowledge or experience sharing. Due to the social impact, interaction or power that traditional leaders, farmer cooperative groups, as well as extension officers have to rural communities it will be easy to distribute and market the organic fertiliser produced in the composting facilities; as well as to influence smallholder farmers to purchase this product. Furthermore, these initiatives will ensure availability of organic fertiliser to those smallholder farmers who are willing to pay for organic fertiliser and who are poorly endowed in terms of livestock ownership. This will also have indirect benefit to rural communities as this has a potential to create jobs and also improve the income of smallholder farmers from the sale of excess organic compost or fertiliser to those with low livestock holding. As a result, this will contribute to poverty alleviation and reduction of food insecurity among rural smallholder farmers due to improved farm productivity as well as the sale of organic fertiliser or compost to those farmers with low livestock holding but with positive WTP. In light of all the findings of this study, production and marketing of organic fertiliser or manure is very crucial and should be encouraged as an alternative soil ameliorant given the high cost associated with chemical fertilisers and lower purchasing power of rural smallholder farmers. Organic fertiliser is not only important for improving the crop productivity of smallholder farmers but it is crucial for the sustainability of the soil and the environment as organic fertilisers is associated with many environmental benefits like enhancing the soil structure as well as supporting soil biodiversity among other benefits.

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Conflict of interest

The authors declare that they have no conflict of interest. Ethical clearance for this study (Ref No: HSS/0103/019M) was obtained from the University of KwaZulu-Natal Research Office.

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