Adoption and Willingness to Pay for Organic fertiliser: A case of Smallholder Potato (*Solanum tuberosum L.*) Farmers in KwaZulu-Natal, South Africa.

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DECLARATION1-PLAGIARISM

I, Bhekani Sandile Zondo, declare that;

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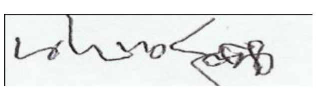

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DECLARATION2-PUBLICATIONS AND PRESENTATIONS

Publications

The following publications (work in progress) form part of the research presented in this thesis.

Publication Manuscript 1 (Chapter 3 and Chapter 4)

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Publication Manuscript 3 (Chapter 4-work in progress)

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ABSTRACT

Potato cultivation involves intensive soil tillage throughout the cropping season, which often results in soil degradation, erosion, and leaching of nitrates. Literature suggest that efforts to produce sufficient food necessitate an increase in agricultural production per unit of inputs by adopting fertility-enhancing techniques (both organic and inorganic fertilisers) to replenish soil nutrients required by crops. However, inorganic fertiliser as a soil ameliorant is known for causing soil degradation, environmental pollution, and it is associated with escalating costs. As a result, smallholder farmers are constrained in realizing their maximum yield potential. One of the ways to boost productivity without degrading the environment is to adopt a more sustainable, low-cost, and efficient integrated nutrient management system, which also suit their socioeconomic status. Although there is sufficient advocacy in the adoption of sustainable agricultural inputs such as organic fertiliser, the economic linkage between farmers' socioeconomic factors and adoption has not been adequately explored. Moreover, there is a dearth of empirical evidence regarding the willingness of farmers to pay a price premium for organic fertilisation of their soil.

The aim of this study was to evaluate socioeconomic factors influencing the adoption and use intensity of organic fertiliser among smallholder potato farmers’ as well as to estimate their willingness to pay (WTP) a price premium for organic fertiliser. Primary data was collected from 189 smallholder farmers in three municipal areas in KwaZulu-Natal Province, South Africa, through a multi-stage sampling technique. The analytical framework incorporated descriptive statistics, double-hurdle, and ordered probit models. The double-hurdle model was used to identify the factors influencing the adoption and use intensity of organic fertiliser, under the assumption that the decision to adopt and the intensity of adoption are separate. The contingent valuation method (CVM) was used to elicit information for the WTP, and after that, the ordered probit model was employed to estimate the determinants of farmers' WTP for organic fertiliser.

Empirical results indicate that factors such as household head gender, household size, access to credit, access to extension, knowledge of organic fertiliser usage, land ownership, livestock size and access to social grants significantly influenced the decision of organic fertiliser adoption. In contrast, factors such as the age of farmer, knowledge of organic fertiliser usage, farm size and livestock size significantly influenced the use intensity of organic fertiliser. In addition, results revealed that factors 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 also statistically significant in determining the farmers' WTP a price premium for organic fertiliser.

The study found that the rate of organic fertiliser adoption is very high among the sampled potato smallholder farmers even though there is still a notably large number of farmers who are not using organic fertiliser. This result leads to the conclusion that organic fertiliser is the most popular soil nutrient ameliorant among smallholder potato farmers in KwaZulu-Natal Province, South Africa. This study also found that WTP a price premium for organic fertiliser was very high and this lead to a conclusion which justify the prospect of commercialization 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 improve technical information dissemination and knowledge of organic fertiliser usage among smallholder farmers. There is also a need to develop policies that strive to institute security of land tenure among smallholder farmers, which will encourage smallholder farmers WTP and also adopt and intensify organic fertiliser.

Keywords: *Organic fertiliser, smallholder farmers, adoption, use intensity, willingness to pay, Contingent valuation, Craggs' Double Hurdle model, Ordered logit model.*

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LIST OF ACRONYMS/ABBREVIATIONS

B	Boron
BFAP	Bureau for Food and Agricultural Policy
Ca	Calcium
Cl	Chlorine
Cu	Copper
CV	Contingent Valuation
CVM	Contingent Valuation Method
DAFF	Department of Agriculture, Forestry and Fisheries
DBDC	Double-bounded dichotomous choice
DH	Double Hurdle
FAO	Food and Agriculture Organisation
Fe	Iron
GDP	Gross Domestic Product
K	Potassium
KZN	KwaZulu-Natal
LBPL	Lower-bound poverty line
MDG	Millennium Development Goals
Mg	Magnesium
Mn	Manganese
Mo	Molybdenum
N	Nitrogen
NAMC	National Agricultural Marketing Council
Ni	Nickel
P	Phosphorus
PSA	Potatoes South Africa
S	Sulphur
SBDC	Single-bounded dichotomous choice
Sq Km	Square Kilometre
SSA	Sub-Saharan Africa

Stats SA	Statistics South Africa
TLU	Tropical Livestock Units
UBPL	Upper-bound poverty line
VIF	Variance Inflation Factor
WTP	Willingness To Pay
Zn	Zinc

Chapter 1

Introduction

1. 1 Background of the study

Potatoes are a widely produced tuber crop, grown in over 100 countries around the world and it is the fourth most important crop after rice, wheat and maize (DeFauw *et al.*, 2012). Potatoes are a staple food crop for the majority of the population and they are regarded as an important food security crop, consumed daily by over a billion people with the majority in developing countries where people depend on it for survival (FAO, 2008). The 2008-2009 financial crisis that was characterised by high price increases, threatened food security and food stability for the majority of low-income countries. This led to increased consumption of potatoes (DeFauw *et al.*, 2012).

In South Africa, potatoes are produced in all nine provinces. The potato industry comprises of few commercial farmers and the majority being smallholder farmers; however, the majority of potatoes produced are from the commercial sector (NAMC, 2012). Potatoes South Africa (PSA) records show that there are about 635 commercial potato producers and over 1000 active smallholder potato farmers. Furthermore, potatoes are the leading vegetable crop in terms of value and volume of production in contrast to others (NAMC, 2012). After harvesting, potatoes have a multi-purpose use, as a fresh vegetable for cooking at home, as food ingredients, starch, feed for animals and they can also be stored as seeds to be grown in the following season (FAO, 2008). In addition, potatoes have a longer shelf life compared to other vegetables provided that they are handled appropriately, therefore, making it a widely consumed crop in the country.

The South African agricultural sector employs approximately 900 000 people, which is about 3.4 % and contributes about 3 % to the country's gross domestic product (GDP) (Potelwa *et al.*, 2016). According to Kapuya and Sihlobo (2015), in Africa, South Africa is the second major exporter of both potato and potato seeds, and over the last five years, it has accumulated export revenues of over R2 billion. The South African potato and potato seed export had a 33% increase from R438 million in 2013 up to R583 million in 2014. Thus, the African continent is the most important source of growth for the South African potato production sector, with the majority of South Africa's commercial potato and potato seed exports, exported to the African market (Kapuya & Sihlobo, 2015).

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). However, potato cultivation usually involves intensive soil tillage throughout the cropping season, which often results in soil degradation, erosion and leaching of nitrates. Nutrient replenishment is required to maintain soil productivity (FAO, 2008). Moreover, population growth and urbanisation have resulted in many challenges which include: food insecurity, urban planning, and management of waste and the degradation of the environment (Cofie *et al.*, 2006).

The issue of land degradation has become the world's environmental threat as it poses a severe challenge on agricultural productivity mostly in developing countries where agriculture contributes substantially to the economy (Ketema & Bauer, 2011). Food production in Africa is constrained by many factors which include: reduction of usable land due to dwindling water resources; variability of climate; unimproved planting materials; poor marketing and distribution system and lastly, high costs of agricultural inputs, specifically fertiliser (Agyekum *et al.*, 2014; Etim & Benson, 2016).

The demand for potatoes has shown an increase over the previous years, shifting from fresh tubers to processed potato products, thus resulting to an increase in the quantities of processed potatoes (FAO, 2008; PSA, 2012). According to the Bureau for Food and Agricultural Policy (BFAP) 2014 baseline, since 2009, the demand for potatoes in South Africa has consistently been rising at an average of 3% per year. Ultimately, demand for potatoes is expected to increase by 20% from its current level of 36kg per capita to 42 kg per capita per annum by 2023 (PSA, 2012; BFAP, 2014). This increment in demand is evident in convenience food and snack markets. The reasons for this increase in demand can mainly be attributed to rising urban populations, increasing income levels, shifts to different diets and lifestyles that require less time to prepare the fresh product for consumption (FAO, 2008).

According to Kapuya and Sihlobo (2015), potato production is anticipated to increase by 23% from 2.2 million tons and reach 2.7 million in the next ten years. The extra half a million tons of potato production will be resultant from higher yields as opposed to area expansion. However, the current levels of agricultural productivity growth in Sub-Saharan Africa (SSA) are under the threshold necessary for meeting the regional food security and poverty reduction goals thus, making increased production and productivity a vital issue in addressing poverty and food security challenges (Sinyolo *et al.*, 2016). Soil infertility and limited use of modern technologies are some of the major factors resulting in low yields (Diiro *et al.*, 2015).

In order to feed the growing population, food production has to be increased on the available land through agricultural production intensification which includes the use of sustainable agricultural practices, fertilisers and other fertilisation methods (Roberts, 2009). Sustainable agricultural intensification means that production and yields are increased without inflicting adverse impacts on the environment and also without cultivating more land (Garnett & Godfray, 2012). In other words, agricultural production intensification must be achieved in an environmentally safe manner, meaning that increased yield per unit of land is attained with minimal or no negative effect in the environment, thus ensuring sustainable production and development (Roberts, 2009). During intensive farming, organic matter and nutrients are depleted from soils. Nutrient replenishment is required to achieve sustainable and optimal yields of crops (Adediran *et al.*, 2005). As a result, adoption of fertility or productivity-improving technologies is essential to enhance agricultural productivity (Terefe T & Ahmed, 2016).

The adoption and use of fertiliser can notably increase the efficacy of other agricultural technologies through enhancing plant nutrients (Diiro *et al.*, 2015). The use of fertiliser may be beneficial or harmful to the environment depending on the type of fertiliser and/or how they are applied (Baiphethi & Jacobs, 2009). For example, chemical fertilisers impose detrimental effects on the ecosystem and the environment while organic fertiliser has proved to have long-lasting positive effects on the soil and thus, ensure environmental sustainability (FAO, 2005). In addition, even though inorganic or chemical fertilisers work faster and give immediate results, these fertilisers require to be applied frequently or else the productivity will be hampered, mainly because they tend to leach away from plants (FAO, 2005; Baiphethi & Jacobs, 2009). Moreover, continued application of chemical fertilisers results in a reduction of microbial activities in the soil due to harmful effects on important micro-organisms responsible for decomposition and returning nutrients to the soil (Baiphethi & Jacobs, 2009).

In spite of the benefits of fertiliser, the use of fertilisers in SSA countries continues to be low compared to other developing countries, where agricultural intensification is marked by a notable increase in fertiliser application (Diiro *et al.*, 2015). Accordingly, Sinyolo and Mudhara (2018b) reported that the use of inorganic fertiliser by smallholder farmers in South Africa is very low and it is not effective for maintaining soil fertility and crop sustainability. The authors recommended that it is necessary to develop and adopt mechanisms that alleviate these challenges faced by smallholder farmers. The main reasons restricting the use of chemical fertilisers can be attributed to their high cost while smallholder farmers are characterised by low purchasing power and risky returns during dry seasons (Cedric & Nelson, 2014).

Given these disadvantages associated with chemical fertilisers, adoption of organic fertiliser by smallholder farmers seems to be a possible alternative to ensure sustainable agricultural production. The use of organic fertilisers is advantageous to smallholder farmers as compared to chemical fertilisers. 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). 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 improves crop yields (Gupta & Hussain, 2014).

The aim of this study is to determine factors influencing adoption and use intensity of organic fertiliser or manure by smallholder potato farmers in KwaZulu-Natal (KZN) and to estimate their willingness to pay (WTP) for organic fertiliser, in other words, whether smallholder potato farmers in KZN are willing to pay a price premium for organic fertiliser.

1.2 Research Problem

Southern Africa economies rely more on agricultural production because of its contribution to GDP, export and employment. However, agricultural productivity has been declining as a result of environmental (natural resources) degradation, poor access to fertiliser, population pressure, fragmentation of land and poor soil fertility management practices (Mapila *et al.*, 2012). Intensive crop production results in depletion of nutrients in the soil, therefore, if these nutrients are not replenished, it means that intensive agriculture cannot be maintained resulting in the world being unable to feed the growing population (Morris *et al.*, 2007).

In the past few years, there has been a change in the potato production industry, involving a reduction in the number of potato producers and the number of hectares planted (PSA, 2014). It is believed that the consumption of potatoes has shown an immerse increase mainly due to the continued growth in population, rising income levels of consumers, different diets and lifestyles that leave less time for preparing fresh products for consumption (FAO, 2008; NAMC, 2012). Consequently, the increased demand for potatoes must be simultaneously met by an increase in the supply of potatoes. Conversely, the current levels of productivity in Southern Africa makes it nearly impossible to achieve this goal. Therefore, the adoption of fertility-enhancing techniques is required.

Efforts to enhance food production to meet food demand also further cause more damage to the environment which consequently result in a decline of the capacity to produce sufficient food for the majority of the population in future. The continual increase in food demand has resulted in many environmental challenges all over the world, which include soil degradation, biodiversity loss, an increased amount of greenhouse and critical water shortages (Mapila *et al.*, 2012). This high food demand can be met by improving sustainable agricultural development through enhancing total farm productivity. This can be achieved through focusing on the level in which farmers can increase food production and incomes at relatively low cost by using locally available technologies and inputs; whether they can do this without harming the environment; and lastly, the ability of farmers to access markets (Kisaka-Lwayo & Obi, 2014).

In South Africa, average rates of inorganic fertiliser application in the smallholder sector are very low; hence, it is not effective in maintaining crop and soil fertility. Inorganic fertilisers require high purchasing power. This restricts the resource least small-scale farmers from using fertiliser at its optimal levels to boost their crop production. Inorganic fertilisers are also known to pose severe threats to the soil and ecosystem due to their salt content as compared to organic fertiliser. Consequently, the use of organic fertiliser has become more desirable to small-scale farmers to enhance the increased productivity of agriculture and also protect and restore the ecosystem.

1.3 Research Questions

The research questions put forward for this study are:-

i.) What are the factors influencing adoption and use intensity of organic fertiliser (manure) by smallholder potato farmers?

ii.) Are smallholder potato farmers willing to pay a price premium for organic fertiliser and what are the factors influencing their WTP?

1.4 Research Objectives

The general objective of this study is to determine adoption and WTP for organic fertiliser by smallholder potato farmers. The specific objectives of this study are:

i) Identify factors influencing adoption and use intensity of organic fertiliser by smallholder potato farmers.

ii) Estimate WTP for organic fertiliser and identify factors influencing WTP a price premium for organic fertiliser by smallholder potato farmers.

1.5 Justification of the Study

In SSA, poor soil fertility has been a major issue concerning smallholder farmers' productivity (Sinyolo & Mudhara, 2018b). The problem of poor soil fertility among smallholder agricultural sector can be addressed through policies that are developed and informed by studies that empirically investigate the causes and consequences of poor soil fertility and also recommend strategies to mitigate these consequences. Several studies suggest that given this problem, efforts to produce sufficient food necessitates an increase in agricultural production per unit of inputs by adopting fertility-enhancing techniques (both organic and inorganic fertilisers) to replenish soil nutrients required by crops.

