Smallholder farmers' adoption decision-making behaviours in the adoption of climate-smart agricultural (CSA) practices: the case of soil conservation practice adoption at Qamata Irrigation Scheme, South Africa

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Abstract:

This study evaluates smallholder farmers' adoption decision behaviours regarding the adoption of climate smart agricultural (CSA) practices, using the adoption of soil conservation practices at Qamata Irrigation Scheme, South Africa as a case study. Using the case study research methodology, 70 smallholder farmers were selected through a focused group interview method. Empirical data analysis was with the probit, logit and the binary logistic regression analysis models. Based on results and congruent with literature, the nature of smallholder farmers' adoption behaviour regarding the adoption of soil conservation technologies is complex, being affected by multiplicity of factors. Of most significance (at $p<0.01$) are gender, marital status, length of time of continuously farming on one spot (LENTFARM) and crop production respectively. The indication is that women farmers prefer their own practices to extension recommendations which is as expected. Similarly, married farmers, LENTFARM, and farmers with increased crop production preferred extension recommendations for soil conservation instead of their own practices. The conclusion is that significant variables of this study are factors influencing smallholder farmers' adoption decision behaviour regarding CSA practices in the study area. Therefore intervention efforts for improved CSA practice adoption should consider the significant variables of this study.

Key words: Smallholder farmers; adoption; adoption decision-making behaviours; climate smart agriculture practices; soil conservation.

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Introduction

Global food production must increase by 70% by 2050 to be able to feed a population projection of more than nine billion people worldwide (World Bank (2013). The daunting reality is that without strong adaptive measures, within the next 50 years, climate change impact will decrease food crop yields by about 16% (25% according to Voegele & Roome, 2016) globally and 28% in Africa (World Bank, 2013). If no adequate sustainable agriculture measures are imbibed, Africa is said to be the hardest hit by climate change, due to its larger rural population number, and the level of rural dependence on agriculture for livelihoods (World Bank, 2013). Since agriculture is the sector most vulnerable to climate change, and also a major cause of climate change, directly accounting for about 15% of greenhouse gas emissions, or as much as about 30% when considering land-use change, addressing climate goals through agriculture is considered a step in the right direction (World Bank, 2013). This is why Nosowitz (2014) suggests that as climate change changes the face of agricultural production, climate smart agriculture could be the only way to feed the planet.

Climate smart agriculture (CSA), though coined in 2010 (Noswitz, 2014), is not really new. It is just another contemporary sustainable agricultural measure, which however focuses extra attention on climate change effects. “CSA uses the language and even some of the methods of ecological agriculture…” (Biowatch South Africa, 2015). It builds on existing efforts to actualize sustainable agriculture intensification such as Sustainable Crop Production Intensification (SCPI) (FAO, 2012, citing FAO, 2001d). Any agricultural practice that contributes to achieving increased agricultural productivity; enhanced resilience or adaptation of livelihoods and ecosystems towards extremes of climate; and reduce and remove greenhouse gas emissions from the atmosphere is said to be climate-smart (Schaller, Barth, Blies, Röhrig & Schümmelfeder, 2017). In another sense, CSA leads to overall food security and nutrition despite climate change activities. It includes tested practical techniques such as mulching, intercropping, zero tillage, agro-forestry, improved grazing and improved water management (World Bank, 2013).

However, the major challenge facing smooth agricultural development today may not be whether or not there are improved technologies to mitigate agricultural problems like climate change, but bother more on adoption behaviours by farmers, especially smallholders. Due to the informal nature of rural environments in developing countries, situations of reality, such as in farming, may be somewhat very unpredictable (Ighodaro, 2016). Supporting this, Weng, (2015) states that smallholder farmers are usually considered as part of the informal economy. Understanding farmers’ behaviours is said to be central to enhancing the capacity of farmers to adapt and promote sustainable agriculture (Feola *et al.*, 2015). Since farmers are the ones carrying out adaptation and sustainability policies and programs, their behaviour therefore influences how and what success such intervention efforts achieve (Feola *et al.*, 2015, citing Home *et al*., 2014 and Moon & Cocklin, 2011).

Theoretical Framework

According to historical review, adoption literature has separated between researchers (such as Rahm & Huffman, 1984; Lee & Stewart, 1983; Anim, 1999; Traore, Landry & Amara, 1998), who see adoption analysis as a binary choice variable, and those (like Ervin & Ervin, 1982; Gould, Saupe & Klemme, 1989; Featherstone & Goodwin, 1993), who say it is not just an issue of whether or not farmers adopt, but also includes level and intensity of adoption. The literature also is divided between the diffusion theorists (Annor-Frepong & Duvel, 2011, citing Roling, 1988), made popular by Everett Rogers in 1983 and 1995, which define human behaviours in five distinct stages: knowledge; persuasion; decision; implementation; and confirmation, and the economic theorists (Annor-Frepong & Duvel, 2011), which argue that farmers' behaviours are based on economic reasons. However, flaws which bedevilled the economic theory, led to the emergence of the behaviourist school of thought (Annor-Frepong & Duvel, 2011). The behavioural approach explains decision-making as a combination of motivational factors and structural/economic features, that constrain, facilitate and, at the same time, reflect the motivational preferences of farmers (Burton, 2004, citing Gasson & Potter, 1988 and Shucksmith, 1993). Historical examples of behavioural models are Lewin (1951) field theory, Tolman (1967) model, Duvel (1991) model.

