Journal of Agricultural Science; Vol. 8, No. 8; 2016
ISSN 1916-9752 E-ISSN 1916-9760
Published by Canadian Center of Science and Education

The Impact of Soil Erosion as a Food Security and Rural Livelihoods Risk in South Africa

Ikponmwosa David Ighodaro[1], Francois S. Lategan[2] & Wiseman Mupindu[3]

[1] Department of Agricultural Economics and Extension, Faculty of Science and Agriculture, University of Fort Hare, Alice, South Africa

[2] Department of Agricultural Extension and Rural Development, Cape Peninsula University of Technology, Western Cape, South Africa

[3] Faculty of Education and Training, North West University, North West, South Africa

Correspondence: Ikponmwosa David Ighodaro, Department of Agricultural Economics and Extension, Faculty of Science and Agriculture, University of Fort Hare, Private Bag X1314, Alice 5700, South Africa. Tel: 27-793-862-779. E-mail: ikdavid2004@yahoo.com

Received: February 18, 2016 Accepted: June 16, 2016 Online Published: July 15, 2016

doi:10.5539/jas.v8n8p1 URL: http://dx.doi.org/10.5539/jas.v8n8p1

Abstract

This study evaluates soil erosion/attrition as a major food security and rural livelihoods risk in South Africa, with the Upper and Lower Areas of Didimana, Eastern Cape Province, as a case study. The survey research method was adopted for the study. Farmers and extension officers' behaviours relating to soil erosion control was negative even though the impact of erosion in the area was high. Approximately 75% of farmers indicated that they lose more than 21% of their crops yearly due to erosion and 55% said their crops and livestock, as well as their household feeding, suffer due to the problem. The results of the multiple linear regression analysis indicate that farm yield and farmers' access to market are positively related to farmers' adoption tendencies regarding erosion control, implying that farmers are more willing to adopt recommendations if their yields and access to market can increase. Similarly, age of farmers is positively related with erosion impact, indicating that older people have a higher tendency to cause erosion in the study area. This is true, as the area consists more of older people, who are generally known to resist change, thus low in adoption. Therefore, it is perceived that if farmers manage soil erosion appropriately, they will achieve higher yields. More so, pull factors like improved rural infrastructures and adequate agricultural incentives for youths are suggested to lure more youth in taking into farming in the study area.

Keywords: impact of soil erosion, soil erosion, food security, rural livelihoods, farmers' behaviour and extension officers' behaviour

1. Introduction

Although soil erosion/attrition (Note 1) is one of the main themes in environmental studies, an unresolved question is whether its relevance is accorded due place in agriculture and related studies. This is of great concern because of all human activities; the agriculture sector is affected the most by erosion (Note 2). It is considered the most conspicuous and widespread agent of soil/land degradation ever known (Lal, 2003; European Cooperation in Science and Technology [COST], 2008; Kumar & Ramachandra, 2003). It is estimated that 1/6 of global soils has already been degraded by erosion due to water and wind, resulting in a reduced ability of society to produce sufficient food (agriculture) (COST, 2008). The productive power of some lands (worldwide) has declined by half due to the effect of erosion and desertification (Eswaran, Lal, & Reich, 2001). Annually, 75 billion tons of soils are lost from farm lands, and 12 million hectares of cropping land which means approximately 1% of the total area is no longer fit for farming, leading to the degradation of 38% of global cropland since World War II (Dahl, 2013). Soil loss also leads to several other farm challenges, and as these problems increase, there comes a point at which the farm is abandoned (COST, 2008; Anthoni, 2000).

One of the reasons soil attrition is not accorded a proper place of relevance in the list of agricultural problems is because of the way it develops. It starts slowly and very small, (Ighodaro, 2012) and develops incrementally. It often happens so slowly that action is often not taken until it has progressed to a point where it is extremely

costly to remedy. One millimetre of soil, easily lost in one rain or wind storm, is so small that its loss goes unnoticed, yet this loss over a hectare of cropland can amount to 15 tons ha^{-1} (Pimentel, 2006). This often neglected development, as small as it may seems, when considered critically, reveals a loss of colossal amount of soil materials (including soil nutrients) being washed away after every passing incidence of erosion. The inherent danger is that, replenishing soil loss under agricultural conditions requires approximately 20 years (Pimentel, 2006).