However, inorganic fertiliser is unviable for soil nutrient management since it is known for causing soil degradation, environmental pollution and it is associated with escalating costs. As a result, smallholder farmers are restricted from realising their maximum potential hence, smallholder farmers may only realise their full potential only if they adopt a more sustainable, low-cost and efficient integrated nutrient management system which is also suited to their socioeconomic status (Raimi *et al.*, 2017).

Addressing soil infertility is essential, more especially to smallholder farmers because this will result in improved productivity which will enhance smallholder farmers' ability to become self-sufficient and depend less on food purchased in the market. This will improve household income generated through sales from excess produce. Consequently, soil fertility improvement among smallholder farmers is believed to be critical for mitigating consequences of food insecurity and poverty.

This study will contribute to emerging and scarce literature on adoption and WTP for organic fertiliser of smallholder farmers, particularly smallholder potato farmers. It can also be adapted and scaled-up to regional and national level analysis based on the availability of data in the future. Moreover, this study focuses mainly on organic fertilisers since they seem to be a potential alternative for smallholder agricultural intensification in attempt to address soil infertility. Organic fertilisers improve the productivity of smallholder potato farmers, as they are more affordable, environmentally friendly as compared to chemical fertilisers. Smallholder farmers can acquire organic fertiliser at a relatively low cost as they can also prepare it in their farms as it requires less skill.

This study evaluates socio-economic and demographic factors influencing smallholder potato farmer's organic fertiliser adoption and their willingness to pay a price premium for organic fertiliser. The evaluation of these factors is relevant as it will provide empirical evidence to support and add new findings into existing arguments relating to adoption and, WTP for organic fertiliser. Empirical evidence generated in this study will also pave the way for recommendations on the necessary policy interventions and institutional innovations. Relevant stakeholders such as policymakers and extension officers can develop better ways or strategies to encourage adoption of organic fertiliser among smallholder farmers and hence, contribute towards improving agricultural productivity, smallholder farmer's income and ensure sustainable production, poverty reduction, food security and environmental sustainability. Lastly, the results generated from this study will provide insight towards future studies related to addressing soil infertility, organic manure adoption and WTP etc.

Chapter 2

Literature Review

2.1 Introduction.

The aim of this chapter is to review literature on the following sub-headings: the South African potato industry, smallholder farming in South Africa, sustainable agriculture, the use of fertiliser and its impact on crop productivity, poverty and food security in South Africa, adoption of agricultural technologies and the concept of willingness to pay (WTP).

2.2 The South African potato industry

In South Africa, potato production is carried out at 16 different regions which are spread all over the country DAFF (2018). Therefore, the potato crop is produced throughout the nine provinces in the country. The potato industry consists of a few commercial farmers and many smallholder farmers; however, most potatoes produced emanates from the commercial sector (NAMC, 2012). According to Potatoes South Africa (PSA) records there are about 635 commercial potato producers and more than 1000 active smallholder potato farmers. The potato industry plays a significant role in alleviating poverty and food insecurity in the country through its contribution to the livelihoods of many individuals by creating jobs and generating income for potato producers (PSA, 2012).

Globally, agriculture is a source of employment for most of the population, especially in developing countries (Von Loeper *et al.*, 2016). Consequently, the Southern Africa economies are not an exception as they rely more on agricultural production because of its contribution to the GDP, export and employment. According to Potelwa *et al.* (2016), about 900 000 people in South Africa are employed by the agricultural sector, and that is approximately 3.4 % and while it also contributes about 3 % to the country's GDP.

On the economic review of South African agriculture for the period of 2017/18, DAFF (2018) reported that the value of South African agricultural production improved by 4.7% and it was estimated to be R281 370 million in 2017/18, at the same time its contributed an estimate of R90 458 million to the GDP in 2017 nominal prices. However, it was reported that the value of the agricultural contribution to GDP in 2017 decreased to 2.2 % (DAFF, 2018). Moreover, according to DAFF (2016), the South African potato industry has contributed about 56.8% to the total gross value of vegetable production, while it also contributed about 11.7% and 3% of horticultural products and total agricultural products respectively. Even though there has been a rapid growth in the potato processing industry of about 19% of the total potato crop, in size the South African potato industry is behind compared to potato processing industries of other developing countries.

The South African potato industry is also an earner of foreign exchange, in 2016, more than 74071 tons of potatoes were exported, which is about 3.4% of total local production (DAFF, 2018). During the same period, about 98.7% of exports of the total potato crop were exported to East Africa, Southern Africa, and Western Africa. Thus, the South African potato industry is the second major exporter of both potato and potato seeds in Africa and it has accumulated export revenues of over R2 billion in the past five years (Kapuya & Sihlobo, 2015). Additionally, the South African potato and potato seed export had a 33% increase from R438 million in the year 2013 up to R583 million in the year 2014. In spite of the small share contributed by South African agriculture to total GDP, it is still an essential sector in the economy of the country given its crucial provision of employment especially in rural areas and being a major earner of foreign exchange (DAFF, 2018).

Due to climatic differences in the country, the potato crop is grown at different times of the year, and as a result, potatoes are always available throughout the year (DAFF, 2018). Even though Kapuya and Sihlobo (2015) reported that potato production is anticipated to increase by 23% from 2.2 million tons and reach 2.7 million in the next ten years, there has also been a decline in potato production in South Africa. On the economic review of the South African agriculture for the period of 2017/18, DAFF (2018) reported that in the year 2016, the area planted of the potato crop declined by 2.2% from 53933 ha in 2015 down to 52722 ha, and there was also a decline in the average potato crop yield of 11.8% from 4611× 10 kg bags per hectare in 2015 down to 4069× 10 kg bags per hectare in 2016.

Nevertheless, consumption of potatoes has shown an increase mostly in urban areas as compared to rural areas where maize crop is still a staple. The main reason for the increase in potato consumption is believed to be due to increasing income levels of the people and hence, resulting in nutritional changes of consumers. Moreover, according to BFAP (2014) and PSA (2016), in the long run, demand for potatoes is expected to increase by 20% from its current level of 36kg per capita to 42 kg per capita per annum by 2023. Lastly, the quantity of potatoes required to meet the needs of consumers has increased, and this is evident in the fast food, snack and convenience food industries (FAO, 2008). Thus, this exerts a lot of pressure on the South African potato industry to make improvements in potato production to meet the current and future anticipated demand for this staple crop, and this can be achieved through increased production. In addition, Kapuya and Sihlobo (2015) suggest that this increment in potato production will be resultant from higher yields as opposed to area expansion.

2.3 Smallholder farming in South Africa

In South Africa, the agricultural sector is dualistic, consisting of the commercial sector which is highly capital intensive and smallholder or subsistence sector which is characterised by less or poor resource endowment and they are mostly situated in rural areas or former homeland areas (Baiphethi & Jacobs, 2009).

Smallholder farmers are defined as those farmers whose farms are endowed with inadequate or fewer resources and they usually own small plots of land from which they grow subsistence crops and/or one or two cash crops and they rely extensively on family labour and their production systems are characterised by simple and outdated technologies, low returns and with women playing the most important role in production (DAFF, 2012). Smallholder farmers are mostly characterised by poor access to both input and output markets, and this has a remarkable effect on their production activities. This is ultimately due to their location as they reside in remote rural areas which limit their access to infrastructure and consequently increase transactions costs and lower profit margins (Fan *et al.*, 2013; Sinyolo & Mudhara, 2018a).

According to Mkhabela (2002), the smallholder farming sector in South Africa consists of a group of individuals that can potentially contribute the country's food security because this sector usually consists of a combination of crops and livestock which substantially contribute to livelihoods of the people. However, the South African resource-least farmers find it difficult to participate in the modern economy (Von Loeper *et al.*, 2016). Smallholder production is crucial for ensuring household food security; however, the smallholder sector is characterised by relatively low productivity (DAFF, 2012). According to Sinyolo and Mudhara (2018a), if smallholder farming can break the subsistence trap and become more market and entrepreneurial-based, smallholder farmers have the potential to enhance the livelihoods of small-scale farmers.

Baiphethi and Jacobs (2009) further argued that if increased subsistence production is achieved, it can potentially enhance the food security status of poor rural and urban households through the improved food supply and thus, reducing reliance on high priced market food. Therefore, attempts to eradicate poverty and food insecurity must be directed towards the development of subsistence and smallholder agriculture (FAO, 2005). This means that increased production of smallholder farmers can lessen the effect of price shocks on rural households and as a result, smallholder farmers can potentially reduce food shortage in Sub-Saharan Africa.

However, the sustainability of smallholder crop production system is threatened by the persistent deterioration of soil fertility due to declining organic matter and other essential soil nutrients (Mkhabela, 2002). Attempts to ensure long-term food security necessitate the significant increase in productivity of smallholder agriculture, which can be obtained by encouraging small-scale farmers to adopt sustainable intensification methods of production. Sustainable intensification is defined as a state wherein production "yields are increased without adverse environmental impact and the cultivation of more land" (Garnett & Godfray, 2012).

Given the poor soil fertility levels which mainly affects subsistence farming and smallholder agriculture, fertiliser application among these sectors have a significant impact in enhancing the productivity of agriculture and in turn result to a reduction in poverty and food insecurity in the country (FAO, 2005). However, smallholder farmers cannot use fertiliser up to their maximum potential and accordingly, Sinyolo *et al.* (2016), reported that constraining factors that smallholder farmer's face with regards to fertiliser use is that inorganic fertilisers are costly and have high-risk returns because they produce varying crop yield responses in dryland smallholder conditions. Similarly, FSSA (1997) cited by Mkhabela (2002), reported that the amount of inorganic fertiliser utilised by smallholder farmers is very low due to the high cost associated with them as smallholder farmers characterised by limited financial resources. Consequently, organic manure continues to be regarded as an alternative soil ameliorant in the country.

2.4 Sustainable agriculture

Sustainable agriculture is defined as "an agricultural system involving a combination of sustainable production practices in conjunction with the discontinuation and/or the reduced use of production practices that are potentially harmful to the environment (Kassie *et al.*, 2009). This concept is concerned with developing agricultural technologies and systems which do not adversely affect the environment, effective and easily accessible to farmers and results in the improvement of food production and has positive effects on the environment (Pretty, 2007).

Francis and Porter (2011) noted that sustainable production systems must be developed to meet current food requirements and also preserve the important natural resource base that will ensure that future production is not compromised and hence, meets future generation's food demands. This generally means that the current generation can meet their needs without compromising the ability of future generations to meet their own needs as well. The main difference between sustainable agriculture and conventional agriculture is that sustainable systems are more concerned with not just production only but also with economics (costs and benefits) of production and meeting environmental regulations (Francis & Porter, 2011). As noted by Francis and Porter (2011), sustainability means maintaining economic productivity whilst being concerned with ecological foundation, social implications, and impacts of farming. Thus, this involves developing production systems that are resilient and hence, can continue for indefinite future.

Moreover, sustainable agricultural practices are not only concerned with conservation but also with an improvement of natural resources through increased soil fertility and soil organic matter without trading off yield levels (Kassie *et al.*, 2013). Practically, sustainable agriculture involves the employment of less external off-farm inputs (e.g., purchased fertilisers) and adopt more natural resources that are locally available. Moreover, sustainable agriculture refers to employment and application of agricultural practices which does not involve harming or depleting other essential resources that support agriculture (Mahama *et al.*, 2018). Consequently, Francis and Porter (2011) reported that using on-farm or nearby sources of nutrients like manure or organic fertilisers is the best alternative strategy for substituting purchased chemical fertilisers. In smallholder farming, soil fertility is highly contingent on the availability of resources locally; hence, the application of organic fertilisers is advantageous as they are usually available on or near the farm at low or zero cost beside labour handling cost, transportation and opportunity cost of land from which they are produced (Gupta & Hussain, 2014).

According to Kassie *et al.* (2009) and Kassie *et al.* (2013), practices of sustainable agriculture often include conservation tillage, legume intercropping, legume crop rotations, and improved crop varieties, use of animal manure, organic fertilisers, soil and stone buds for soil and water conservation. Hence, chemical fertilisers are not appropriate for sustainable agriculture because they do not improve physical soil characteristics such as moisture retention capacity and bulk density among others, and they can improve current agricultural production at the expense of future production and thus, resulting in high levels of poverty in the long run (Mahama *et al.*, 2018). Small-scale farmers will be the most suitable candidates for achieving sustainable or conservation agriculture since the smallholder farming sector has more people compared to commercial agriculture and they use less external inputs and hence, have minimal impact on the environment (Von Loeper *et al.*, 2016).

2.5 The use of fertiliser and its impact on crop productivity

Fertiliser is defined as "any material, organic or inorganic, natural or synthetic, that supplies plants with the necessary nutrients for plant growth and optimum yield" (Gupta & Hussain, 2014). Fertilisers generally supply plants with the following macro and micro-nutrients. The macro-nutrients includes Nitrogen (N); Phosphorus (P); Potassium (K); Calcium (Ca); Magnesium (Mg); and Sulphur (S), while the micronutrients are Boron (B); Chlorine (Cl); Copper (Cu); Iron (Fe); Manganese (Mn); Molybdenum (Mo), Zinc (Zn) and Nickel (Ni) (Gupta & Hussain, 2014).

The use of fertiliser has a significant contribution to enhancing agricultural productivity. Consequently, the demand for fertilisers all over the world continues to grow higher and without fertiliser use, farmers will only be able to produce half of the required staple food crops and as a result, there will not be enough food to feed the growing world population which is anticipated to be more than double by the year 2030 (Roberts, 2009). Agricultural productivity can be achieved by producing more per unit of land with agricultural inputs or via expansion of area under cultivation (Hailu *et al.*, 2014). However, land expansion is less possible given issues involving urbanisation, poor infrastructure and technology, environmental concerns, political issues, and increased population pressure and hence, agricultural output increment is expected to emanate from producing more from the less available land through agricultural intensification (Alimi *et al.*, 2006; Garnett & Godfray, 2012; Stewart & Roberts, 2012).

According to Tiffen *et al.* (1994) as cited by Carswell (1997), defined agricultural intensification as "increased average inputs of labour or capital on a smallholding, either cultivated land alone or on cultivated and grazing land, for the purpose of increasing the value of output per hectare". Therefore, agricultural intensification can be defined as an increment in agricultural production per unit of inputs (for example, land, labour, fertiliser, etc.). Practically, intensification is achieved when the total production is increased as a result of enhanced productivity of inputs or when agricultural production is sustained while other inputs are reduced (FAO, 2004). Agricultural intensification can be achieved through either of the following: a) increased gross output in fixed proportions as a result of a proportional increase of inputs, b) transmission towards more valuable inputs and c) technical improvement which enhances land productivity (Carswell, 1997).

According to Alimi *et al.* (2006), agricultural intensification is a critical way of ensuring sufficient production in smallholder farming. Alimi *et al.* (2006) further argued that even though agricultural intensification can be viewed as a tool for simultaneously alleviating poverty and food security, it is also believed to pose severe threats to the environment through natural resource degradation, and hence, agricultural intensification can be viewed as both an opportunity and a threat to the environment. Nevertheless, intensification is very essential, especially during the times when increased food supply is desirable (Carswell, 1997).