Due to the complexity associated with human behaviours, there is as yet no agreed theory for its explanation and factors responsible for it. According to Surry (1997), there are no unified theories of adoption decision-making. Supporting, Duvel (1991) states that largely because of the complexity of adoption behaviour, and due also to the impermeable boundaries and perspectives of the traditions and disciplines of adoption research, there is as yet no generally accepted theory to guide the extension practitioner and users in the search for factors of adoption behaviour. Kabwe, Bigsby and Cullen (2009), citing Feder *et al*. (1985) and Rogers (2003) maintain that suggestions from literature indicate that successful adoption is a product of favourable convergence of technical, economic, institutional and policy factors. This seems also to be the view of Rezvanfar, Samiee and Faham (2009), except that their list of factors was divided into two main groups: individual level characteristics of farmers and farm structural factors.

According to Oyewole and Ojeleye (2015), the most important factors influencing smallholder farmers' decision to adopt improved farm practices are age, level of education and extension contact. Reporting on the review done by Feder *et al*. (1985), Kaguongo *et al*. (2010) posit among other things, that farmer's adoption decision-making is controlled by four main factors, which seems to agree with the view of Kabwe, Bigsby and Cullen (2009), as indicated. In their opinion, farmers' adoption decision is influenced by factors such as socioeconomic, demographic, ecological and institutional, which are dependent on the technology in question. Reporting on a study conducted in Zambia, to assess factors influencing farmers' decisions to adopt improved fallows, Kabwe, Bigsby and Cullen (2009) reveal that non-farm income, method of ploughing, limited land, lack of seed and lack of interest were found to be responsible for adoption.

As hypothesized by Ervin and Ervin (1982), and adapted by Asafu-Adjaye (2008), the process involved in a farmer's decision to adopt soil conservation practices begins with a perception of soil erosion (degradation). In their view, once the problem has been perceived, the farmer then adopts a soil conservation practice(s). This decision is affected by a number of factors, including personal, institutional, physical and economic factors. In addition, the level of perception is determined by farmers' personal characteristics (such as age, education, marital status, gender, et-cetera.) and the physical characteristics of the farmland (e.g. size of farm). Furthermore, institutional factors such as farmers' participation in extension services also play a part in the relationship in that they assist in increasing farmers' awareness of the problem. Economic factors such as farm income and off-farm income are also important in that they provide suitable conditions for farmers' decisions.

In an attempt to contribute to providing a framework for the analysis of farmers' behaviours, Ighodaro (2016) suggests that any holistic understanding and analysis of smallholder farmers' behaviour regarding the use of soil conservation technologies must be based on the premise that adoption decision-making is best understood from four distinct stages. These are perception; adoption; extent of adoption; and adoption impact stages. The perception stage is the stage where farmers first form a view on a new technology or proposed behaviour change. There is a general agreement in the literature (Ervin & Ervin, 1982; Asafu-Adjaye, 2008) that farmers' adoption of a soil conservation measure can only occur when they have well perceived the problem of soil erosion. Amsalu and De Graaff (2007) also maintain that farmers who have positive perceptions of problems are also the ones most willing to invest in conservation efforts. Duvel (1991), Duvel, Chiche and Steyn (2003), and Annor-Frempong and Duvel (2011) agree that, due to the relevance of the mediating variables in decision-making, they should be of utmost concern in extension research, because they are the ones immanently responsible for decision making. But from his study, Ighodaro (2016) however argues that perception should not only be regarded just as a member of the mediating variables, but the main mediating variable directly responsible for behaviour, and through which the effects of all other variables (both independent and the other mediating variables), are transmitted. It was lamented that despite the obvious relevance of perception as a behaviour determinant, there is currently a dearth of information on factors influencing farmers' perception toward technology adoption like soil conservation or CSA practice, even though several evidences abound on farmers' perception as a concept (Ighodaro & Mushunje, 2017).

The adoption stage is the stage where farmers decide whether or not to accept the new technology or proposed behaviour change. Several factors prevail on the farmer at this stage, including the independent and mediating variables, which ultimately define whatever decision the farmer adopts, whether for or against the new innovation. The extent (intensity) of adoption stage is the stage farmers decide on how much of the innovation they can adopt in the farm. Obuobisa-Darko (2015) defines intensity of adoption as the level of adoption of a certain innovation (for example the number of hectares planted with an improved seed or the amount of fertilizer used per hectare of farmland). It could mean the number of soil conservation practices adopted by a farmer, or how much of farmers' farmland is given to the technology. The last stage according to Ighodaro (2016) is the adoption impact stage. This is the stage where a farmer determines how the technology or proposed behaviour change has or will impact on his livelihood. This is actually the stage that determines whether the farmer will continue using the technology or not. The effect of adoption has been widely documented. Li *et al*. (2011), citing FAO maintain that conservation agriculture (CA), an example of CSA practices aims at achieving sustainable and profitable agriculture, which subsequently aims at improved livelihoods for the farmer. Figure 1 is a pictorial presentation of the four stages of adoption as suggested by Ighodaro (2016).