Soil attrition can be devastating to agricultural development and food security (Ighodaro, Lategan, & Yusuf, 2013). It leads to productivity or overall farm yield losses, especially because of decreased fertility of the soil due to loss in soil nutrients. It diminishes the quality of soil through the loss of water, soil organic matter, nutrients, biota, and depth of soil, thus reducing the productivity of natural, agricultural and forest ecosystems (Pimentel & Kounang, 1998). Further, eroded sediment contains a considerably higher measure of organic matter and nutrients than that of the topsoil from where it is derived (Young, 1989).

Annual soil loss in South Africa is estimated at 100-400 million tons, nearly three tons for each hectare of land (Kumar & Ramachandra, 2003; Hoffman et al., 1999). It has been estimated that it will take R1000 million to replace the soil nutrients carried out to sea by rivers in South Africa each year, with fertilizer (Kumar & Ramachandra, 2003). Over 70% of the land surface of South Africa has been affected by varying degrees and types of soil erosion (Le Roux, Newby, & Sumner, 2007). In fact, it is perceived that soil attrition is the principal, or largest, environmental problem in South Africa (Muliban, 2001). Compounding the problem is the fact that soil formation rates in the country are thought to be about 30 times slower than rates of soil loss (Hoffman et al., 1999). Thus, to attain food security and improvements in livelihoods, especially in the rural areas of South Africa, soil erosion is no doubt one of the agricultural problems that need to be addressed.

1.1 Background of the Study

The Eastern Cape Province, where this study consists, is rated as one of the three most degraded and poorest provinces in South Africa (Department of Environmental Affairs, Republic of South Africa [RSA], 2007; Bank, Minkley, & Kamman, 2010). Therefore a study such as this in the area is very relevant, seeking amongst other things, to demonstrate that soil erosion is a major food security and rural livelihoods risk in South Africa, using the Upper and Lower Areas of Didimana in the Eastern Cape as a case study. It thus aims at providing answers to the following objectives:

1) To assess farmers' adoption behaviour in respect to the use of erosion control methods in the study area;

2) To assess agricultural extension officers' behaviour with respect to the use of erosion control methods in the study area; and

3) To evaluate the impact of erosion on food security and livelihoods of rural farmers in the study area.

1.2 An Overview of the Study Area

The area of study consists of Upper Didimana, Lower Didimana and Romanslaagte villages, respectively, located in Ward three of the Tsolwana Local Municipality in the Chris Hani District Municipality of the Eastern Cape Province of South Africa. These villages are less than three kilometres apart. The Chris Hani District Municipality is characterised by approximately 56.6% of people living in poverty and some experiencing high unemployment rate (Chris Hani District Municipality, 2010/2011). Nevertheless, livestock farming is said to be an important source of income for people.

In terms of its geology, the area is made up of rolling and undulating hilly to very steep areas within the valleys, and consists mostly of Beaufort sediments intruded by dolerite, and its altitude varies from 1280.2 m to 1463.0 m (District of Whittlesea, 1966).

The climatic conditions of the study area vary from arid climate to very cold high veld climate and falls largely into two climatic zones (Tsolwan Local Municipality, 2010/2011). Further, its mean annual precipitation is between 301 ml and 600 ml and its average maximum temperature is 22.3 ºC and an average minimum of up to 8.9 ºC, respectively. The study area is said to have some of the most erodible soils in the entire region of Chris Hani District Municipality (Tsolwan Local Municipality, 2010/2011).

2. Research Methodology Procedure

The study adopted a survey research methodology using self administered questionnaires distributed to a total of 60 farmers through a one-on-one collection process. The random sampling technique was applied and data was collected through a joint effort of the researcher as well as the services of five other survey assistants, who speak the local dialect of respondents, and who also were well trained to understand the objective and intentions of the

survey. The enumerators were well trained to employ specific protocol in order to establish rapport and encourage farmers to cooperate and give honest and unbiased answers (Mukarumbwa, 2009). Further, the enumerators, apart from helping to overcome the problem of farmers' conservatism and reluctance to discuss matters, helped to ensure consistency and reliability in the data collection process.