Efforts to enhance food production to meet high food demand to feed the growing population inflicts more damage to the environment which consequently reduces the capacity to produce sufficient food (Tilman *et al.*, 2011; Garnett & Godfray, 2012). During intensive farming, organic matter and nutrients are depleted from soils, and hence, for sustainable and optimal yields of crops, nutrient replenishment is necessary (Adediran *et al.*, 2005). According to Kassie *et al.* (2013), depletion of soil fertility is the main factor limiting increased per capita food production for small-scale farmers in the Sub-Saharan African region.

Land and natural resource degradation compromise future production and further exacerbate poverty and food insecurity; thus, any choice of agricultural intensification method or soil management practice must support production and environmental sustainability (Alimi *et al.*, 2006). Agricultural sustainability cannot be achieved if nutrients removed from the soil as a result of increased crop production are not replenished and these nutrients can be replenished through the use of organic and chemical fertilisers (Morris *et al.*, 2007).

If there are no external inputs applied to restore nutrients consumed by crops and washed away by soil erosion, plots of land require to be rested or left unploughed for longer periods; however, due to increasing demands for food in Africa, this has become more difficult (Kassie *et al.*, 2013). As a result, this necessitates the application of mineral fertilisation as one of the important inputs in crop production in order to enhance crop yield and soil fertility. Mineral fertilisation process involves the use of manures and inorganic or mineral fertilisers which supplement plant nutrients to soils characterised by low or poor fertility and it began at about the year 1880, became practised commonly in the 1920s and it was adopted largely since 1950 (Roy *et al.*, 2006).

Fertiliser is considered the most crucial input in crop production for replenishing the essential soil nutrients and organic matter depleted during cropping (Adediran *et al.*, 2005). Moreover, maintaining soil fertility levels and preserving the environment while increasing agricultural production is the main challenge to modern agriculture (Hoffmann *et al.*, 2010). Gupta and Hussain (2014) suggested that it is imperative to consider the method and time in which fertiliser is applied, because, for organic materials, the rate of decomposition and application time affect nutrient release to the crop.

2.5.1 Implications of using inorganic fertiliser

Inorganic fertilisers are usually processed and produced from mineral deposits (e.g. lime, potash or phosphate rock) or industrially prepared through chemical processes (e.g. urea) (Gupta & Hussain, 2014). Inorganic fertilisers are also known as mineral or chemical fertilisers, and they have relatively high nutrients that are released quickly for plant uptake as compared to organic fertilisers which require time for decomposition before they are consumed by the crop plant (Morris *et al.*, 2007).

Examples of chemical fertilisers commonly used are straight fertilisers made up of a single nutrient, mostly nitrogen (N), phosphorus (P) or potassium (K) and compound or mixed fertilisers including one or more macronutrients or some traces of zinc and boron elements (Morris *et al.*, 2007). Inorganic fertilisers require to be applied at least two times within the growing season, either basally during planting or top-dressed at the vegetative growth stage and they are usually available to crops immediately for consumption (Gupta & Hussain, 2014).

However, chemical fertilisers are also notorious for their high cost and the negative effect they impose on the environment after some time which often involves the damage of soil structure and texture which consequently leads to soil erosion and nutrients leaching (Morris *et al.*, 2007). Hence, the use of inorganic fertiliser in smallholder farms is low due to poor purchasing power (Gupta & Hussain, 2014). The modern farming methods in which inorganic fertiliser is used, it has resulted in most soils becoming less productive and fertile (Anim, 1999). Consequently, the decline in soil fertility has become a major restriction on food production. Additionally, heavy application of chemical fertilisers can burn seedlings and young crops, due to salt concentration in the soil and chemical imbalances. Therefore, this necessitates the adoption of fertiliser that supports the restoration of soil fertility and the production of food that is free from inorganic salts (Anim, 1999).

Moreover, even though chemical fertilisers are instantly available to plants, they are subject to being washed away by rainfall or irrigation water to a level underneath the plant roots and into water streams and hence, causing water pollution (Gupta & Hussain, 2014; Mahama *et al.*, 2018). Therefore, in addition to being expensive, chemical or inorganic fertilisers are also believed to pollute the surface and groundwater (Kuwornu *et al.*, 2017).

2.5.2 Implications of using organic fertiliser

Organic fertilisers mainly constitute of animal manure, compost, animal waste, crop residues, green manure, etc., and they supply nutrients and also add soil quality by enhancing the soil structure, chemistry and biological activity in the soil (Gupta & Hussain, 2014). Consequently, small-scale farmers who are concerned with ensuring environmental sustainability, use organic fertilisers for sustaining the health of their crops as well (Gupta & Hussain, 2014; Omidire *et al.*, 2015). Organic manure is applied to crops through the following methods: broadcasting, banding, and spot application and consistent application of organic fertilisers improve soil organic matter, reduce soil erosion, and improve soil water holding capacity, increase soil biological activity (Gupta & Hussain, 2014). Thus, Organic fertilisers enhance long term productivity and soil biodiversity and thus, environmental sustainability.

Adediran *et al.* (2005) reported that the use of farm manure in crop production was found to neutralize acidity levels to the soil and further supply essential micronutrients such as zinc, boron, copper, etc. Hailu *et al.* (2014) argued that organic fertiliser adoption positively influences agricultural productivity, and those farmers who choose to adopt organic fertiliser obtain higher yields which indirectly result in increased household incomes.

However, according to Sarkar *et al.* (2003) cited by Omidire *et al.* (2015), organic fertilisers are usually characterised by their slow release of nutrients because it takes a long time for organic material to be decomposed and be available for plant uptake. Before organic fertilisers can be utilised by crops, they need to be broken down by soil micro-organisms into smaller inorganic molecules and ions, and thus, they are not available immediately to plants (Gupta & Hussain, 2014). This is contrary to inorganic or synthetic fertilisers which are already in the usable inorganic form.

Morris *et al.* (2007) advised that, as a result of this slow release of nutrients, it is possible that they will be released when the plant does not need them. As a result, Omidire *et al.* (2015) concluded that farmers, especially resource least farmers (small-scale), need to consider the time in which they apply organic fertiliser thus ensuring its availability to plants at the right time and hence, recommended that organic fertiliser should be applied longer before planting period to allow for sufficient decomposition and nutrient release. Moreover, Organic manure is labour intensive and thus, requires to be used in large quantities for obtaining adequate nutrient levels (Morris *et al.*, 2007).

Given the issue of nutrient content release of organic fertiliser, along with high prices of inorganic fertilisers, some smallholder farmers decide to use the combination of both organic and inorganic fertilisers (Omidire *et al.*, 2015). Nevertheless, to ensure environmental sustainability, smallholder farmers apply organic fertilisers for their crop production and thus, prevent nutrient runoff and leaching (Omidire *et al.*, 2015). Hence, agricultural intensification methods that encourage the use of locally available resources such as organic fertilisers potentially improve soil fertility and consequently, reduce poverty and food insecurity through increased productivity (Gupta & Hussain, 2014).

2.6 Poverty and food security in South Africa

Poverty refers to the condition of not having the means to afford basic human needs such as clean water, nutrition, health care, education, clothing and shelter (Du Toit *et al.*, 2011). According to the World Bank (2018), the level of poverty in South Africa has shown a significant decline ever since 2006 from 25.5% down to 18.8% in 2015. Furthermore, using the national lower-bound poverty line (LBPL) of R647 per person per month using 2015 prices, indicated that about 51% of the people were poor in 2006 which significantly dropped to 40% in 2015. However, using the upper-bound poverty line (UBPL) of R992 per person per month using 2015 prices, it is evident that about half of the South African population is still considered to be chronically poor. This essentially means that even though there has been a decline in poverty, but a majority of the population in South Africa is still affected by poverty.

Poverty in South Africa is most prevalent in rural areas, where it has proved to be higher than in urban areas, as in 2015 about 65.4% of the people in rural areas were living below the LBPL while in urban areas only 25.2% were regarded as poor (World Bank, 2018). Poverty is most prevalent among the Black South Africans, in 2015 there was about 47% of Black South African households who are poor compared to 23% of the coloured population, more than one per cent of Indian population and lastly, less than one per cent of White South African population (World Bank, 2018). Poverty is closely related to the concept of food security, and they influence one another.

Southern Africa, for the past 20 years, there has also been a persistent rise in food security challenges (Von Loeper *et al.*, 2016). Food security is defined as the condition that "exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (Roy *et al.*, 2006; Du Toit *et al.*, 2011; Stewart & Roberts, 2012). World Food Summit (1996) cited by Panneerselvam *et al.* (2010) and Du Toit *et al.* (2011), reported that food security consists of four elements: food availability, food accessibility, food utilisation, and food stability.

At the national level, food security can be defined as the condition that exists when the nation can manufacture, import, retain and sustain food needed to support its population with minimum nutritional standards per person (Du Toit *et al.*, 2011). At farm household level, food security is concerned with whether individuals can meet their daily food needs from the food they produce or whether they can acquire food from off-farm sources (Panneerselvam *et al.*, 2010). Hence, a household is regarded as food secure if it can produce food for all the family and/or if the household possess enough resources to purchase food and whether the food that is available and accessible, meet the dietary requirements for the rest of the family and lastly, whether the households have enough food at all times (Roy *et al.*, 2006).

Mwangi and Kariuki (2015) suggest that agriculture is essential for ensuring economic growth, improving food security, reducing poverty and rural development. As noted by Eba and Bashargo (2014), agriculture continues to be a necessary tool for achieving sustainable development, alleviating poverty and food insecurity in developing countries. Thus, this makes agriculture the most crucial element for achieving the Millennium Development Goals (MDG), which includes: eradicating extreme hunger and poverty and ensuring environmental sustainability, among most. In Africa, agriculture can be viewed as a vital tool for increasing growth, eradicating poverty and ensuring food security; since, the productivity growth of the agricultural sector is essential for stimulating the growth of other sectors as well (Eba & Bashargo, 2014). Hence, to successfully alleviate poverty and food insecurity, a better performing agricultural sector is essential (Gelgo *et al.*, 2016).

Over the past 20 years, the issue of food security has continued to result in a lot of challenges in South Africa (Von Loeper *et al.*, 2016). Stewart and Roberts (2012) reported that issues regarding food security are anticipated to persist longer globally, more especially because in the next 40 years the global population is expected to increase by at least 35%. As a result, this continued growth in the world population requires to be accompanied by a simultaneous increment or improvement in agricultural output. At the national level, South Africa is regarded as food secure; however, this is not the case with households residing in rural areas (Du Toit *et al.*, 2011). This is mainly because the country can produce sufficient staple foods and has the capacity to import food and thus, meet nutritional requirements for the whole population. However, at the household level, people are still regarded as food insecure as they are still living in poverty and characterised by high levels of unemployment.

Food insecurity is the opposite of food security and is defined as a state whereby people are deprived of both physical and economic access to enough amounts of safe and nutritious food, and hence, they cannot consume enough quantities required for an active and healthy lifestyle (Stewart

& Roberts, 2012). According to Du Toit *et al.* (2011), food insecurity has been a major problem in many parts of the world, and South Africa is not an exception. Moreover, food insecurity begins with unemployment which in turn results in a remarkable fall of living standards.

Von Loeper *et al.* (2016) suggests that it is illogical to address food security challenges with the main focus being on increasing productivity of commercial farmers only. Efforts to address poverty and food insecurity can be directed or achieved through expansion of employment opportunities and hence, improving household incomes (Altman *et al.*, 2009). Smallholder or subsistence agriculture is most likely to contribute to incomes and savings, and also encourage food diversification (Altman *et al.*, 2009). Hence, subsistence or smallholder agriculture can play a vital role in creating livelihoods or income for poor rural households

The productivity of smallholder farmers or subsistence farmers can be increased through improved access to assets or inputs; these are the major factors influencing participation in agricultural input and output markets and assure livelihoods via agricultural production (Baiphethi & Jacobs, 2009). Increased productivity of smallholder farmers results in the increased household food supply which often minimises the effects of rising food prices, and therefore, Baiphethi and Jacobs (2009) suggested that in order to ensure long-term food security there is a significant need to increase smallholder farmers' productivity.

Baiphethi and Jacobs (2009), suggests that this can be achieved by supporting or advising farmers to undertake sustainable production intensification by using improved inputs. This will be achieved through extensive use of fertiliser, organic inputs, and conservation investments. However, considering the negative impacts and risks towards the environment and human health associated with the use of chemical or inorganic fertilisers, then the next alternative for enhancing subsistence and smallholder agricultural productivity remains to be organic manure.

2.7 Adoption of agricultural technologies

Jain *et al.* (2009), cited by Mwangi and Kariuki (2015), argued that agricultural technologies consist of all types of improved techniques and practices which impact agricultural output growth. Agricultural technologies are regarded as the most essential tool for eliminating poverty in developing countries; however, these countries are characterised by low adoption of these technologies (Mwangi & Kariuki, 2015). Living conditions of poor rural communities and agricultural productivity can be improved through the adoption of proven technologies. If the adoption of agricultural technologies is very low it is impossible to enhance the livelihoods of rural farm households through improved productivity of the agricultural sector in developing countries (Hailu *et al.*, 2014).

Attempts to reduce levels of poverty and enhance food security require an improved agricultural sector and this can be achieved through the adoption of different agricultural technologies to ensure the sustainability of agricultural productivity (Gelgo *et al.*, 2016). The concept of agricultural technology refers to a specific tool developed to improve production in an agricultural activity and if the main aim is to enhance agricultural productivity in an agricultural environment then adoption of agricultural technology is the main alternative to land expansion which is believed to be harmful to environmental conservation (Gelgo *et al.*, 2016). Essentially, agricultural technologies are all those practices and improved techniques that influence agricultural output growth (Mwangi & Kariuki, 2015).

According to Gelgo *et al.* (2016), producers are rational on their technology adoption decisions, and as a result, adoption of agricultural technologies may not be automatic as farmers require to observe performances of such technologies from other adopters before they adopt it. Barnard and Nix (1979) cited by Mahama *et al.* (2018), argued that farmers may choose to adopt new agricultural technologies (or inputs) given that they will accrue positive net return or their associated costs (both direct and transaction costs) per unit are lower than the associated benefits compared to those of existing inputs. Consequently, if producers believe that the costs associated with the new agricultural technology are high, they are discouraged to adopt that input resource and therefore, producers need to familiarise themselves with the cost and benefits so that they will choose an input resource that is more favourable compared to the old input resource being discarded.

Uaiene *et al.* (2009) and Foster and Rosenzweig (2010), cited by Hailu *et al.* (2014) argued that developing countries can best match developed countries through diffusion and adoption of agricultural technologies, and if this is not achieved then, rural poverty will persist, and agricultural production and productivity will be hampered. Eba and Bashargo (2014), suggest that adoption and use of improved agricultural technologies are essential for enhancing agricultural productivity and hence, these agricultural technologies can also potentially enhance the livelihoods of farmers in developing countries through improved productivity of both land and labour.