As indicated (Figure 1), for adoption of soil technologies by smallholder farmers to take place, independent variables of farmers, consisting of personal, socioeconomic, cultural, institutional, and physical or environmental factors, first impact on the first two members of the mediating variables: farmers' needs and knowledge. The overall effect is only given expression based on the type of perception farmers have, whether positive or negative. This perception could be on three basic aspects: the problem that needed mitigation, the new technologies (soil) being introduced, and/or the technology disseminator (extension officers). The sum of the type of perception eventually determines whether farmers adopt, partially adopt, or not adopt the technology. Although attention was given to the study of perception and its factors in a previous study (Ighodaro & Mushunje, 2017), effort is this current paper focuses on the analysis of factors affecting smallholder farmers adoption decision-making in the adoption of CSA practices, using the case study of soil conservation adoption at Qamata Irrigation Scheme, Eastern Cape, South Africa.

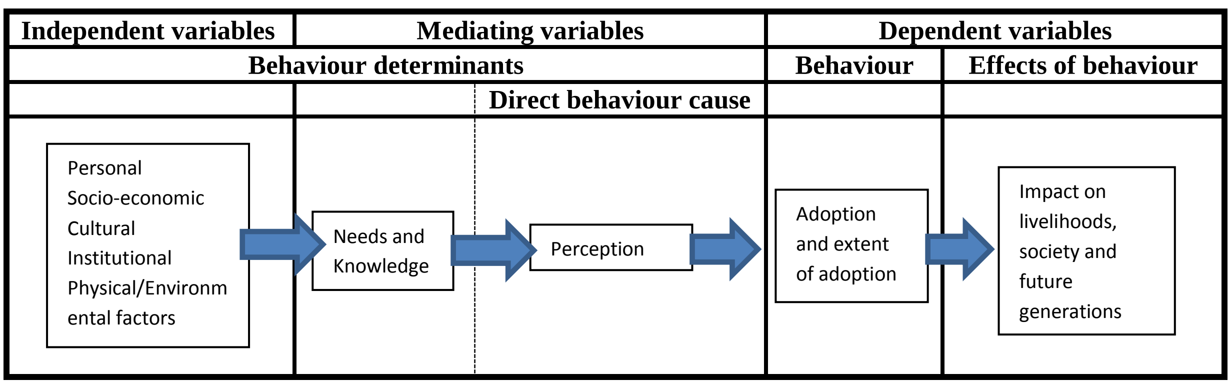

Figure 1: A framework of soil conservation adoption by smallholder farmers

Objectives

1. To characterise smallholder farmers in the study area;
2. To determine the nature of smallholder farmers' adoption decision-making behaviours; and
3. To evaluate specific factors affecting smallholder farmers' adoption decision-making behaviours in the adoption of soil conservation practices in the study area.

Materials and Method

The study was conducted at Qamata Irrigation Scheme, Qamata. Qamata is a small town located in Intsika-Yethu Local Municipality, Chris Hani District (formerly St. Mark's District), Eastern Cape Province, South Africa. The town is located on latitude $31^{0}58^{'}39^{''}$S and longitude $27^{0}26^{'}2^{''}$E, with an altitude of 867 m. It is located on Route R61 on the Qamata River, 18 kilometres (24 miles) east of the R61 junction with Route N6 and 58 kilometres (36 miles) east of Queenstown. Qamata Irrigation Scheme was established in 1960 but only became operational in 1972. It focuses primarily on the cultivation of crops to address the situation of hunger and food insecurity in the study area and its environs, which mainly are due to low rainfall in the area.

Research Design and Data Collection Process

Yin (1994) defines a case study as an empirical inquiry that studies a current phenomenon within the framework of real-life situation, particularly when there is not much understanding regarding boundaries that exist between events and contexts of the phenomenon. Although Patton (2002) acknowledges the crucial role of research goal in determining research designs and the analysis that must follow, he however alluded to the fact that there is no perfect research design; as such, necessary compromise has to be made based on real-life limitations of a research. In this regard, the case study research design was adopted because the goal of the study was to understand how smallholder farmers in South Africa responds to soil conservation practices introduced by Extension Officers, using the farming situation of Qamata Irrigation Scheme as a case study.

In line with the Department of Higher Education and Training (DHET) policy for research studies, an ethical clearance was obtained on the 24th of July, 2014 from the University of Fort Hare, South Africa Ethical Clearance Committee, with Certificate Reference Number MUS0111SIGH01. Subsequently, primary data was based on information collected from seventy smallholder farmers at Qamata Irrigation Scheme, using a pretested semi-structured questionnaire. While the focus group interview method was used to collect data from smallholder farmers, the purposive sampling process was used to collect information from the Extension Officer overseeing the irrigation scheme. The study questionnaire was used to capture data on farmers' demographic and personal characteristics, farmers' adoption decision-making regarding soil conservation practices, and factors influencing farmers' adoption of soil conservation technologies in the study area.