Data collected were coded and analysed with the aid of SPSS statistical package version 20, and statistical techniques used include basic descriptive statistics (like frequencies, percentages, and means) and the multiple linear regression model. The descriptive statistics are first step, needed to determine the distribution of variables and to give a summary of large amounts of information (Annor-Frempong & Duvel, 2009). However, to test for relationships (such as the understanding of the effect of independent variables, predictors, on the dependent, outcome, variables) which exist between variables, other higher statistical test are needed like the multiple linear regression model (Annor-Frempong & Duvel, 2009). The multiple linear regression models were adopted because all three dependent variables were linear in nature.

2.1 Conceptual Framework

The problem conceptualization can be defined as a mental or hypothetical construct which provides a scientific basis for purposeful and systematic probing into the causes of a problem and it offers a frame of reference from where extension problems are investigated (Duvel, 1991). Table 1 is a mental construct which offers a concise understanding of the problem of this study, and thus provides a basis for questionnaire design and variables of analysis.

Table 1. A conceptual framework suitable for the information needs of the study

Decision making environment of farmers	**Yield**	**Product quality**	**Sustainability**	**Profitability**	**Accessibility**	**Availability**
Farmers' behaviour with respect to soil management/ erosion control in study area	How does farmers' behaviour impact on their farm yield?	How does farmers' behaviour impact on the quality of their product?	How does farmers' behaviour impact on their farming sustainability?	How does farmers' behaviour impact on their profitability?	How does farmers' behaviour impact on access to food in their area?	How does farmers' behaviour impact on the availability of food in their area?
Extension behaviour with respect to soil management/ erosion control in study area	How does extension behaviour impact on farm yield in study area?	How does extension behaviour impact on the product quality in study area?	How does extension behaviour impact on farming sustainability in study area?	How does extension behaviour impact on farming profitability in study area?	How does extension behaviour impact on access to food in study area?	How does extension behaviour impact on food availability in study area?
Impact of soil erosion in study area	How does soil erosion impact on farm yield in study area?	How does soil erosion impact on product quality in study area?	How does soil erosion impact on farming sustainability in study area?	How does soil erosion impact on farming profitability in study area?	How does soil erosion impact on access to food in study area?	How does soil erosion impact on food availability in study area?

2.2 The Multiple Linear Regression Modelling

The multiple linear regression model was adopted for the analysis of data. The multiple regression model is defined as a statistical technique that allows the user the opportunity to be able to predict the result of a dependent variable based on the scores of several other variables which are called the independent variables (Melusi, 2012). The multiple linear regression models usually take the form of:

$$y = \alpha + \beta x + \varepsilon \quad (1)$$

Where:

y = Farmers' food security and livelihoods in study area after soil erosion impact; x = Exogenous input data of food security and farmers livelihoods (independent variables); α = Intercept of y; β = Partial regression coefficient; α and β= Parameters to be estimated; ε = Stochastic error term.

Incorporating the demographic characters of farmers into the model, plus the food security and rural livelihoods variables chosen for the study, the expected equation is as represented in Equation 2,

$$y = f(A) + f(G) + f(M) + f(E) + f(Y) + f(PQ) + f(S) + f(P) + f(A) + f(Av) \quad (2)$$

Where,

A = Age of farmers; G = Gender; M = Marital status; E = Education level; Y= Yield; PQ = Product quality; S = Sustainability; P = Profitability; A = Accessibility; Av = Availability.

2.3 Description of Variables Used for the Study

Three dependent variables were adopted for the study against ten independent variables as indicated in the Table 2. The first dependent variable was farmers' behaviour with respect to erosion control in the study area, which was measured in terms of how farmers utilized extension officers' advice or recommendations on erosion control. The second dependent variable was extension officers' behaviour with respect to erosion control, which was measured in terms of how often extension officers talked about the control of soil attritiion during times of their visit. The third dependent variable was impact of soil erosion, which was measured upon the percentage of farmers' crops perceived to be lost annually due to erosion impact as well as the impact of erosion on the farmer's livelihoods.