Agricultural technologies usually result in higher earnings and a decline in poverty; improved nutritional status; lower food prices and increased job opportunities as well as income for landless labourers; and as a result, those that adopt agricultural technologies experience increase in their productions and constant socio-economic development (Mwangi & Kariuki, 2015). As a result, the adoption of agricultural technologies can help enhance the livelihoods of rural smallholder farmers through increased agricultural productivity, in other words, smallholder farmers are required to adopt the proven agricultural technologies in order to enhance their farm productivity and their living conditions (Hailu *et al.*, 2014). Thus, in order to improve the current production level of the agricultural sector, it is essential to increase the adoption of agricultural technologies (Melesse, 2018). To ensure the efficacy of agricultural technologies, provided that these technologies have already been adopted; assistance, monitoring, and technical advice from an agricultural expect are essential (Gelgo *et al.*, 2016).

Adoption of farm practices or agricultural technologies may be affected by various factors, these are: characteristics of farm practice; the characteristics of adopters; change agent (extension agent or professional, etc.); and the socio-economic, biological and the environment with which the technology is ought to adopted (Farid *et al.*, 2015). Additionally, Ajewole (2010) noted that objectives of the technology to be adopted, as well as its characteristics, an advantage of the new technology relative to that of existing one, its profitability, compatibility, and complexity also plays a significant role in the adoption of innovations or agricultural technology. The attitude of farmers towards change, land, sources of information, membership of farmer's organisations, educational level, farm income, farmers' exposure, social status, attitude, resource endowments are essential socio-economic factors affecting the adoption of farm innovations or technologies (Ajewole, 2010; Farid *et al.*, 2015).

Various studies have been conducted by several authors to determine the factors influencing the adoption of agricultural technologies (Ajewole, 2010; Ketema & Bauer, 2011; Farid *et al.*, 2015; Mwangi & Kariuki, 2015; Gelgo *et al.*, 2016; Melesse, 2018). Factors influencing the adoption of agricultural technologies do not always have a similar outcome on agricultural technology adoption; the effect of these determinants differs with the type of technology being introduced (Mwangi & Kariuki, 2015).

The age of a farmer, level of education, income level, family size (household), credit use among others, are believed to positively influence adoption (Farid *et al.*, 2015). Additionally, Uaiene and Rafael (2009) cited by Gelgo *et al.* (2016) noted that advanced or enhanced diffusion of information through farmer organisations positively influences new agricultural technologies adoption decisions. Essentially, this means that those farmers who are well connected may be well informed about new and different agricultural technologies. Thus, farmers who are members of farmer-based organisations are more likely to adopt new agricultural technologies.

2.8 The concept of willingness to pay (WTP)

Willingness to pay (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). Alternatively, 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. The concept of WTP is related to the reservation price, which is the maximum price with which the buyer is certain to purchase a specific commodity (Le Gall-Ely, 2009). Furthermore, Etim and Benson (2016) argued that WTP for any commodity can be viewed as the amount of money which an individual is willing to pay for a higher level of environmental or commodity quality. Therefore, in this case, WTP is generally a measure of resources that an individual is willing and able to pay in order to reduce the chances of experiencing health hazards.

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, they require consumers' willingness to pay for a product to be determined and also to 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 question on WTP and/or closed-ended question on the intention to buy at a proposed price and lastly, price tests which applies a simulated purchase price (Le Gall-Ely, 2009). These methods enable economists or analysts to elicit money values that individuals are willing to pay in order to acquire a good or service. CV 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).

2.8.1 Contingent valuation method (CVM) of measuring WTP

Different methods or techniques have been developed by economists for valuing non-market services or goods consistent with the valuation of marketed goods (Carson, 2000; Navrud, 2000). Accordingly, Jinbaani (2015) argued that these valuation methods are usually grouped into monetary and non-monetary measures, and monetary valuation methods are dependent upon individual preferences which can either be based on revealed or stated preference approach.

In the stated preference valuation methods for natural resources and other non-market commodities, respondents provide value estimates in a survey contingent upon information previously given to them in the hypothetical market; hence they are referred to as contingent valuation methods (CVM) (Jinbaani, 2015). Therefore, the stated preference approach is regarded as a contingent valuation method when it is applied in the case of environmental services (Carson, 2000; Navrud, 2000). Moreover, this approach enables survey respondents to state their preferences regarding different possible future government actions or programmes.

Alternatively, revealed preference valuation methods are those which are mainly dependent upon observed behaviour (reaction) by consumers towards a marketed commodity in relation to the non-marketed good of interest (Carson, 2000; Navrud, 2000; Jinbaani, 2015). In both approaches, economic value emanates from choices in the case of a real market or in the hypothesized market scenario created in the survey (Carson, 2000).

CVM is a survey-based technique that is frequently applied in order to assign monetary values on environmental goods and services mostly which are not currently available in the market for being bought or sold (Carson, 2000). Thus, CVM can be best used in situations where there is no real market for the goods and/or services and that is in the case of a hypothetical market. In a hypothetical market scenario, consumers are asked if they are willing to pay a specific and stated amount for a particular commodity or if they would be willing to pay for that commodity or services offered, this means that consumers or respondents have the ability to indicate their preference (Njoko, 2014). Furthermore, survey respondent's choices in the hypothesized scenario are then subjected to analysis in a similar way as the choices by consumers in real markets (Carson, 2000).

According to Tang *et al.* (2013) cited by Njoko (2014), contingent valuation is used as a determinant for non-market commodity demand by allowing respondents to directly state their WTP or willingness to accept (WTA) for goods and services concerned. Cameron and James (1987) argued that CV models are the most suited methods for obtaining willingness to pay. WTP can be obtained by CVM through the use of several different elicitation methods, and these methods include the open-ended question, closed-ended question, payment card, the bidding game, dichotomous choice approach (Njoko, 2014; Jinbaani, 2015).

In open-ended CV method, respondents are asked to express their WTP for a certain product directly, e.g. "Please indicate the highest price you would accept to pay for this offer", whereas, in closed-ended CV, respondents are presented with several questions on whether they would or would not purchase the product at a proposed price (e.g. Would you be willing to pay RX amount for this offer?) (Le Gall-Ely, 2009; Njoko, 2014; Jinbaani, 2015). In closed-ended CV, attributes or characteristics of a good or service are identified, then the potential consumer is asked if he or she would be willing to pay or accept the specific amount of money in order to access that good or service (Cameron & James, 1987).

Open-ended CV format is associated with several problems, including high rates of non-responses and strategic high or low valuations among others (Njoko, 2014). Open-ended CV method is unrealistic as consumers state their own prices and hence, they may intentionally express their answers to affect the outcome of the survey to support their own interests and thereby creating a strategic bias (Le Gall-Ely, 2009). As a result, they can either over-estimate their WTP or underestimate it. Respondents might also undervalue or overestimate their WTP because they may lack market information about free riding and the costs and benefits related to the good and/or service concerned (Jinbaani, 2015).

In the payment card method, respondents are instructed to choose from a range of potential bid amounts, the amount that is close to their WTP (Njoko, 2014). Alternatively, the bidding game format involves asking respondents if they are willing to pay a specific bid amount for the goods and services. If the answer is “Yes”, then the respondent is asked the same question for a higher bid amount, and the bid amounts are increased until the respondent responds with “No”. Alternatively, if the respondent responded with the answer “No” to the first bid, then the successive bid amounts are reduced until the respondent's response is “Yes” (Njoko, 2014). However, Cummings (1986) as cited by Njoko (2014), reported that WTP estimated using the bidding game format results in starting point bias resulting from correlation with the first value.

The dichotomous choice method is divided into single-bounded and double-bounded or multiple bounded choices, and the main reason for the development of this method was to solve the problems or limitations associated with other elicitation formats applied at the early stages of CVM studies (Njoko, 2014). Thus, the dichotomous choice format is progressively being widely adopted mainly because it provides room for the follow-up questions, thus increasing the accuracy of respondents’ value estimates they provided in the survey (Jinbaani, 2015).

In the single-bounded dichotomous choice method, respondents are asked to respond with an answer “Yes” or “No” to a single randomly selected bid amount that is offered. The respondent “Yes” or “No” answers are converted into a variable that is subjected to statistical methods used to estimate WTP using the probability of “Yes” or “No”, the bid amount and other socio-economic variables (Njoko, 2014). In the single dichotomous choice approach, respondents do not have a reason to bias their answers to influence the outcome; thus, there is less strategic bias (Njoko, 2014).

Alternatively, the double-bounded dichotomous approach gives respondents the bid twice. If the answer to the initial bid is “Yes” then the respondent will be given a higher bid, and if the answer is “No” to the first bid, then a reduced lower bid will be given. Therefore, the double-dichotomous approach reduces the tendency of respondents responding with “Yes” continuously (Carson, 2000; Navrud, 2000). Double-bounded dichotomous choice models are advantageous mainly due to their statistical efficiency (Lusk & Hudson, 2004).

Unlike single-bounded dichotomous choice models, double-bounded dichotomous choice models capture more information about individuals WTP and thus, do not require a large sample size (Lusk & Hudson, 2004; Njoko, 2014). Hence, the use of the dichotomous choice approach is widely diffused due to increased precision of estimates provided by respondents as this approach allows for follow up questions (Jinbaani, 2015).

Despite the above-mentioned advantages of double-dichotomous choice models, it is possible that respondents might choose the second bid due to post-exposure from the first offer; hence, there is some starting point bias. However, Jinbaani (2015) reported that this source of bias could be remedied with a cost-benefit dichotomous-choice method which has additional information about the commodity of interest and thus, helps respondents in decision making.

Chapter 3

Determinants of adoption and use intensity of organic fertiliser by smallholder potato farmers

3.1 Introduction

In this chapter, the methodologies and the empirical results regarding the factors influencing the adoption and use intensity of organic fertiliser by smallholder potato farmers are presented and discussed. The rest of the chapter is structured as follows; section 3.2, constitutes the research methods which includes the description of the study area, data collection, and sampling techniques. In section 3.3, the theoretical and conceptual framework, the description of variables used in the empirical models and the empirical models employed in the study are presented. In section 3.4, the empirical results and discussions are presented while in section 3.5 concludes the chapter with a summary of the results as well as policy recommendations.

3.2 Research methods

3.2.1 Study area description

This study was conducted in the uMsinga, uMshwathi and uMzumbe local municipalities of KwaZulu-Natal (KZN) Province, South Africa. According to Msinga Municipality Integrated Developent Plan (MMIDP, 2018), Msinga is a mostly rural area with 70% of its area being Traditional Authority land held by the Ingonyama Trust. While, the remaining 30% of the land is commercial farmland, all of which is located to the north of Pomeroy. Due to the rural nature of the municipality, approximately 99% of the population lives in traditional areas. The municipality is in the south western part of the district municipality area.

According to Media (2018) and MMIDP (2018), Msinga is estimated to have population of about 160 000 people, in an area of 2500 square kilometre (sq km), resulting in a population density of 64 people per sq km. uMsinga is a poverty-stricken area with few economic resources. Farming contributes 18% of the income for the area (MMIDP, 2018). In addition, subsistence agriculture is practised in areas adjoining the Tugela River irrigation schemes. Several community garden groups utilise about 89 hectares of land to cultivate vegetables, and these are mainly located along with the available water sources. Consequently, this serves as an incentive for the community to be involved in crop production.

uMshwathi Municipality is situated within the uMgungundlovu District Municipality immediately adjacent to Pietermaritzburg. uMshwathi comprises of four major urban centres (New Hanover, Wartburg, Dalton, and Cool Air) as well as rural residential settlements of Swayimane, Mpolweni, Thokozani, and Ozwathini. uMshwati covers an area of about 1 811 sq km (Media, 2018). Furthermore, the land is mostly agricultural, although urban development is found in the towns of New Hanover, Wartburg, Dalton and Cool-Air. The communities living in the underdeveloped areas have extremely limited access to basic physical and social requirements and have very few economic opportunities.

Lastly, uMzumbe municipality extends along the coast for a short stretch between Mtwalume and Hibberdene and spreads out into the hinterland for some 60 km and it covers a vast, largely rural area of about 1 182.7 sq km (Media, 2018). While only about 1% of the municipality is built up (semi-urban) and the rural hinterland incorporates 17 traditional authority areas. According to Stats SA (2018) and Media (2018), income levels in Umzumbe are very low and reflect a situation of acute impoverishment. Almost 60% of all households have an income of less than R500 per month. Households rely on pension and other welfare grants, migrant remittances, informal earnings, and casual employment wages for survival.

These three municipal areas (uMsinga, uMshwathi and uMzumbe municipalities) were chosen for this study because they comprise of a majority of rural smallholder farmers with relatively homogeneous socio-economic characteristics (for example they have low income, and they live in poverty-stricken communities.) and they also depend mainly on social grants and smallholder farming (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. Figure 1 illustrates the location of the study areas (indicated by red triangles) selected in KwaZulu-Natal.

Figure 1: The map of KwaZulu-Natal Province showing the study areas

Source: Stats SA (2018)

3.2.2 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, Mshwathi and uMzumbe local municipalities. The second stage employed a simple random sampling technique to select sub-samples 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 understand the 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' socio-economic characteristics and household demographic information such as gender, age, marital status, farming experience, household size, and education level. The questionnaire also included measures of adoption and use intensity of organic fertiliser, 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.

3.3 Theoretical and conceptual framework

To examine the factors influencing adoption and use intensity of organic fertiliser by smallholder potato farmers, this study employed the random utility framework model. The random utility framework model assumes that since the main aim or objective of a decision-maker is to maximise utility then, the individual decision-maker will choose an option with which his or her utility is maximised (Danso-Abbeam & Baiyegunhi, 2017).

The random utility theory suggests that a farmer's decision to adopt organic fertiliser is based on the expected utility function. Therefore, a farmer decides to adopt organic fertiliser provided that the expected utility (Yield) resulting from organic fertiliser adoption (U_i^O) is greater than that of non-adoption (U_i^N). For example, a farmer chooses to adopt organic fertiliser if the expected net utility (net yield) ($U_i^O - U_i^N$) is greater than zero. Following previous research (Kassie *et al.*, 2009;

Diiro *et al.*, 2015; Gelgo *et al.*, 2016; Danso-Abbeam & Baiyegunhi, 2017; Ali *et al.*, 2018), the unobserved net utility can be expressed as a function of observable elements in the following latent variable model:

$$U_i^* = \beta Z_i + \varepsilon_i; \qquad U_i = 1 \text{ If } \; U_i^* > 0 \qquad (1)$$

Where U_i is a binary variable which equals 1 for i^{th} farmer in the case of organic fertiliser adoption and 0 otherwise; β is a vector of parameters to be estimated; Z_i is a vector of farmer and farm characteristics, and ε_i is an error term. The outcome variables considered were the decision to use organic fertilisers and the amount used. The amount of fertiliser used applies to the adopters only, as the non-adopters do not have these figures.

The dependent variable is a binary indicator of whether or not a farmer adopts organic fertiliser. Households' socio-economic characteristics and other institutional support variables that are included in the model as explanatory variables based on empirical evidence from literature based on factors influencing adoption of agricultural technologies (Ajewole, 2010; Ketema & Bauer, 2011; Farid *et al.*, 2015; Mwangi & Kariuki, 2015; Gelgo *et al.*, 2016; Melesse, 2018).

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, credit, training, information, etc.), infrastructural and/institutional support (distance to the source of organic fertiliser). The interaction between these variables and the dependent variables is illustrated diagrammatically in Figure 2.