Data Analysis

Data collected were analysed using the statistical package for social sciences (SPSS) version 23. Data analysis techniques include basic descriptive statistics (like frequencies, percentages, and means), probit and logit, as well as the binary logistic regression analysis model. Descriptive statistics are usually regarded as first steps required to determine the distribution of variables and to summarise large amounts of data, but to test for how variables relate, other higher statistical techniques are required such as the regression models (Annor-Frempong & Duvel 2011). Although the binary logistic regression model was deemed more fitting for the analysis, since the dependent variable is a binary choice variable, the probit and the logit regression analyses were also conducted to provide a measure of comparison.

Model specification: the binary logistic regression analysis model.

The binary logistic regression analysis was used as the main analytic tool in this paper to analyse both objectives because they deal with issues of whether or not farmers are adopting soil conservation practices (dichotomous variables). The binary logistic regression analysis was used to investigate the manipulative power of adoption decision-making processes based on factors that may influence smallholder farmers to adopt soil conservation technologies. Smallholder farmers adoption decision-making processes is taken as the dependent variable. According to Tranmer and Elliot (2008), in scenarios where the response variable is dichotomous or 0/1 as in this study, the most common analytic technique is to use the binary logistic regression model.

Using a randomly sampled data based on farmers' adoption decision-making processes; two homogenous mutually exclusive strata was created for independent variables' analysis. The SPSS statistical software package version 23.0 was used for the econometric analysis. The dependent variable was dichotomized with a value of '0' or 'yes' if a farmer preferred their own soil conservation practice (Non-SCP adopter) and '1' or 'no' if they preferred extension recommendations (SCP adopter). In other words, the question for dependent variable was constructed thus: 'do you prefer your own soil conservation practice to extension recommended practices? Seventeen input or predictor independent variables, based on farmer perceptions and soil conservation practice factors, were regressed against the binary outcome variable of soil conservation adoption decision-making status of smallholder farmers. Farmers participating in soil conservation practices are based on an assumption that each attains household food security through increased productivity from participating in soil conservation practices for production.

According to this theory, households are hypothesized to participate more in soil conservation practices, if the utility resulting from participation exceeds that of non-participation. The binary logistic model as indicated in equation (1), according to Tranmer and Elliot (2008) and Gujarati (1992), was used to predict the manipulative power of farmers' adoption based factors that may influence smallholder farmers to participate in the use of soil conservation technologies introduced by extension officers.

$$\text{In}\left\{\frac{\left(p(Y=\frac{1}{X})\right)}{\left(1-P(Y=\frac{1}{X})\right)}=\alpha+\beta 1X1+\cdots+\beta nXn \quad\text{.......... (1)}$$

Where p= the predicted probability of farmers' adoption making processes; 1-p= the predicted probability of non-adoption/ participants; α= the constant of the equation; β= the coefficient of predictor variables; X= the predictor variables. Incorporating all variables into the model, the model could be presented as follows:

$$\text{In}\ \frac{\left(p(Y=\frac{1}{X})\right)}{\left(1-P(Y=\frac{1}{X})\right)}=\alpha+\beta 1AGE+\ \beta 2EDU+\ \beta 3MAR+\ \beta 4GEND+\ \beta 5EXP+\ \beta 6FARMSIZE+\ \beta 7LANDOWN+\ \beta 8SOURLAND+\ \beta 9FARMINC+\ \beta 10OFFFINC+\ \beta 11TOTALINC+\ \beta 12HHSIZE+\ \beta 13FARMAWAR+\ \beta 14PARTEXT+\ \beta 15FARMTYPE+\ \beta 16LENTFARM+\ \beta 17CROPPROD+\ \beta 18LENTFARM\ \text{..........(2)}$$

The Table 1 provides a pictorial outlook or description of all variables (dependent and independent) used in the binary logistic model, their units of measurement, as well as their direction of impact on adoption behaviours of farmers in the study area.

Table 1: Description and units of variables used in the models

Variables		Description	Unit of measurement	A priori expectation
	Dependent variables:			
Y_i	FARMPREF	Do you prefer your own soil practices to the recommended practices by extension?	0= Yes or 1= No	
	Independent variables:			
X_1	AGE	Age of farmer	Years	+/-
X_2	EDUCATE	Education of farmer	Years	+
X_3	MARRIAGE	Marital status of farmer	1=Married; 2= Single; 3= Divorced; 4= Widow/widower	+