Table 2. Description of variables used for the research

Variables	Description	Unit of Measurement
Dependent variable:		
FINNORAD	How does the farmer use extension advices/recommendations on soil erosion control in their area?	1 = Not at all; 2 = Very limited; 3 = Sometimes; 4 = Quite often; 5 = Regularly
EXTTALK	How often do extension officers talk about erosion control?	1 = Always; 2 = Very often; 3 = Often; 4 = Sometimes; 5 = Never
EROSIMP	How much percentage of crops is lost due to soil erosion? And what area of farmers' livelihoods does erosion impact the most?	1 = 0%; 2 = 0-20%; 3 = 21-40%; 41-60%; 61-80%; > 80% Open-ended
Independent variables:		
AGE	Age of farmer	Years
EDU	Education of farmer	Years
MAR	Marital status of farmer	1 = Married; 2 = Single; 3 = Divorced; 4 = Widow/widower
GEND	Gender of farmer	Male/female
YIELD	Farmers' satisfaction with quantity of crop produce	1 = Totally dissatisfied; 2 = A litter dissatisfied; 3 = Moderately satisfied; 4 = Satisfied; 5 = Very satisfied
PROQUAL	Farmers' satisfaction with quality of crop produce	1 = Totally dissatisfied; 2 = A litter dissatisfied; 3 = Moderately satisfied; 4 = Satisfied; 5 = Very satisfied
SUST	How sustainable is farm business to the farmer?	1 = Unsustainable; 2 = Sustainable with major support; 3 = Sustainable with minor support; 4 = Sustainable without support
PROF	How profitable is farm business to the farmer?	1 = Very unprofitable; 2 = A little profitable; 3 = Moderately profitable; 4 = Profitable; 5 = Very profitable
ACCESS	How easy is it for farmers to sell their crops?	1 = Very easy; 2 = Easy; 3 = Moderately easy; 4 = Difficult; 5 = Very difficult
AVAIL	Families that always have enough food?	1 = None at all; 2 = Very few; 3 = About half of the families; 4 = More than half of the families; 5 = All the people

3. Results and Discussion

The demographic characters of farmers, which are part of the independent variables in the study, impact on the mediating variables (perceptions, needs and knowledge of farmers) to create and determine farmers' behaviours and the eventual production efficiency or problems in an area (Duvel, 1991). These are very important because they help to indicate behavioural patterns of respondents (Shaw & Constanzo, 1970).

According to the findings of the study highlighted on Table 3, the study area consists of older people whose age group ranges from 46-55 and 56-65 years old, as compared to young people less than 35 years of age, which is the maximum age of youth in South Africa, is just only 15% (Rural Urban Consultant, 2001). The average age of

farmers is approximately 57 years, revealing the problem of ageing phenomenon (Ighodaro, Lategan, & Yusuf, 2013, citing Ayinde, 2011). The indication of this is that farming decisions are left in the hands of older people who are more conservative in thinking, and tend to avoid more risk which is one great factor needed for any business success (Bembridge, 1991). Similarly, the study area constitutes more males (53.3%) than females (46.7%), while 60% are married as compared to other marriage groups in the area.

As findings reveal, education level of farmers is poor in the area as only 5% of farmers' population barely exceeded grade 12, which is not quite different from education levels of rural people in the Eastern Cape. For example, a study done in Sheshegu community also in the Province show that only 6% barely exceeded grade 12 (Ighodaro, 2010). This of course do not speak good concerning sound decision making regarding farming in the study area, as poverty and inadequate education were said to be two main factors which lead to poor farming decisions (Pender and Hazell, 2000). The findings of this study show that 48.2% of the farmers have been in farming for less than ten years. This does not show much experience in the farming business as suggested by Barkai and Levhari (1973) and Pender and Hazell (2000). Moreover, any learning that is associated with accumulation of experience, contributes to production (Pender & Hazell, 2000).