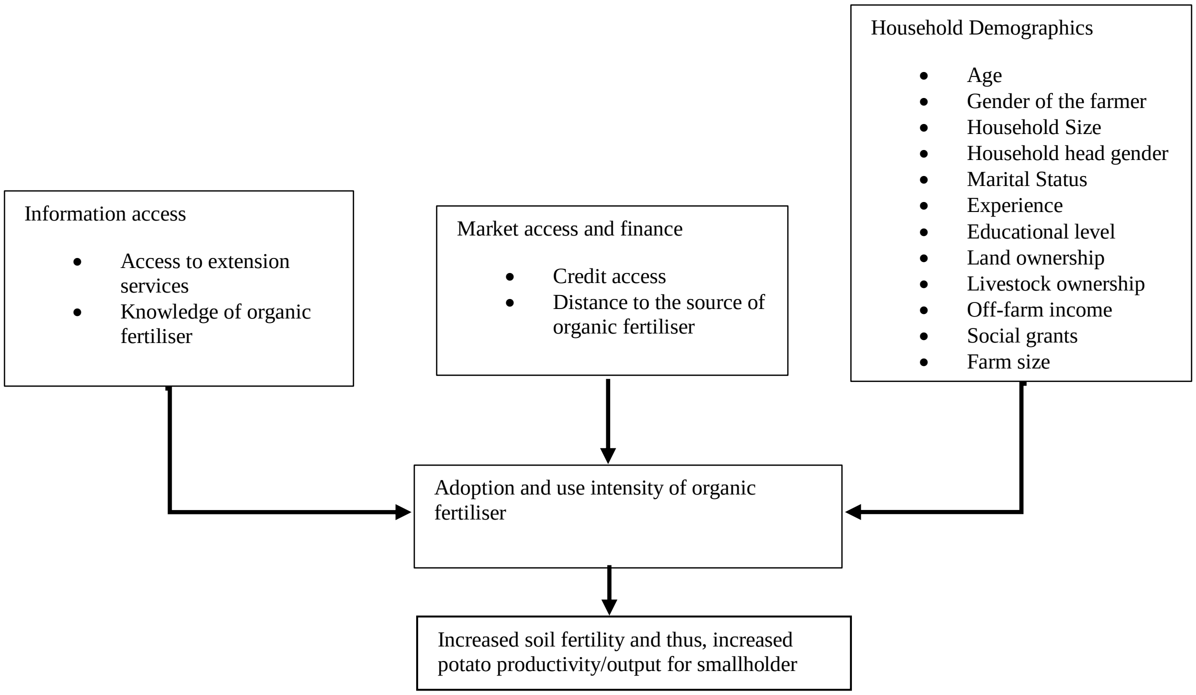

Figure 2: Factors influencing adoption and use intensity of organic fertiliser

For this study, it was hypothesized that the above mentioned factors influence the adoption and use intensity of organic fertiliser. For example; age, access to extension services, farm size and knowledge of organic fertiliser usage is hypothesized to positively influence adoption and use intensity of organic fertiliser. Whereas, the distance to the source of organic fertiliser is expected to negatively influence adoption and use intensity of organic fertiliser. Furthermore, off-farm income, household size (family size) and farming experience are hypothesised to positively influence organic fertiliser adoption and use intensity. High off-farm income, more years of farming experience and large household size is expected to increase the likelihood of organic fertiliser adoption and use intensity. Household size is the measure of labour availability; as a result, the larger the household size, the higher the likelihood of a farmer adopting organic fertiliser. Since organic fertiliser is labour intensive, an increase in household size simply means that the household has enough labour for the preparation and application of organic fertiliser.

Livestock size and land ownership are also expected to increase the likelihood of organic fertiliser adoption because smallholder farmers can easily collect livestock manure from the kraal; while, land ownership ensure the security of tenure; as a result, it increases the farmers' incentive to invest in soil fertility in order to increase crop productivity. Livestock size was measured using the tropical livestock units (TLU) which provides different weights for several types of livestock. According to Ghirotti (1993), the TLU conversion weights for cattle, goats/sheep, pigs, and poultry are 0.7, 0.2, 0.1 and 0.01, respectively. However, farmers in the study area reported that during composting, they use only kraal manure (cow dung). Hence, livestock size was measured by the number of cattle that the smallholder farmer own times 0.7 units.

Extension services are the primary source of information for farmers. Advanced or enhanced diffusion of information through advisory and extension services positively influence new agricultural technologies adoption decisions. Farmers with a better network may possess superior information about different agricultural technologies. Thus, improved access to these information sources positively influence the adoption of organic fertiliser. Therefore, access to information increases the likelihood of adopting organic fertiliser. Lastly, the adoption of organic fertiliser enhances long term soil fertility and hence, increasing crop yield, thus increased farm productivity.

3.3.1 Variable specification

The dependent variables and predictor variables hypothesized to influence adoption and use intensity of organic fertiliser were identified based on the theory of adoption of agricultural technologies. These variables employed in the analysis are defined and presented in Table 1.

Table 1: Definition of variables used in the empirical models and their expected direction

Variable	Definition	Measurement	A *Priori* expectation
Dependent :			
ADOPTION	Selection variable	Dummy; 1 if adopted organic fertiliser; 0 if otherwise	
USE INTENSITY	Outcome variable	Kg/ha	
Explanatory:			
AGE_OF	Age of farmer	Years	Positive
HH_GENDER	Gender of the household head	Dummy; 1 if a farmer is a male; 0 if otherwise.	Positive
F_EXPER	Years of experience	Number of years a farmer had been involved in farming.	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.	Positive
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; 0 if otherwise.	
HH_SIZE	Household size	Number of household members	Positive
LSTOCK_SIZE	Cattle ownership	Number of livestock owned	Positive
OWN_LAND	Land ownership	Dummy; 1 if a farmer has land ownership rights; 0 if otherwise.	Positive
OFF_INCOME	Off-farm income	Total monthly off-farm income	Positive
DIST_FARM	Distance from farm to fertiliser market	Measured in kilometres (km)	Negative
SOC_GRANT	Access to social grants	Dummy; 1 if a farmer has access to social grants; 0 if otherwise.	Positive
M_STATUS	Marital status	Dummy; 1 if a farmer is married; 0 if otherwise.	Positive/negative

3.3.2 Empirical models

To estimate the factors influencing adoption and use intensity of organic fertiliser, this study employed the Cragg's Double Hurdle (DH) model proposed by (Cragg, 1971). The DH model makes the assumption that there is no selectivity bias and the decision to adopt and the intensity of adoption are separate. Moreover, it solves the problem of dual endogeneity and heteroscedasticity between the decision to adopt and the use intensity of organic fertiliser (Gelgo *et al.*, 2016).

According to Cragg (1971), the household head decision of adopting and the use intensity of a given technology are supposedly independent and sequential. Thus, given the two separate decisions, the initial stage of the DH model deals with the decision of adoption, and this can be expressed by the following function:

$$d_i^* = \alpha_i x_i + u_i \qquad (1)$$

Where d_i^* is the latent (unobservable) variable for the choice of the decision to adopt technology; χ_i is a vector of coefficient estimates for explanatory variables that were hypothesised to influence the decision to adopt organic fertiliser, and u_i is an error term (random and normally distributed with a zero mean and constant variance). Equation 1 is a probit model that examines the probability that the i^{th} smallholder farmer would decide to adopt organic fertiliser. Since d_i^* is unobservable, then the observable decision to adopt organic fertiliser is:

$$\text{If } d_i^* > 0 \text{ then } D_i = 1 \text{ and } d_i^* \leq 0 \text{ then } D_i = 0 \qquad (2)$$

Where: D_i is the observable decision made by the i^{th} smallholder farmer to adopt organic fertiliser, therefore: $D_i = 1$ if the respondent has adopted organic fertiliser and $D_i = 0$ if otherwise.

The second stage of the DH model applies a truncated model to estimate the use intensity of organic fertiliser. This stage is essential for determining the level or extent of organic fertiliser use to those respondents who reported to use organic fertiliser.

The use intensity equation can be expressed as follows:

$$\text{Let, } y_i^* = \alpha_1 z_i + \varepsilon_i \qquad (3)$$

Where: $y_i = Y_i^* \geq \mu$ if $D_i = 1$ and

$$Y_i^* \leq 0 \text{ When } D_i = 0 \qquad (4)$$

Y_i shows the observed use intensity of organic fertiliser by the i^{th} smallholder farmer, Y_i^* is the latent variable of use intensity, μ is the threshold for the minimum of organic fertiliser used considered as optimum in the study area, Z_i is a vector of coefficient estimates for household characteristics that are hypothesized to influence the extent or level of using organic fertiliser, and ε_i is the error term.

According to Cragg (1971), assuming that the error terms are independent, the log-likelihood for the DH model is given by the following expression:

$$LogL = \sum_{0} \ln\left[1 - \Phi\left(\alpha X_i^{'}\right)\left(\frac{\beta Z_i^{'}}{\sigma}\right)\right] \sum_{+} \ln\left[\Phi\left(\alpha X_i^{'}\right)\frac{1}{\sigma}\phi\left(\frac{Y_i - \beta X_i^{'}}{\sigma}\right)\right] \quad (5)$$

Where: Φ is the standard normal cumulative distribution function, and ϕ is the density function. The log-likelihood function has two parts; the first part is for the probit, whereas the second part is for the truncated regression with the truncation of zero.

Initially, a farmer household makes a choice whether to adopt a certain new practice or technology and secondly, depending on the farmers' adoption decision, the level of adoption is determined (Nazziwa-Nviiri *et al.*, 2017). Similarly, the case of adopting organic fertiliser is not an exception; farmers first decide to use organic fertiliser or otherwise, then conditional to their decision to use organic fertiliser, the extent or quantity of organic fertiliser (measured in kilograms per hectare) used is determined on the second stage.

Given the scenario above, not all farmers will adopt a given technology. Hence, it is likely that the data generated through this decision process will generate a series of zero values for the quantity of organic fertiliser used in the case of those farmers who decided not to adopt fertiliser. According to Tobin (1958) cited by Nazziwa-Nviiri *et al.* (2017) and Solomon *et al.* (2014), in such cases when observations are clustered at a censoring point, a suitable model to use is a standard Tobit model.

Nevertheless, the Tobit model makes an assumption that the decision to adopt a particular technology and the amount adopted is determined by the same process; which essentially means that the size of the coefficient estimates for adoption and use intensity is assumed to be one and similar (Nazziwa-Nviiri *et al.*, 2017). Thus, this model seems to be constrictive since it requires that zeros and positive values are generated by a similar process. Therefore, the DH model is appropriate because it takes into account the probability that the factors that influence the decision to adopt a certain technology and those influencing the use intensity may be separate. In a scenario when the technology adoption decision and the level of adoption are separate, the double hurdle model is more appropriate (Obuobisa-Darko, 2015).

To substantiate the choice of using the DH model, the log-likelihood values generated from an individual estimation of the Tobit, Probit and truncated regression models were used to conduct a restriction test using the likelihood ratio test statistic displayed below on equation 6.

$$\lambda = 2(LL_{\text{Probit}} + LL_{Truncated} - LL_{Tobit}) \quad (6)$$

If the likelihood ratio test statistic (λ) is greater than the suitable chi-square critical value; therefore, the Tobit model is rejected (Martey *et al.,* 2014). Hence, the DH model is appropriate. In the case where there is sample selection bias, the Heckman selection model would have been a suitable model to use. To address this problem, the Heckman initially estimate the selection equation using the probit model and then, adds the correction factor (Inverse Mills Ratio (IMR) calculated from probit model) into second stage of the Ordinary Least Squares (OLS) regression (Baiyegunhi & Oppong, 2016; Chipfupa & Wale, 2018). However, the results from the Heckman selection model for this study revealed that the IMR was statistically insignificant, suggesting that there was no sample selection bias. Hence, the Heckman selection model was inappropriate.

3.4 Empirical results

3.4.1 Descriptive statistics

The descriptive analysis for the household demographics and socio-economic characteristics of sampled smallholder potato farmers by adoption levels for both continuous and dummy variables are reported in Table 2.

Table 2: Household demographics and socio-economic characteristics of sampled potato farmers by adoption level. (*n*= 189)

Variable	Adopters [*n*=123]		Non-adopters [*n*=66]		t -value
	Mean	SD	Mean	SD	
Age (Years)	43.53	13.51	40.36	14.47	4.34***
Household size	6.45	3.80	3.34	2.11	6.14***
Household head gender	0.40	0.04	0.27	0.05	1.83*
Marital status	0.62	0.04	0.92	0.48	0.85
Experience (Years)	17.91	12.96	14.69	12.71	1.63
Educational level (Years)	4.10	4.57	4.06	4.51	0.064
Farm size (hectares)	0.06	0.01	0.05	0.2	0.48
Livestock size (TLU)	16.44	1.49	0.23	0.13	7.93***
Off-farm income (Rands)	2182.07	1283.07	1825.76	1355.63	1.78*
Distance (Km)	2.58	3.59	8.40	4.04	10.13***
Extension support	0.79	0.04	0.03	0.02	14.69***
Knowledge	0.93	0.02	0.69	0.06	4.608***
Land ownership	0.65	0.04	0.62	0.06	0.39
Credit access	0.43	0.04	0.64	0.06	2.73***
Social grants	0.90	0.03	0.74	0.05	2.96***

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

Among the sampled smallholder potato farmers, there are about 65% and 35% of adopters and non-adopters of organic fertiliser. This implies that the rate of organic fertiliser adoption in the study area is very high. However, even though there is a high rate of organic fertiliser adoption among the sampled smallholder potato farmers, there is still a significantly large number of smallholder farmers who are not using organic fertiliser in their farm production.

The t-statistic results show that there are statistically significant differences between adopters and non-adopters of organic fertiliser in terms of age, household size, household head gender, livestock size, off-farm income, and distance to the source of organic fertiliser, extension support, knowledge of organic fertiliser usage, access to credit and access to social grants.

There is a statistically significant difference in the age of adopters and non-adopters of organic fertiliser. The average age for adopters and non-adopters of organic fertiliser is about 44 and 40 years, respectively. This implies that smallholder farmers engaged in potato production are relatively young, and they are within the economically active population. There is also a statistically significant difference in terms of household size for adopters and non-adopters of organic fertiliser. The average household size for adopters and non-adopters is about 7 and 3 people, respectively. This shows that smallholder potato farmers who adopt organic fertiliser have relatively large household sizes.

The results show that there is a statistically significant difference between adopters and non-adopters in terms of household head gender. There are about 40% of the adopters, and 27% of non-adopters who are from male-headed households. In terms of livestock size, there are statistically significant differences between adopters and non-adopters of organic fertiliser. The average livestock size for the adopters of organic fertiliser was about 16.44 (TLU), compared to an average of 0.23 TLU for non-adopters. This implies that smallholder farmers who adopt organic fertiliser have large livestock holding compared to non-adopters.

The results also show that there are statistically significant differences between adopters and non-adopters in terms of off-farm income. The average off-farm income for adopters and non-adopters is R 2182.07 and R 1825.76 per month, respectively. This result indicates that off-farm income of smallholder farmers who adopted organic fertiliser is higher than that of non-adopters. The major sources of income for both adopters and non-adopters were social grants, pension, remittances, and street hawking.