X_4	GENDER	Gender of farmer	0= Male; or 1= female	+/-
X_5	EXP	Farm experience of farmer	Years	+
X_6	FARMSIZE	Size of farm	Hectares	+
X_7	LANDOWN	Land ownership	0= Yes or 1= No	+
X_8	SOURLAND	Sources of land	1= Government; 2= Rented; 3= Inheritance; 4= Purchase; 5= Community; & 6= Others	+/-
X_9	FARMINC	Income from crops	Rand	+
X_{10}	OFFFINC	Off farm income	Rand	+/-
X_{11}	TOTALINC	Total income of farmer	Rand	+
X_{12}	HHSIZE	Household size	Numbers	+/-
X_{13}	FARMAWAR	Farmer's awareness of soil conservation practice	0= Yes; or 1= No	+
X_{14}	PARTEXT	Is the farmer attending extension programmes?	0= Yes; or 1= No	+
X_{15}	FARMTYPE	Farming type of farmer	1= Smallholder; 2= Commercial;3= Others	+
X_{16}	LENTFARM	Time of continuous farming on same piece of land	Years	+
X_{17}	CROPPROD	Level of crop yield	1= Insufficient for own consumption; 2= Just enough for own consumption; 3= Just enough for own consumption & ceremony; 4= Sufficient excess for limited sale; 5= Sufficient excess for expanded sale	+

Results

Characteristics of Smallholder Farmers in the Study Area

According to this paper, variables used to describe smallholder farmers are their age, education, overall income, marital status, gender, household size, farming experience, farm size, sources of farmland, and farming continuously on one spot. Based on findings (Table 2), majority (60%) are old, with low education levels, as only 3% exceeded Grade 12. Also majority (66%) earn annual total income which is not greater than R30, 000 (R2500 monthly), which when compared to the current R3500 minimum wage advocated by President Cyril Ramaphosa in South Africa indicates the poverty situation of the study area. More so, majority (74%) of farmers are married, with 60% men, indicating a problem of gender bias in the study area. Similarly, average household size is not large with only four members, while farming experience is relatively large with over half of the farmers (50%) having been farming for 18 years and above.

Table 2. Smallholder farmers' characteristics in the study area

Farmers' characteristics	Statistics	Farmers' characteristics	Statistics
Average age	60yrs	Average household size	4 members
Education	None (20%) Grade 1-12 (77%) Diploma (3%)	Farming experience	<18yrs (50%) ≥18yrs (50%)
Overall income/year	≤R30, 000 (66%) >R30, 000 (34%)	Farm size	1-2ha (70%) >2ha (30%)
Marital status	Married (74%) Others (26%)	Sources of farmland	Inheritance (21%) Others (79%)
Gender	Male (60%) Female (40%)	Farming on one spot	≤10yrs (38%) >10yrs (62%)

Source: Fieldwork, 2014

Study findings also indicate that farming in the study area is majorly smallholdings as majority (70%) farm on land not more than two hectares. Furthermore, a large percentage (79%) obtain their farm land through means other than inheritance, while a huge number (62%) have continuously cultivated on one same piece of land for over ten years.

The Nature and Factors Affecting Smallholder Farmers' Adoption of Soil Conservation Practices in the Study Area

Although there are several factors influencing farmers' adoption decision-making in the literature, this study chose seventeen deemed fit to assist in providing answers for the objectives. In order to check for multicollinearity, an important principle in the use of regression models, a correlation matrix of independent variables was conducted, as represented in the Table 2. Apart from the correlation coefficient for age and education, which is fairly negatively high (r= -0.530), and that of off-farm income and total income, which also is positively high (r= 0.701), the correlation coefficient of the remaining cases are low, with absolute values of majority (almost 75%) falling below 0.2. This thus suggests that the problem of multicollinearity is not serious among variables.

Table 2: Correlation matrix of independent variables of the study

	AGE	GEN	MAR	EDU	SIZ	HHS	LAN	SOU	LEN	CRO	OFF	TOT	AWA
AGE	1												
GEN	-.315	1											
MAR	.024	.335	1										
EDU	-.530	.327	.062	1									
SIZ	.028	-.026	.216	.069	1								
HHS	-.185	.045	.041	.173	.045	1							
LAN	.171	-.214	-.180	.017	.091	-.070	1						
SOU	.108	-.061	-.207	-.117	.067	0.000	.166	1					
LEN	.396	-.119	.006	.036	-.135	-.234	.231	.136	1				
CRO	-.018	-.034	-.099	-.018	.050	.153	.223	050	.022	1			
OFF	.321	-.164	-.109	-.330	.307	.205	.044	.155	.027	.099	1		
TOT	.217	-.164	-.054	-.130	.198	.177	.169	.049	.024	.240	.701	1	
AWA	.126	-.167	-.093	-.227	-.072	-.230	0.000	.057	.040	-.112	.045	-.117	1

Note: AGE: Age; GEN: Gender; MAR: Marital status; EDU: Education level; SIZ: Size of farm; HHS: Household size; LAN: Land ownership; SOU: Sources of land; LEN: Length of time of continuously farming on same piece of land; CRO: Level of crop production; OFF: Off-farm income; TOT: Total income; AWA: Awareness of soil conservation

Further effort to ensure reliability of results and for better analysis of study objective, this study adopted in addition to the binary logistic regression analysis, the probit and logit regression models, to ascertain factors influencing farmers' adoption decisions regarding soil conservation practices introduced by extension. The goal for this was to provide a measure for comparisons of results. Results are as presented in the Table 3.