Table 3. Personal and demographic characters of farmers in the study area

Age groups (years)	**Frequency**	**Percent**	**Median**
25-35	9	15.0	
36-45	8	13.3	
46-55	12	20.0	
56-65	19	31.7	57 years
66-75	10	16.7	
> 75	2	3.3	
Total	60	100	
Gender of farmers	**Frequency**	**Percent**	
Male	32	53.3	
Female	28	46.7	
Total	60	100.0	
Marital status of farmers	**frequency**	**Percent**	
Married	36	60.0	
Single	14	23.3	
Divorced	3	5.0	
Widowed/ widower	6	10.0	
No response	1	1.7	
Total	60	100	
Education levels of farmers (years)	**Frequency**	**Percent**	
No formal education	1	1.7	
Grade 1-6	16	26.7	
Grade 7-10	16	26.7	
Grade 11-12	23	38.3	
Diploma certificate	1	1.7	
Agricultural degree	2	3.3	
No response	1	1.7	
Total	60	100	
Farmers' number of years in farming	**Frequency**	**Percent**	
< 10	29	48.2	
10-20	19	31.7	
21-40	7	11.7	
41-50	4	6.7	
> 50	1	1.7	
Total	60	100	

Source: Survey research (2012).

3.1 Farmers' Use of Extension Officers' Advices and Recommendations

The farmers' behaviours which relate to decisions taken with respect to use of extension advice or recommended soil management practices concerning erosion control in the study area were found negative as indicated on the Table 4. The study shows that 41.7% of the farmers do not use extension advices, and a total of 36.7% use them inappropriately. Similarly, 58.3% of the farmers had a problem with using the recommended practices on soil management in their area. In fact, 25% said they never use them at all, 13.3% said they rarely use them, while 20% said they sometimes use them. The implication of these findings is that most farmers do not use extension advices neither recommended soil management practices regarding erosion control in their area. Of those who use them, there are still some who use them inappropriately. The problems normally encountered in agricultural settings are ultimately related to issues of non-adoption or inappropriate use of particular recommended practices (Duvel, 1991).

Table 4. Use of extension officers' advices and recommendations in study area

Use of extension advices	**Frequency**	**Percent**
Not at all	25	41.7
Very limited	10	16.7
Sometimes	12	20
Quite often	11	18.3
Regularly	2	3.3
Total	60	100
Use of recommended soil management practices	**Frequency**	**Percent**
Never	15	25
Rarely	8	13.3
Sometimes	12	20
Often	8	13.3
Always	17	28.4
Total	60	100

Source: Survey research (2012).

The above findings can be interpreted as inappropriate behaviour of farmers regarding the control of erosion problem in the study area, and an indication that soil erosion is not accorded proper place of relevance. Otherwise, appropriate recommended practices or advices by experts would have been given top priority.

3.2 Extension Officers' Perception on Soil Erosion

The behaviours of extension officers regarding soil attrition problem in the study area was measured in relation to their perception and efforts towards the control of soil attrition in the country. This is because, if extension officers' perception is in accord with farmers' perception on the level of the problem in study area, it will form part of their major themes during times of their visits. The idea is that the more extension officers' talk on controlling the problem, the less the problem would be in the study area, and vice versa.

However, as Table 5 indicates, over half of the population of farmers (58.3%) said extension agents never talk about soil erosion and its control during times of their visit, which is a reflection of poor behaviour with respect to the problem. This is because as glaring as the problem is in the study area, if soil erosion was given proper place of relevance, it ought to form part of extension major themes in the area. Notwithstanding the above, agricultural extension is the most important source of information to farmers in most African countries (Oladele & Tekena, 2010). Further, agricultural extension plays significant roles in influencing farmers' adoption behaviours (Oladele & Tekena, 2010).

Table 5. Frequency of extension officers' talk on erosion in study area

Extension talk on erosion	Frequency	Percent
Always	6	10
Very often	4	6.7
Often	4	6.7
Sometimes	11	18.3
Never	35	58.3
Total	60	100

Source: Survey research (2012).