The average distance travelled to the source of organic fertiliser by adopters and non-adopters was 2.58km and 8.40km, respectively. In general, a high percentage of smallholder farmers who did not adopt organic fertiliser were located farther away from the nearest source of organic fertiliser than adopters; thus, the average distance to the nearest source of organic fertiliser was significantly higher for non-adopters than adopters. This implies that organic fertiliser is within close reach for adopters compared to non-adopters. There is a statistically significant difference between adopters and non-adopters of organic fertiliser adoption in terms of access to extension services. There are about 79% and 3% of adopters and non-adopters of organic fertiliser who have access to extension services. This implies that the majority of smallholder potato farmers who adopt organic fertiliser have access to extension services while among non-adopters, there are only a few smallholder farmers who have access to extension services.

The results also show that there is a statistically significant difference between adopters and non-adopters of organic fertiliser in terms of knowledge of organic fertiliser usage. There are about

93% and 62% of adopters and non-adopters with knowledge of organic fertiliser usage. This implies that smallholder potato farmers are very knowledgeable about the preparation and use of organic fertiliser. There is also a statistically significant difference in access to credit between adopters and non-adopters. The average of respondents who have access to credit for both adopters and non-adopters of organic fertiliser is about 43% and 64%, respectively. This implies that smallholder farmers with access to credit did not adopt organic fertiliser were significantly larger than adopters. The majority of smallholder potato farmers are beneficiaries of social grants, and on average, the percentage of smallholder farmers who have access to social grants were 90% and 74% for adopters and non-adopters, respectively. However, there is a statistically significant difference in access to social grants between adopters and non-adopters of organic fertiliser.

3.4.2. Cragg's double hurdle results of factors influencing the adoption and use intensity of organic fertiliser.

In order to test for the possibility of multicollinearity which occurs when there is a perfect linear association between the predictor variables, this study used the variance inflation factor (VIF). According to Gujarati and Porter (2009), if the VIF is greater than the critical value of 10 then Multicollinearity is a major problem. The mean VIF was 1.62 which is less than the critical value of 10, thus indicating that multicollinearity was not a concern. The Breusch-Pagan-Godfrey test was also conducted for the outcome equation to test for the possibility of heteroscedasticity in the model. The Chi-square test statistic for the test was statistically significant at 1% level of significance, which indicates that the outcome equation might be biased. To correct for the presence of heteroscedasticity, the outcome equation was estimated with robust standard errors. The results of the selection regression (Cragg's DH model), which involved the probit analysis of the adoption decision of organic fertiliser and also the results of the underlying truncated regression, which establishes the determinants of the of use intensity of organic fertiliser are estimated jointly and are presented in Table 3.

Table 3: Results of the Cragg's DH model for the factors influencing adoption and use intensity of organic fertiliser

Variables	Probit model: First stage			Truncated model: Second stage	
	Coefficient	**Std. Err.**	**Marginal Effect**	**Coefficient**	**Robust Std. Err.**
AGE_OF	0.0310	0.0295	0.0017	-1.7681*	1.0612
HH_GENDER	1.8533**	0.8242	0.0011	5.9173	19.989
M_STATUS	0.0459	0.1475	0.0026	21.011	23.216
HH_SIZE	0.4455*	0.2397	0.0250	2.7323	3.2301
F_EXPER	-0.0279	0.0359	-0.0016	1.5847	1.0201
EDUC_LEVEL	0.0844	0.0725	0.0047	-4.7907	2.9582
ACC_CREDIT	-2.9270**	1.3282	-0.1643	-9.8867	23.169
ACC_EXT	4.1621**	1.9861	0.2337	-	-
KNW_UOF	3.0773*	1.8229	0.1728	175.24***	53.333
FAR_SIZE	2.5024	1.6823	0.1405	214.60***	52.504
OWN_LAND	4.2909*	2.0269	0.2409	-13.260	21.529
LSTOCK_SIZE	0.9562***	0.3409	0.0537	2.1751***	0.6012
SOC_GRANT	7.0403**	2.8770	0.3953	-11.202	27.959
DIST_FARM	0.0197	0.0961	0.0011	0.7525	3.2515
OFF_INCOME	0.0002	0.0003	0.0001	-0.0012	0.0081
CONSTANT	-17.0773***	6.0236		-0.0126*	64.578
/sigma	-	-	-	68.930***	7.6266
n = 189 LR $chi^2(15)$ = 206.52 Prob > chi^2 = 0.0000 Log likelihood = 19.0 Mean VIF = 1.62 BP Chi^2 = 39.42 Classification accuracy = 96.3% Prob > chi^2 = 0.0000				n = 123 Wald $chi^2(15)$ = 62.78 Prob > chi^2 = 0.0000 Log pseudo likelihood = -19.8	

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

In order to explain the differential effect of explanatory variables on the dependent variable, the coefficient estimates, as well as the marginal effects of the probit model estimates, are presented in Table 3. The DH model fits the data well, as 96.3% of organic fertiliser adoption decision outcomes were correctly classified. Additionally, the Likelihood and Wald test of the hypothesis that all the regression coefficient estimates are jointly equal to zero is rejected at 1% level of significance. This implies that all explanatory variables included in the probit and truncated regression model explain the variations in the smallholder farmers' probability to adopt and intensify the use of organic fertiliser.

In the analysis of the decision to adopt organic fertiliser (first stage), eight explanatory variables were statistically significant, these are: household head gender (HH_GENDER), household size (HH_SIZE), access to credit (ACC_CREDIT), access to extension services (ACC_EXT), knowledge of organic fertiliser (KNW_UOF), land ownership (OWN_LAND), livestock size (LSTOCK_SIZE) and access to social grants (SOC_GRANT). The coefficient estimates have expected signs except for access to credit. Household head gender, household size, access to extension services, knowledge, land ownership, livestock size and access to social grants have a statistically significant positive effect on the probability of adopting organic fertiliser, whereas access to credit has a statistically significant negative influence on the probability of adopting organic fertiliser.

While, in the analysis of the use intensity of organic fertiliser (second stage), four explanatory variables were statistically significant, and these were: age of a farmer (AGE), knowledge of organic fertiliser (KNW_UOF), farm size (FAR_SIZE), and livestock size (LSTOCK_SIZE). The coefficient estimates have expected signs. Age, knowledge, farm size and livestock size have a statistically significant positive effect on the use intensity of organic fertiliser by smallholder potato farmers.

3.4.3 Discussion

This study found that male-headed households were more likely to adopt organic fertiliser. The coefficient estimate of household head gender was found to be positive and statistically significant in explaining the decision to adopt organic fertiliser by smallholder potato farmers. The marginal effects show that male-headed households were 0.11% more likely to adopt organic fertiliser compared to their female-headed counterparts. These results are consistent with findings obtained by Diiro *et al.* (2015). A possible explanation for these results might be that male-headed households in the study area have more livestock holding and have better access to kraal manure, and hence, they are most likely to use organic fertiliser. According to Solomon *et al.* (2014), female-headed households are mostly poorly endowed in terms of labour, assets (including livestock) and income.

Results show that a one year increase in the age of a farmer decreases the use intensity of organic fertiliser by 1.7681kg/ha. This implies that as smallholder farmers become older, they reduce their use intensity of organic fertiliser. A possible explanation for this outcome might be due to the high labour demand of organic fertiliser during preparation, therefore, as older farmers have less energy compared to young farmers, so it is likely that older farmers will use low quantities of organic fertiliser. Moreover, risk aversion of younger farmers is lower compared to older farmers and they are more likely to adopt and intensify the use of agricultural technologies and invest in long term farm investment (Mwangi & Kariuki, 2015).

As expected, these results indicated that an increase in the household size (HH_SIZE) increased the likelihood of organic fertiliser adoption. Marginal effect results show that an increase in the household size by one person will increase the probability of organic fertiliser adoption by 2.5%. This implies that farmers with large household sizes are also more likely to adopt organic fertiliser. An increase in household size means there is more labour available for the preparation and application of organic fertiliser (Ketema & Bauer, 2011; Mwangi & Kariuki, 2015). Therefore, considering the high labour demand for organic fertiliser preparation and use, large household size influences the quantity of labour available to facilitate organic fertiliser adoption.

Although access to credit (ACC_CREDIT) is expected to positively influence the adoption of agricultural technologies, smallholder farmers with access to credit were found to be less likely to adopt organic fertiliser. The marginal effect results show that farmers with access to credit were 16.43% times less likely to adopt organic fertiliser. A possible explanation for this result is that farmers with access to credit could prefer to redirect their financial resources to other productive activities rather than investing in organic fertilisation (Martey *et al.*, 2014). For example, farmers with access to credit might decide to purchase synthetic fertilisers rather than adopting organic fertiliser because they can afford them.

As expected, smallholder farmers with access to extension services are more likely to adopt agricultural technologies. This study found that access to extension services increases the likelihood of organic fertiliser adoption by about 23.37%. This finding is similar to the result obtained by several other studies such as Eba and Bashargo (2014); Obuobisa-Darko (2015); Gelgo *et al.* (2016); Nazziwa-Nviiri *et al.* (2017), and Ali *et al.* (2018). Extension services serve as an important source of information to farmers. Accordingly, access to information empowers and encourages farmers to seek or adopt relevant agricultural technologies that sought to enhance their agricultural productivity (Gelgo *et al.*, 2016). Moreover, extension agents usually achieve the latter through the provision of training and advisory services. Thus, extension services have an essential role in the demonstration and dissemination of agricultural technologies.

This study also found that farmers with knowledge of organic fertiliser usage (KNW_UOF) are more likely to adopt and intensify their use of organic fertiliser. The marginal effect results show that farmers with sufficient knowledge of organic fertiliser usage are 17.28% times more likely to adopt organic fertiliser. At the same time, smallholder farmers with sufficient knowledge of organic fertiliser usage increased the use intensity of organic fertiliser by 175.24kg per hectare. According to Jabbar *et al.* (2003), the adoption of agricultural technologies is mainly influenced by the knowledge and perception of the type of technology concerned. Therefore, having enough knowledge about the preparation and use of organic fertiliser increases the likelihood of organic fertiliser adoption and use intensity.

As expected, an increase in farm size (FAR_SIZE) increases the use intensity of organic fertiliser. The results show that an increase in farm size by one hectare increases the level of organic fertiliser applied by 214.60kg per hectare. This implies that as smallholder farmers' farm size increase they tend to apply more organic fertiliser in their potato production. These results are consistent with those obtained by Gelgo *et al.* (2016) and Obuobisa-Darko (2015). Since organic fertiliser can be obtained at a relatively lower cost compared to synthetic fertilisers, farmers can benefit through economies of scale by increasing the level of organic fertiliser applied as farm size increases (Gelgo *et al.*, 2016).

As expected, smallholder farmers with land ownership rights are more likely to adopt agricultural technologies. Hence, results show that land ownership (OWN_LAND) increases the likelihood of organic fertiliser adoption by 24.09%. According to Hailu *et al.* (2014), farmers are rational decision-makers and as they incur costs of technologies, they prefer to adopt and use technologies on their own plots of land. Therefore, smallholder farmers who have ownership rights to their plots of land are more likely to invest in long term soil fertility by adopting organic fertiliser in their potato production, mainly because the benefits of their investment will accrue to them and they will not share it with anyone in the form of rent for land used.

As expected, smallholder farmers with larger livestock size (LSTOCK_SIZE) are more likely to adopt organic fertiliser. Results from this study show that an increase in livestock size by one TLU increases the probability of organic fertiliser adoption by 5.37%. These results are consistent with the findings of Gelgo *et al.* (2016). Livestock manure is the main ingredient for compost, and hence, it is the major source of organic fertiliser. Consequently, the larger livestock size increases the probability of organic fertiliser adoption. Similarly, increasing livestock size increases organic fertiliser use intensity. Truncated regression model results show that an increase in livestock size by one TLU increases the use intensity of organic fertiliser by 2.1751kg per hectare. Therefore, smallholder farmers with more livestock holding are more likely to adopt and intensify their use of organic fertiliser on their potato production because they have better access to livestock manure.

In addition, this study found that smallholder farmers who have access to social grants are more likely to adopt organic fertiliser. The marginal effect results show that access to social grants increases the likelihood of organic fertiliser adoption by 39.53%. According to Sinyolo *et al.* (2016), access to social grants is essential for reducing liquidity limitations faced by smallholder farmers. Smallholder farmers who are receiving social grants use some portion of it for purchasing agricultural inputs. Therefore, social grants are crucial for reducing financial constraints on their agricultural production.

3.5 Chapter summary

This chapter examines the determinants of adoption and use intensity of organic fertiliser by smallholder potato farmers in KwaZulu-Natal. This study found that majority (about 65%) of smallholder farmers were using organic fertiliser to enhance their potato production even though there is still a significant number (about 35%) of smallholder potato farmers who are not using organic fertiliser in their crop production. Results of the Cragg's DH model revealed that household head gender, household size, access to credit, access to extension services, knowledge of using organic fertiliser, land ownership, livestock size, and social grants are statistically significant factors explaining smallholder farmers adoption of organic fertiliser. While age, knowledge of organic fertiliser usage, farm size and livestock size are statistically significant factors in determining smallholder farmers' organic fertiliser use intensity.

Chapter 4

Determinants of WTP for organic fertiliser by smallholder potato farmers

4.1 Introduction

In this chapter, the methodologies and the empirical results regarding the factors affecting smallholder potato farmers' WTP a price premium for organic fertiliser are presented and discussed. The rest of the chapter is structured as follows: section 4.2, consists of the description of the study area, data collection, sampling techniques. In section 4.3, the theoretical and conceptual framework are presented. Section 4.4 consists of the research methods are described. In section 4.5, the empirical results and discussions are presented, while section 4.6 concludes the chapter with a summary of the results as well as policy recommendations.

4.2 Study area and data collection

The study area and data collection method for this study are as described in Chapter 3.

4.3 Theoretical and conceptual framework

This study employed the 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 & 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 & 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).

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 & 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 $E\left[\Omega(\gamma^1)_i\right]$ is positive and is higher than the expected utility of using inorganic fertiliser $E\left[\Omega(\gamma^0)_i\right]$. 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: WTP= $h\left[\Delta\Omega(\gamma)\right]$. 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 $\left[\Delta\Omega(\gamma) = \Omega(\gamma^1) - \Omega(\gamma^0) > 0\right]$ 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 good of interest (organic fertiliser) was initially defined, the benefits of organic fertiliser and also 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 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 3.

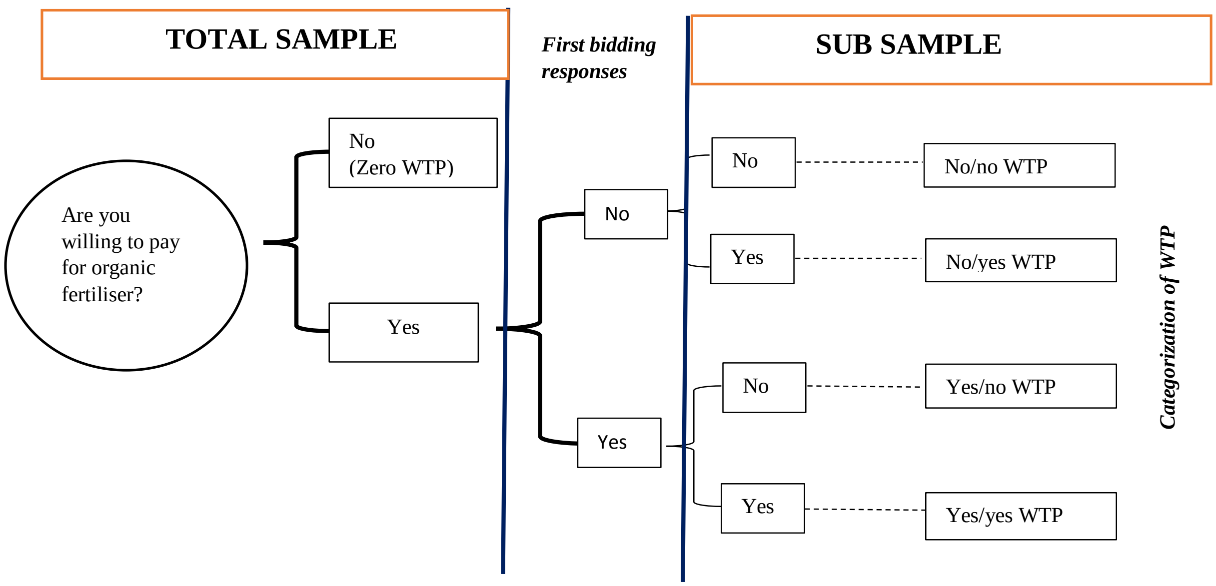

Figure 3: CVM elicitation method for WTP a price premium for organic fertiliser

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 4.