Table 3: Regression estimates for factors of adoption decision-making

Variables	Binary logistic		Probit		Logit	
	B	**Sig.**	**Dy/dx**	**P>/Z/**	**Dy/dx**	**P>/Z/**
AGE	2.470	0.099*	.1949689	0.086*	.1942641	0.088*
GENDER	4.383	0.031**	.4352119	0.000***	.4214774	0.000***
MARRIAGE	-4.522	0.025**	-.4017135	0.001***	-.399953	0.002***
EDUCATE	1.171	0.206	.0536222	0.414	.0503182	0.452
SIZEFARM	-1.532	0.198	.0499528	0.598	-.0505581	0.587
HHSIZE	-1.712	0.091*	-.0779686	0.177	-.0789872	0.159

LANDOWN	2.622	0.218	.1167045	0.581	.1204231	0.559
SOURLAND	-1.347	0.063*	-.0765876	0.097*	-.0770962	0.101*
LENTFARM	-2.980	0.013**	-.2603467	0.000***	-.264658	0.000***
CROPPROD	-0.947	0.103	-.1463721	0.002***	-.1512637	0.003***
OFFINCOM	0.000	0.147	-2.42e-06	0.837	-5.28e-01	0.967
TOTALINC	0.000	0.081*				
AWARESC	-6.345	0.169				
CONSTANT	23.006	0.033**	5.702022	0.069*		
Contingency table			**Prob. > x^2**	0.0185	**Prob. > x^2**	0.0199
Observed	Yes= 6		**Pseudo R^2**	0.3712	**Pseudo R^2**	0.3675
Expected	No= 5.899		**Log likelihood**	-19.360	**Log likelihood**	-19.474
Overall %	80%					

NOTE: Significance levels- *= p< 10%, **= p< 5% and ***= p< 1%

According to results (Table 3), except for household size (HHSIZE), crop production (CROPPROD) and total income (TOTALINC), where results of the probit and logit regressions vary from the binary logistic regression, values of all the other five significant factors are the same across all three models, thus indicating, to a large extent reliability of results. From the binary logistic analysis, household size was a fairly significant (p<10%) factor contributing to farmers' adoption decision-making, but insignificant in the probit and logit regression analysis, though its coefficient was negative throughout all three models. In terms of the level of crop production (CROPPROD), results of the probit and logit regressions indicate a negatively significant relationship with farmers' adoption decision-making, which is as expected. In the results of the binary logistic model, total income of farmers (TOTALINC) is positively fairly significant (p<10%) in propelling adoption decision-making of farmers.

The impact of age, gender, marital status, sources of land, and length of time of continuously farming on one spot on farmers' adoption behaviours.

Based on the three models adopted in this paper, results for impact of age (AGE), gender (GENDER), marital status (MARRIAGE), sources of land (SOURLAND), and length of time of continuously farming on one spot (LENTFARM) seem to agree across all models, apart from differences existing in their coefficients. Age is fairly positively (p< 10%) related with farmers adoption decision-making process regarding soil conservation practices introduced by extension agents. The indication is that older people will prefer their own practices as against extension practices, which is as expected. Gender (GENDER) also is positively significant in influencing farmers' adoption decision-making process, implying that women are more likely to adopt their own practices as compared to extension recommended practices, which also is congruent with literature.

Marital status (MARRIAGE) of farmers relates significantly negative with farmers' adoption decision-making. The indication is that increase in the marital status of farmers reduces the chance that farmers will prefer their own soil conservation practice to extension recommendation. Similarly, farmers who have easy and more stable access to farmland are expected to be positively related with adoption decisions. This is because land as a main factor of agricultural production is one of the main determinants that motivate farmers to invest or not invest on farmland. As results indicate, sources of land (SOURLAND) are fairly negatively influential on farmers' adoption decision-making regarding extension recommended practices for soil conservation.

Farming continuously on one spot for a long time, especially without appropriate soil conservation technologies, is expected to lead to quick nutrient depletion, and subsequent low yield, which serves as motivation for adoption of conservation. According to results, LENTFARM is negative and significantly influential on farmers' adoption decision-making at $p < 1\%$. The suggestion therefore is that as the length of time of farmers' farming continuously on one piece of land increases, the probability that they will adopt their own practices instead of extension recommended practices decreases. One notable result of this paper is that of education (EDUCATE). Education was expected to be significantly positive in affecting smallholder adoption decision-making processes in the study area. But as results indicate, education is statistically insignificant in the analysis, which is opposite to many findings in the literature.

Discussion of Results

According to findings (Table 2), the study area consists of older farmers, with low education levels. The problem with this characteristics is that old and less educated people are very slow to change from their traditional ways, which is a great hindrance to technology adoption. Also majority (66%) earn annual total income which is not greater than R30, 000 (R2500 monthly), which when compared to the current R3500 minimum wage advocated by President Cyril Ramaphosa in South Africa indicates the poverty situation of the study area. Pender and Hazell (2000) suggest that inadequate education and poverty are said to be two main reasons for poor farming decisions in rural communities. The study area also consists of a gender bias of more males than females. This finding do not seem to reflect the gender constitution of the Eastern Cape, where females slightly out-number the men. It does not also reflect literature evidence of most rural areas of the world, which indicates that women form the largest population of agricultural production in most parts of the world, even though their relevance remains greatly unrecognized (Raidimi, 2014).

Moreover, findings suggest 50% of the farmers have been in farming (experience) for a relatively longer period of 18 years and above, which seems to indicate a population consisting of some wealth of farming experience. According to Bean (2010), experience plays a crucial role in terms of success in the business world. Although many can argue that land obtained through inheritance is arguably a more secure land tenure system, findings of this study indicate that most farmers obtain land through other means like purchase, rent/lease, government, and so forth. This may be understood in areas where the many problems resulting from land by inheritance creates huge challenges for agricultural development. Problems can sometimes range from family members fighting over a piece of land, land fragmentation, and even a litigation. Further findings suggest that a large proportion of farmers farm on land not more than two hectares, and have been farming on one piece of land for over ten years. This is remarkable, because farming on a piece of land for a long time especially without little or adequate soil management practices creates a good platform for soil erosion/degradation. An appropriate perception of the level of soil erosion usually motivates farmers towards adoption of soil conservation technologies (Ervin & Ervin, 1982; Asafu-Adjaye, 2008).

However, empirical results (Table 3) indicate that household size was a fairly significant ($p<10\%$) factor contributing to farmers' adoption decision-making. The indication is that, any unit increase in household size reduces the chance of farmers adopting their own practices as compared to extension recommendations, which partially is as expected. Authors are divided regarding the contribution of household to adoption decision-making. This is because, on one side, large sized household implies more mouth to feed, and thus a reduction of money that would have been meant for agriculture. On the other hand, large household implies more family labour for smallholder agriculture. For example, Odendo, Obare and Salasya (2010) hypothesized that the proportion of household population available for labour on-farm has a positive influence on the adoption of all integrated soil nutrient management (INM) in Kenya, although, according to them, this innovation is labour-intensive.

Findings also indicate that the level of crop production, was negatively significant in relationship with farmers' adoption decision-making, suggesting that every unit increase in the level of production of farmers' crops reduces the chance that they will adopt their own practices instead of extension recommendations. This is as expected, because increase in crop yield implies more income for the farmer, which eventually is ploughed back into farming. Ighodaro, Lategan and Mupindu (2016) discovered in their study in the Upper and Lower Areas of Didimana, Eastern Cape that farm yield of farmers was positively significant in propelling the adoption of soil erosion control measures.

Further findings indicate that total income of farmers is positively fairly significant ($p<10\%$) in propelling adoption decision-making of farmers. The suggestion is that every unit increase in farmers' overall income increases farmers' tendencies to use their own practices as against extension recommendations. This is unexpected because income as it were, means higher social stability and purchasing power for the farmer, which supposedly should encourage adoption of extension recommended practices for soil conservation. However, due to the informal nature of rural environments in developing countries, situations of reality may be somewhat very unpredictable. Some farmers may sometimes prefer to marry a new wife when income increases, as the case may be, instead of investing for the improvements of their farms. This also may not be surprising, especially in most rural part of the former homeland areas of South Africa, where people depend more on government social grants than on farming or any other income generating source. For example, in Sheshegu community (Ighodaro, 2010) and the Upper and Lower Areas of Didimana, Eastern Cape (Ighodaro, 2012), most farmers though still involved in agricultural production, actually obtain most part of their incomes from government social grants.

Age as a factor in adoption decision-making could be dual in impact. There are areas where research has found age to be negatively related with adoption decision-making process, while it was positive in others. Hence, result for age is said to be unpredictable a priori. For example, Bonabana-Wabbi (2002) maintains that age was positively influential in the adoption of sorghum in Burkina Faso. However, in the same study, it was also mentioned that age has been found to negatively impact on adoption decision-making, or not significant in farmers' adoption decision-making process. In this study, age is fairly positively ($p< 10\%$) related with farmers adoption decision-making process regarding soil conservation practices introduced by extension agents. The indication is that older people will prefer their own practices as against extension practices. This is as expected, because older people generally are very traditional and very conservative to change. According to Ighodaro, Lategan and Mupindu (2016), the problem of soil erosion was on the rise in the Upper and Lower Areas of Didimana, Eastern Cape, because the area consists more of older people, and very few of them were willing to accept extension advices regarding soil erosion control. This was also supported by Bembridge (1991). It was stated that older people are often very conservative and tend towards avoidance of risks.