Table 4: 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; 0 if otherwise.	Positive
HH_SIZE	Household size	Number of household members	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	Non-farm income	Total monthly off-farm income	Positive
DIST_FARM	Distance from farm to fertiliser market	Measured in kilometres (km)	Positive
SOC_GRANT	Access to social grants	Dummy; 1 if a farmer has access to social grants; 0 if otherwise.	Positive

4.4 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:

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

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

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

Where:

$\lambda_i =$ Smallholder farmers' WTP for organic fertiliser, $\lambda_i^* =$ the latent (unobserved) continuous variable, $X_i =$ explanatory variables, $\beta =$ unknown parameters to be estimated, $\varepsilon_i =$ error term and $\gamma =$ 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 $\lambda, \gamma_i, \gamma_L$ and γ_H 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.

$\lambda_0 = 0 if \ \lambda_0^* \leq 0$ For zero WTP

$\lambda_1 = 1 if \ 0 < \lambda_1^* \leq \gamma_1$ For n/n WTP

$\lambda_2 = 2 if \ \gamma_1 < \lambda_i^* \leq \gamma_2$ For n/y WTP

$$\lambda_3 = 3 \; if \; \gamma_2 < \lambda_i^* \leq \gamma_3 \text{ For y/n WTP}$$

$$\lambda_4 = 4 \; if \; \lambda_i^* \leq \gamma_3 \quad \text{For y/y WTP} \tag{3}$$

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:

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

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

$$\pi_0(\lambda_i = 0 | X_i) = \Lambda(-X_i^{'}\beta)$$

$$\pi_1(\lambda_i = 1 | X_i) = \Lambda(\gamma_1 - X_i^{'}\beta) - \Lambda(-X_i^{'}\beta)$$

$$\pi_2(\lambda_i = 2 | X_i) = \Lambda(\gamma_2 - X_i^{'}\beta) - \Lambda(\gamma_1 - X_i^{'}\beta)$$

$$\pi_3(\lambda_i = 3 | X_i) = \Lambda(\gamma_3 - X_i^{'}\beta) - \Lambda(\gamma_2 - X_i^{'}\beta)$$

$$\pi_4(\lambda_i = 4 | X_i) = 1 - \Lambda(\gamma_3 - X_i^{'}\beta) \tag{6}$$

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:

$$\ln l = \sum_{i=1}^{N} \left\{ d^{yy} \ln^{yy}(\gamma_i, \gamma_H) + d^{yn} \ln^{yn}(\gamma_i, \gamma_H) + d^{ny} \ln^{ny}(\gamma_i, \gamma_L) + d^{yy} \ln^{nn}(\gamma_i, \gamma_L) + d^{zero} \ln^{zero}(\gamma_i) \right\} \tag{7}$$

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.

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

Where: $\ln(\frac{\pi_i}{1-\pi_i})$ 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.

4.5 Empirical results

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

The majority of smallholder farmers (about 83.6%) reported that they are willing to pay a price premium for organic fertiliser, while about 16.4% of them indicated that they are not willing to pay for organic fertiliser (zero WTP). Only about 24.34% of smallholder farmers indicated WTP a price premium for organic fertiliser, but they were not willing to accept the two consecutive bids proposed to them (n/n WTP). There is also approximately 16.93% of smallholder farmers who indicated their WTP a price premium but rejected the first proposed bid and accepted the second lower bid (n/y WTP). While there is only about 13.23% of smallholder farmers who were also willing to pay a price premium for organic fertiliser and they accepted the first proposed bid, but they were not willing to pay the second offered higher bid (y/n WTP). Also, there are about 29.10% of smallholder farmers who indicated their WTP a price premium by accepting both proposed bid premiums for organic fertiliser (y/y WTP). The distribution of smallholder farmers WTP a price premium for organic fertiliser is presented in Table 5.

Table 5: Distribution of smallholder farmers' WTP a price premium for organic fertiliser

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

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) a price premium and those that are not willing to pay (not WTP) for organic fertiliser are presented in Table 6.

Table 6: Household demographics and socio-economic characteristics of sampled potato farmers by WTP for organic fertiliser

Variable	WTP (*n=158*)		Not WTP (*n=31*)		t -value
	Mean	SD	Mean	SD	
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)	2169.59	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.*

The t-statistic results show that there are statistically significant differences between smallholder farmers who are willing to pay a price premium 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. The results indicated that there are about 55% of smallholder farmers who has access to credit and they are willing to pay a price premium for organic fertiliser compared to about 26% who are not willing to pay. This finding shows that the majority of farmers who are willing to pay a premium for organic fertiliser have access to credit. The level of education among the sampled potato farmers is very low. Smallholder farmers who are willing to pay a price premium for organic fertiliser have spent an average of about four years in school compared two years spent by farmers who are not willing to pay.

In relation to knowledge of organic fertiliser usage (KNW_UOF), results show that of the majority (about 88%) of smallholder farmers who are willing to pay a price premium for organic fertiliser had sufficient knowledge about organic fertiliser usage compared to about 71% of those that are not willing to pay a price premium. This means that smallholder potato farmers in the study area are knowledgeable about the application and use of organic fertiliser. The average household size for smallholder farmers who were not willing to pay a price premium for organic fertiliser and farmers that were willing to pay is about 7 and 5 people, respectively.

In terms of livestock size, the results show that smallholder farmers with large livestock holding were not willing to pay a price premium for organic fertiliser compared to smallholder farmers with low livestock size. The average livestock size for smallholder farmers who are willing to pay and those that are not willing to pay a price premium for organic fertiliser is about 9 TLU and 20 TLU, respectively. The results also show that there are about 72% of smallholder farmers with land ownership rights who are willing to pay a price premium for organic fertiliser, while about 26% of farmers are not willing to pay a price premium for organic fertiliser.

The average off-farm income received by smallholder farmers who are willing to pay a price premium for organic fertiliser and farmers who are not willing to pay is about R2169.59 and R1487.10 per month, respectively. Regarding access to social grants, the results show that the majority of farmers (about 88%) who has access to social grants are willing to pay a price premium for organic fertiliser compared to about 68% of smallholder farmers who are not willing to pay. In addition, the results indicate that smallholder farmers whom organic fertiliser is within close reach are not willing to pay a price premium for organic fertiliser. The average distance travelled by farmers who are willing to pay a price premium for organic fertiliser, and those that are not willing to pay is about 5.1km and 2.11km, respectively.

4.5.2 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 a price premium for organic fertiliser are presented in Table 7. To explain the differential impact of explanatory variables on smallholder farmers WTP a price premium, the coefficient estimates, as well as the marginal effects (which represent changes in the probability of WTP a price premium) of the ordered logit estimates, are also presented in Table 7.

Table 7: Parameter estimates and marginal effects of the ordered logit model

Variable	Coefficient		Marginal Effects (*dy*/dx)				
	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*.

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 a price premium for organic fertiliser.

The results show that explanatory variables such as marital status, extension support, 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 a price premium for organic fertiliser. The coefficient estimates have 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 a price premium for organic fertiliser, while livestock size has a statistically significant negative effect on the probability of WTP a price premium for organic fertiliser.

4.5.3 Discussion

The results presented in Table 7 show a statistically significant positive relationship between marital status (M_STATUS) and WTP a price premium for organic fertiliser. The probability of smallholder farmers' WTP a price premium for organic fertiliser increases with marital status. The marginal effect results show that the likelihood of a married farmer's WTP both proposed bids (y/y WTP) increases by 9.3%, while the probability of not willing to pay both proposed bid (n/n WTP) decreases by 10.62%. This implies that smallholder farmers who are married are more willing to pay a price premium for organic fertiliser to enhance the soil fertility of their farm plots. A possible explanation for this finding might be that married farmers may have more dependents in their households and hence, they are more likely to be willing to pay a price premium for organic fertiliser and invest in long term soil fertility improvement and increase their farm output. This finding is consistent with a priori expectations and the results obtained by other studies (Kamri, 2013; Mezgebo & Ewnetu, 2015; Etim & Benson, 2016).

Access to extension services (ACC_EXT) has a statistically significant positive effect on smallholder farmers' WTP a price premium for organic fertiliser. The likelihood of a smallholder farmer with access to extension choosing zero WTP a price premium for organic fertiliser (zero WTP) and refusing to accept both proposed bids (n/n WTP) decreases by 4.6% and 13.4%, respectively, while 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) increases by 6.1% and 11.7%, respectively. This implies that smallholder farmers who have access to extension services have a high likelihood of WTP a price premium for organic fertiliser compared to their counterparts who do not have access to extension services. A possible reason for this positive and statistically significant association between access to extension and WTP a price premium for organic fertiliser might be that farmers who receive extension services are more aware of the benefits of organic fertiliser and they are knowledgeable about its use. As a result, there is a high chance that they will be willing to pay for organic fertiliser. This result is consistent with a priori expectations and findings obtained by (Njoko, 2014).

Similarly, there is a positive and statistically significant relationship between knowledge of organic fertiliser usage (KNW_UOF) and WTP a price premium for organic fertiliser. Marginal effects show that the probability of a smallholder farmer with sufficient knowledge of organic fertiliser usage not willing to pay a price premium (zero WTP) and refusing to accept both proposed bids (n/n WTP) decreases by about 6.2% and 18.1%, respectively. 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 by 8.2% and 15.8%, respectively. This result is in line a priori expectations and findings obtained by (Agyekum *et al.*, 2014). Farmers who possess knowledge of organic fertiliser usage are expected to be more willing to pay for organic fertiliser because from their experience and knowledge of using organic fertiliser they may perceive organic fertiliser to beneficial and hence, they are more likely to be willing to pay for organic fertiliser compared to those farmers who are not knowledgeable about organic fertiliser.

Livestock size (LSTOCK_SIZE) has a statistically significant negative effect on smallholder farmers' WTP a price premium for organic fertiliser. The probability of not willing to pay a price premium (zero WTP) and refusing to accept both proposed bids (n/n WTP) increases by 0.26% and 0.75% respectively, with one TLU increase in livestock size. 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) decreases by 0.34% and 0.66%, respectively. This means that an increase in smallholder farmers' livestock size reduces the likelihood of WTP a price premium for organic fertiliser. This finding is consistent with 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 are expected to have less WTP a price premium for organic fertiliser.

The results also show that land ownership (OWN_LAND) has a statistically significant positive effect on smallholder farmers' WTP a price premium for organic fertiliser. The probability of a smallholder farmer with land ownership choosing zero WTP a price premium for organic fertiliser (zero WTP) and refusing to accept both proposed bids (n/n WTP) decreases by 10.9% and 31.5%, respectively, 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 by 14.3% and 27.5%, respectively. This result is consistent with 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 and Sanyal (2011), who concluded that land ownership guarantees the security of tenure for farmers and hence, increases the WTP for agricultural services.

In addition, there is a positive and statistically significant relationship between the distance from the farm to the source of organic fertiliser (DIST_FARM) and the WTP a price premium for organic fertiliser. Marginal effect results show that the probability of not willing to pay a price premium (zero WTP) and refusing to accept both proposed bids (n/n WTP) decreases 0.65% and 1.87%, respectively, with an increase in the distance to the source of organic fertiliser by 1km. 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 by 0.85% and 1.64%, respectively. 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 a price premium 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 and Ewnetu (2015).

4.6 Chapter summary

The main aim of this chapter was to determine the factors influencing WTP a price premium for organic fertiliser by smallholder potato farmers. This study found that the majority (83.6%) of smallholder potato farmers were willing to pay a price premium for organic fertiliser, while only about 16.4% were not willing to pay a price premium for organic fertiliser. This finding shows that smallholder potato farmers are willing to pay more for organic fertiliser to enhance their farm productivity. This high level of farmers' WTP for organic fertiliser implies that they value organic fertiliser more and they continuously seek to find ways of improving their crop productivity and also decrease costs of farm production by using this soil fertiliser which is suited to their socio-economic status. The results of the ordered logit regression model indicated that marital status, access to extension services, knowledge of organic fertiliser usage, land ownership, livestock size and distance to the source of organic fertiliser are statistically significant factors explaining the smallholder farmers' WTP a price premium for organic fertiliser in the study area.

Therefore, there is a need for policymakers and other development partners to initiate programs that improve smallholder farmers' access to extension services and land ownership. In addition, the high rate of WTP a price premium for organic fertiliser as their soil ameliorant reflects the potential for commercialization 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.

Chapter 5

Conclusions, Summary and Policy recommendations

5.1 Introduction

This chapter presents the conclusions and summary of key results drawn from this study. Also, this chapter further outlines the policy recommendations, as well as the limitations of this study and suggestions for further research.

5.2 Conclusions and summary of key results

This study attempted to determine factors influencing adoption and use intensity of organic fertiliser by smallholder potato farmers and to estimate their willingness to pay (WTP) for organic fertiliser, in other words, whether smallholder potato farmers are willing to pay a price premium for organic fertiliser. This study was conducted in KwaZulu-Natal province, South Africa. Primary data was obtained using a structured questionnaire administered to 189 farm households in three municipal areas, through a multi-stage sampling technique. The data sets were analysed using descriptive and econometric techniques.

The first objective of the study was to determine the factors which influence the decision to adopt and intensify the use of organic fertiliser. This objective was estimated using the two-step estimation technique called Cragg's Double Hurdle (DH) model. In addition, the second objective was to determine the factors influencing smallholder farmers' WTP a price premium for organic fertiliser. The analysis of this objective involved the use of an ordered logit regression model.

This study found that organic fertiliser is the most popular soil nutrient ameliorant among smallholder potato farmers in KwaZulu-Natal Province, South Africa. In addition, findings reveal that the majority of smallholder farmers are willing to pay more for organic fertiliser to enhance their farm productivity. This implies that they value organic fertiliser more and they continuously seek to find ways of improving their crop productivity and also decrease costs of farm production by using this soil fertiliser which is suited to their socio-economic status.

In Chapter Three, the determinants of adoption and use intensity of organic fertiliser were analysed. The empirical results from the Cragg's DH indicate that household head gender, household size, access to extension services, knowledge of using organic fertiliser, land ownership, livestock size, and social grants are positive and statistically significant factors explaining smallholder farmers adoption of organic fertiliser whereas knowledge of organic fertiliser usage, farm size and livestock size are also positive and statistically significant factors determining smallholder farmers' organic fertiliser use intensity. The findings indicated that factors influencing organic fertiliser adoption decision and the use intensity of organic fertiliser are separate, which means that the factors which influence the adoption of organic fertiliser and the level of adoption are not the same.