Gender in this study is positively significant in influencing farmers' adoption decision-making process, implying that women are more likely to adopt their own practices as compared to extension recommended practices, which is as expected. Most conservation practices are highly labour-intensive, thus making it difficult for women, except the ones who have the financial means to buy man-power. Arguing in support, Bayard, Jolly and Shannon (2006) maintain that male farmers are most likely to invest in certain conservation practices like rock walls than their female counterparts. It was also indicated however regarding women, that those female farmers who have the financial means to hire labour, have been noted able to adopt rock walls on their farms in Haiti (Bayard, Jolly & Shannon 2006).

Marital status as a factor in adoption decision-making, according to Dűvel (1991), is one of the independent variables determining individual behaviours. Wood *et al*. (2007) state that a rapidly growing literature opines that marriage may have a broad range of benefits that may include improvements in individual's economic well-being, mental and physical health, and the well-being of children of such individuals. According to Dűvel, Chiche and Steyn (2003), most female respondents in a study in Ethiopia, considered their quality of life of less quality than women whose husbands are around, because of the absence of a partner to support and to share the burdens and tasks of household responsibilities. Based on this, marital status was expected to be positive in this study. However, according to results, marital status of farmers relates significantly negative with farmers' adoption decision-making. The indication is that any unit increase in the marital status of farmers reduces the chance that farmers will prefer their own soil conservation practice to extension recommendation, which is in line with literature.

Moreover, results reveal, that sources of land are fairly negatively influential on farmers' adoption decision-making process in the study area. Land by inheritance is arguably the most stable form of access to farmland. The percentage of farmers' population who accessed land through means like inheritance (21%) in the study area was lower than those who accessed land through the 'other' group (52%) of access to land (Ighodaro, 2016). It therefore suggests that the more people access land for farming through the 'other' means, the lower the chance that they will adopt their own practices at the expense of extension recommended practices. This is also as expected. Previous studies show that farmers who own their own land are more likely to adopt soil conservation practices, as against those who do not (Asafu-Adjaye, 2008). The main factor at play here is not just an issue of owning land per se, but that of security of tenure.

Length of time of continuously farming on a piece of land (LENTFARM), in this study was expected to be positive. This is because, farming continuously on one spot for a long time, especially without appropriate soil conservation technologies, is expected to lead to quick nutrient depletion, which serves as motivation for adoption of conservation. According to results, LENTFARM is negative and significantly influential on farmers' adoption decision-making process at $p < 1\%$. The suggestion therefore is that as LENTFARM increases, the probability that they will adopt their own practices instead of extension recommendation decreases, which agrees with literature.

Several literature indications are that education significantly impacts positively on adoption decision-making, but result for this study is unexpectedly insignificant. Although this is the case, certain situational factors do sometimes impact negatively on expectations in researches. One reason that can be adduced for this is that, it could be because most of the soil conservation practices introduced by extension do not require much educational knowledge to operate. This is alluded to by a number of authors. Bayard, Jolly and Shannon (2006) in their study in Fort Jacques, found that education was among variables unexpectedly negative in their influence on the adoption of rock walls. Similarly, among the Fujian cane farmers, although education was positively significant in influencing adoption of soil erosion control measure, it was however insignificant in exerting any influence on effort for soil conservation, as well as on the number of conservation practices used on farm (Asafu-Adjaye, 2008). More so, in the Upper and Lower Areas of Didimana, Eastern Cape, Ighodaro (2012) found that the impact of education in influencing the adoption of soil erosion control measures was also statistically insignificant.

Conclusion and Recommendations for Policy

Climate smart agricultural practices, though a new concept, is not really new, but its goals however emphasize contemporary agricultural challenges due to climate change. In this paper the adoption of soil conservation technologies was used as a proxy for the adoption of climate smart agricultural practices because principles underpinning the former are similar to the latter. As such, the adoption behaviours of smallholder farmers at Qamata Irrigation Scheme, Eastern Cape was studied to ascertain how smallholder farmers behave with respect to soil conservation practices introduced by agricultural extension officers in South Africa. Based on results, majority of farmers in the study are old, with low education, smallholders/subsistence, and have been farming on one spot for over ten years. Similarly, congruent with literature, findings suggest that the nature of smallholder farmers' adoption behaviour regarding the adoption of soil conservation or CSA practices is complex (not straight), being affected by multiplicity of factors. These factors are age, gender, total income, marital status, sources of land, length of time of continuously farming on same piece of land, and level of crop production. Of most significance (at $p<0.01$) are gender, marital status, length of time of continuously farming on one spot (LENTFARM) and crop production respectively. The indication is that women farmers prefer their own practices to extension recommendations which is as expected. Similarly, married farmers, LENTFARM, and farmers with increased crop production preferred extension recommendations for soil conservation instead of their own practices.

The conclusion is that significant variables of this study are factors influencing smallholder farmers' adoption decision behaviour regarding CSA practices in the study area. Therefore intervention efforts for improved CSA practice adoption should consider the significant variables of this study. It is therefore recommended that women farmers should be assisted financially, especially in relation to some soil conservation practices which require extra man-power to operate, which most rural women do not have. Similarly, appropriate education should be provided for smallholder farmers on easy ways to improve the quality and sustainability of farmland since due to pressure on land, most farmers farm continuously on a piece of land for long time.

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