In Chapter four, factors influencing WTP a price premium for organic fertiliser by smallholder potato farmers were also evaluated. The results of the ordered logit regression model indicated that marital status, access to extension services, knowledge of organic fertiliser usage, land ownership, livestock size and distance to the source of organic fertiliser are statistically significant factors explaining the smallholder farmers' WTP a price premium for organic fertiliser in the study area.

This study concludes that information dissemination among smallholder farmers through extension advisory services, education, and training is essential to improve farmers' knowledge about the adoption and use of organic fertiliser to improve their agricultural productivity. This is also crucial for encouraging WTP a price premium for organic fertiliser. In addition, this study concludes that land ownership is very essential adoption, use intensity and WTP for organic fertiliser. This is mainly due to that security of land tenure assure full access to future returns in production. Improvement in the above-mentioned determinants of adoption, use intensity as well as WTP a price premium is essential for encouraging adoption of organic fertiliser among smallholder farmers so that they can improve their potato productivity.

5.3 Policy recommendations

Useful findings have emerged that offer insight into pathways for improvement in organic fertiliser adoption and also relating to WTP a price premium for organic fertiliser. These are appropriate for policy implication and recommendations towards improving the productivity of smallholder potato farmers in KwaZulu-Natal and South Africa.

It is imperative to improve smallholder farmers' contact and access to extension services to enhance technical information dissemination among smallholder farmers through extension advisory services, education, and training. This will strengthen smallholder farmers' knowledge about the adoption and use of organic fertiliser to improve their agricultural productivity. This will also increase their WTP a price premium for organic fertiliser. Therefore, there is a need for policymakers and other development partners to initiate programs that improve smallholder farmers' access to extension services.

The importance of land ownership rights in increasing the likelihood of organic fertiliser adoption, the use intensity of organic fertiliser, and WTP a price premium suggests the need to develop policies that strive to institute security of land tenure among smallholder farmers. Security of tenure is essential to smallholder farmers because it assures full access to future returns in production. As a result, policies that institute security of land tenure will encourage smallholder farmers to adopt and intensify organic fertiliser in an attempt to improve their crop productivity. Increased productivity will ensure that smallholder farmers have sufficient output for home consumption, and they can also sell surplus output to their communities, thus generating cash income.

Livestock ownership is crucial for adoption and use intensity of organic fertiliser. While findings also revealed that smallholder farmers with low livestock holding were willing to pay more for organic fertiliser. Therefore, this study supports the development of appropriate options for farmers with small livestock holding. Taking into account the high rate of WTP a price premium for organic fertiliser as their 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. This initiative 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. Furthermore, this will also create jobs and also improve the income of smallholder farmers and hence, contribute to poverty alleviation and reduction of food insecurity among rural smallholder farmers.

Furthermore, findings revealed that access to social grants increases the likelihood of organic fertiliser adoption. This is not surprising because the majority of smallholder farmers' in the study area were social grant beneficiaries. Therefore, government and other development partners can still encourage organic fertiliser adoption by improving access to social grants among smallholder farmers who match the criteria of being social grant beneficiaries.

5.4 Limitations of the study and suggestions for further research

Potatoes are produced in different provinces in South Africa where there is a wide variety of cultures, religion and socio-economic characteristics of the people. The study is limited to KwaZulu-Natal province, mainly due to time and financial constraints for data collection. Therefore, this study recommends that further research of this kind should be conducted in other smallholder potato producing areas across the country. To generate more information that can be generalised about South Africa, a larger sample size of respondents is also recommended.

In addition, this study only focused on the factors influencing adoption and WTP a price premium for organic fertiliser in the study area. Therefore, the study commends that further studies could consider the impact of organic fertiliser adoption on smallholder farmers potato productivity.

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APPENDICES

Appendix A: Ethical clearance

UNIVERSITY OF KWAZULU-NATAL™
INYUVESI YAKWAZULU-NATALI

25 June 2019

Mr Bhekani Sandile Zondo (213517578)
School of Agriculture, Earth & Environmental Science
Pietermaritzburg Campus

Dear Mr Zondo,

Protocol reference number: HSS/0103/019M
Project title: Adoption and willingness to pay for organic fertilizer: A case of smallholder potato (*Solanum tuberosum L.*) farmers in KwaZulu-Natal, South Africa

Approval Notification – Expedited Application

In response to your application received on 14 March 2019, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 1 year from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

....
Dr Shamila Naidoo (Deputy Chair)

/ms

Cc Supervisor: Professor Lloyd Baiyegunhi
cc Academic Leader Research: Professor Hussein Shimelis
cc School Administrator: Ms Marsha Manjoo

Humanities & Social Sciences Research Ethics Committee
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Appendix B: Questionnaire

UNIVERSITY OF KWAZULU-NATAL

COLLEGE OF AGRICULTURE, ENGINEERING AND SCIENCE

SCHOOL OF AGRICULTURE, EARTH AND ENVIRONMENTAL SCIENCES

DISCIPLINE OF AGRICULTURAL ECONOMICS

ADOPTION AND WILLINGNESS TO PAY FOR ORGANIC FERTILISER: A CASE OF SMALLHOLDER POTATO FARMERS IN KWAZULU-NATAL, SOUTH AFRICA.

QUESTIONNAIRE

INTRODUCTION

My name is Bhekani Sandile Zondo. I am from the University of KwaZulu-Natal. I am conducting research in KwaZulu-Natal that is looking at **the factors influencing adoption and willingness to pay for organic fertiliser by smallholder potato farmers**. There are no wrong and right answers to these questions. I would like to assure you that all the information provided here will be treated as **STRICTLY CONFIDENTIAL**, and will be used for academic purposes only. Lastly, this interview will take about 40-60 minutes (Approximately 1 hour).

IDENTIFICATION

Name of respondent		Respondent cell.	
District		Municipality	
Tribal area		Date of interview	

SECTION A: HOUSEHOLD DEMOGRAPHICS

Record household demographic details by completing the table below

A1. Household head name		
A2. Gender of household head (*1= Male, 2= Female*)		
A3. Marital status of household head (*1= Single, 0= Otherwise*		
A4. Age of household head (*years)*		
A5. Level of education of household head (*No. of years spent in school)*		
A6. Occupation (*1= Farmer, 2= Temporary job, 3= Self-employed, 4= Unemployed, 5= Retired, 6= Student, 7= Other (specify)*)		
A7. What is the total number of your household members**?		
A8. How many of the household members are adults? (*15 years or older*)		
A9. How many of the household members are children? (*less than 15 years*)		
A10. How many of the household members are employed?	Permanently employed	
	Temporary employed	
A11. How many of your household members work on the farm?		
A12. Do you hire labour to work on the farm? (*1= Yes, 2= No*)		

**Household head refers to the household head that stays in the household for 4 or more days per week.*

***Please include only those members who stay in the household for 3 or more days per week.*

A14. Information of the person responsible for farming activities

	Age	Gender	Highest level of education obtained	Years of farming experience.
Farmer				

SECTION B: USE AND ADOPTION OF FERTILISER

B1. Did you use any fertiliser in the past 12 months? (*1= Yes; 0= No*)		
B2. If yes on B1, which type of fertiliser did you use in your farm in the last 12 months? (*1= Organic fertiliser; 2= Inorganic fertiliser; or 3= Both*)		
B3. If you used organic fertiliser, what were the sources of the organic fertiliser and how many kg did you get from the source?	Bought	kg
	Government	kg
	NGO	kg
	Animal/cattle manure	kg
	Household wastes	kg
	Other (specify)	kg
B4. If you bought organic fertiliser, how much was its price per 10 kg bag?		
B5. Do you think the price of organic fertiliser is high, low or average? (*1= Low; 2= High; 3= Average*)		
B6. If bought, where did you buy your organic fertiliser? (*1= Small informal agro-dealers; 2= large agro dealers; 3= Hawkers or vendors; 4= Other farmers; 5= Other (specify)*……………………………………………….)		
B7. How would you rate your access to organic fertiliser? (*0= Poor; 1= Easy*)		
B8. What is the distance from the source of organic fertiliser to your farm?		km
B9. How would you rate your knowledge of organic fertiliser? (*0= low; 1= high*)		
B10. What was your source of knowledge of organic fertiliser? (*1= Extensional officer; 2= Agricultural training; 3= other farmers; 4= Other (specify)*………………………)		
B11. 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? (0= No; 1= Yes)		
B12. If Yes in B11, are you willing to pay R100 for organic fertiliser per 10kg bag?		R
B13. If Yes in B12, are you willing to pay (25%, 50%, 75% and 100% based on a tossed dice) more for a 10kg bag of organic fertiliser?		
B14. If No in B12, are you willing to pay (25%, 50%, 75% and 100% based on a tossed dice) less for a 10kg bag of organic fertiliser?		

B15. If No in B11, why you do not want to pay anything? (*1= I am not satisfied with effect of organic fertiliser in production; 2= I do not have enough money; 3= I do not have access to organic fertiliser market; 4= It is the responsibility of the government to provide; 5= I do not know how to use organic fertiliser; 6= Other (specify)…………………………………………………………………….)*	

SECTION C: POTATO CROP PRODUCTION AND LANDHOLDING

C1. How long have you been involved in potato farming activity?		
C2. What is the total size of land the household has access to?	Irrigated land	ha
	Dry-land	ha
C3. How do you feel about the size of your land? (1= Small; 2= Medium; 3= large)		
C4. How many hectares of the land you have access to were used to grow potatoes?	Irrigated land	ha
	Dry-land	ha
C5. Rate the quality of your land for potato crop production. (*0= Poor; 1= Average; 2= Good*)		
C6. How many bags of potatoes did you harvest in the past 12 months?		
C7. How did you acquire the land and what was the size in hectares?	Allocated by the Chief (Inkosi)	ha
	Inherited	ha
	Leasing/ renting	ha
	Bought	ha
	Other (specify)…………	ha

C8. If you adopted and used organic fertiliser, has it improved your potato production? (*0= No; 1= Neutral; 2= Yes*)	
C9. If Yes in C8, how many more bags were produced compared to the period when organic fertiliser was not used?	

C10. What are your reasons for growing potatoes? (*1= Household consumption; 2= Cash income; 3= Both*)	
C11. If selling, who do you sell your produce to? (*1= Community; 2= Spaza shops; 3= Pensioners; 4= Other (Specify)……………………………….*)	

SECTION D: LIVESTOCK AND ASSET OWNERSHIP

D1. Indicate the type and number of livestock owned by household on the table below

Type of livestock	**Number of livestock owned by household**
Cattle	
Goats	
Pigs	
Chickens	
Sheep	
Other (*specify*)	

D2. Indicate the type of assets you use in your farm and the source.

Asset	**Do you own it? (0= No; 1= Yes)**	**Source (1= Bought; 2= renting/leasing; 3= Government)**
Plough		
Planter		
Cultivator		
Tractor		
Other (specify)		

SECTION E: OFF-FARM INCOME AND EXPENDITURE PATTERNS

E1. What were your other sources of income in the last 12 months? *(Indicate how much each source contributed and how often*).

Source of off-farm income	Amount (in Rands)	Number of times in the past 12 months	Total
Remittances			
Arts and craft			
Permanent employment			
Temporary/ casual employment			
Hawking/ petty trading			
Other (specify)			
Total off-income monthly			

E2. Do you use your off farm income to buy agricultural input? (*0= No; 1= Yes*)	
E3. How much money was spent on organic fertiliser?	R

SECTION F: ACCESS TO GRANTS

F1. Are any of your household members receiving government grants? (*0= No; 1= Yes*)		
F2. If yes in F1, how many are on the:	Old age grant?	
	Child support grant?	
	Disability grant?	
	Foster child grant?	
F3. Do you pool your income from social grants with other income sources in the household? (0= No; 1= Yes)		
F4. Do you use some of your household social grant money to buy agricultural inputs? (*0= No; 1= Yes*)		

F5. If yes in F4, how much of it is spent on organic fertiliser?	R
F6. If yes in F4, how often do you do that? (*1= Sometimes; 2= Always*)	

SECTION G: GOVERNMENT SUPPORT (EXTENSION SERVICES)

G1. Is there an extension office in your area? (0= No; 1= Yes)	
G2. Did you have any contact with extension officer in the past 12 months? (0= No; 1= Yes)	
G3. If yes in G2, how often did you contact extension officers (1= Sometimes; 2= Always)	
G4. If yes in G2, did you invite the extensional officer? (0= No; 1= Yes)	
G5. Are the extension officers from: (1= Government; 2= Non-governmental organisation (NGO); 3= Private company)	
G6. What is the distance to the extension office?	km
G7. Did you or any one of your family members receive any training from government or any other organisation? (0= No; 1= Yes)	
G8. If yes in G7, specify the type of training received………............................	
G9. How do you describe the usefulness of the training received in your potato production farming activities? (0= Not useful at all; 1= Somewhat useful; 2= absolutely useful)	
G10. Has the information received from extension services been useful in improving your potato crop production? (0= Not useful at all; 1= Somewhat useful; 2= absolutely useful)	

SECTION H: ACCESS TO CREDIT SOURCES OF INFORMATION

H1. Did you use any credit or loan facility in the past 12 months? (0= No; 1= Yes)	
H2. If yes in H1, what was the main source of credit/loan? (1= Relative/friend; 2= Money lender; 3= Savings club (stokvel); 4= Bank; 5= Input supplier; 6= Other (specify)………………………..	
H3. What was the purpose of the loan/credit? (1= Family emergency; 2= agricultural input; 3= Other (specify)……………………………	

H4. Were you able to pay back the loan? (0= No; 1= Yes)	
H5. If No in H4, what were some of the challenges you faced with the loan repayment? (Specify)…….	
H6. Did you receive any funding or other sources of credit support from the government in the past 12 months? (0= No; 1= Yes)	

H7. Do you use the following sources of agricultural information?

Source of information	**0= No; 1= Yes**
Extension officers	
Radio/television	
Newspaper	
Cell phones/SMS	
Internet	
Others (specify)……………………….	

H8. What is your main source of farming information? (0= None; 1= Radio/television; 2= Extension officers; 3= Cell phones/SMS; 4= Internet; 5= Newspaper; 6= Other farmers; 7= Others (specify)……………………….	
H9. Do you understand the disseminated by the main source of information in H8? (0= Not at all; 1= Somewhat; 2= Absolutely)	
H10. Has the information from your main source of information in H8 helped in improving your potato crop production? 0= Not at all; 1= Somewhat; 2= absolutely)	

SECTION I: CHALLENGES FACED BY SMALLHOLDER FARMERS

I1. What kind of challenges do you face in your farming activities? (Indicate your response with either 1= Strongly disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly agree)

Challenge (s)	**Response**
Lack of information (market information)	
Poor markets	
Poor infrastructure	
Lack of skills and training	
Shortage of funding	
Insufficient water	
Insufficient land	
Lack of access to credit	
Lack of access to input	
High input prices (especially chemical fertiliser)	
High cost of labour	

CONCLUDING REMARKS

Final general comments……………………………………………………………………. ………………………………………………………………………………………………… ………………………………………………………………………………………………… ………………………………………………………………..

SIYABONGA/THANK YOU