3.3 Impact of Soil Erosion on Food Security and Rural Livelihoods

The level of crop loss in an area is a reflection of food security or insecurity, especially for rural areas. Nutrient deficient soils, which are one main impact of erosion, produce 15 to 30% lower crop yields than an un-eroded soil (Pimentel, 2006). According to the findings of this study outlined on the Table 6, 75% population of farmers confirmed that they lose well above 21% of crops every year due to erosion. This is a high reflection of food insecurity in the study area, because the level of crop loses is positively related with food security of an area. In support of this, Odendo, Obare, and Salasya (2010) emphasize that soil fertility degradation on smallholder farms (which is mostly caused by erosion) is reported as the primary biophysical root cause of food insecurity and poverty in sub-Saharan Africa, where most people live in rural areas and obtain their livelihoods from farming.

Table 6. Percentage of crop loss due to soil erosion impact

Percentage of crop loss due to soil erosion (%)	Frequency	Percent
0	12	20
0-20	3	5
21-40	16	26.7
41-60	16	26.7
61-80	6	10
> 80	7	11.6
Total	60	100

Source: Survey research (2012).

According to farmers, the impact of erosion on farmers' crops and livestock (40%), as well as farmers' household feeding (15%) (factors of farmers' livelihood) were the major livelihood factors impacted the most by soil erosion in the study area (Table 7). This is highly remarkable because the census data of 2002 indicates that the main land use of people in the Eastern Cape is sheep farming (Statistics South Africa, 2002) even though other livestock are also reared (Statistics South Africa, 2002). The implication is that the main source of livelihood is severely threatened.

Table 7. Impact of soil erosion on livelihoods of farmers

Soil erosion impact on farmers' livelihoods	Frequency	Percent
Household feeding	9	15
Impact on crops and livestock		40
Destruction of infrastructures/properties	8	13.3
Other impacts	12	20
No impact at all	5	8.3
No response	2	3.3
Total	60	100

Source: Survey research (2012).

3.4 Results of Variables' Relationship Using Regression Analysis

3.4.1 Farmers' Behaviour Regarding the Control of Soil Erosion

The yield of farmers was found to be positively related with farmers' adoption behaviours in the study area with a statistical significance of 0.021, at a p-value of 0.05 (5%), which is remarkable as indicated by the results on Table 8. It agrees with findings of the descriptive statistics, as yield of farmers in the area was perceived low, hence also low adoption rate of recommended practices. The yield is supposed to be positively related with farmers' adoption behaviours because high yield is an indication of increased profit. It is expected that farmers will, in the adoption decision making process compare the advantages and appropriateness of different soil conservation technologies, based on the available resources at their disposal and their opportunity for profit (Tiwari et al., 2008).

Similarly, food accessibility of farmers was found to be positively related with farmer's adoption behaviour with a statistical significance of 0.027, at a p-value of 0.05 (5%) significance level (Table 8). This also is remarkable because, as expected, the more accessible food is in the study area, the more economically and socially empowered farmers become. Therefore, they would like to adopt more soil management technologies to access more of the gains of improved production and social status. This is because, hunger is one of the socioeconomic factors which can lead to poverty and disease, and ultimately to food insecurity, as well as to slow economic growth of society. In fact, the Parliamentary Office of Science and Technology (2006) maintains that "*hunger, poverty and disease are interlinked, with each contributing to the occurrence of the other two*". The selling of crops which is one measure of accessibility in the area was found to be difficult and this contributed towards the low adoption rate of recommended practices.

3.4.2 Agricultural Extension Officers' Behaviour and Soil Erosion Control

According to results (Table 8), extension behaviour with respect to erosion control was found to be negatively related with farm yield and profitability with a statistical significances of 0.043 (5% p-value) and 0.003 (1% p-value) levels of significance respectively. These are actually unexpected, which disagree with earlier literature findings on relationship of farm yield and profitability of farmers and effective extension service. As expected, the more farmers achieve higher yields and profitability, the more they accept extension messages and vice versa. For example, the rational choice theory propounds that every action is essentially '*rational*' in nature, and that individuals calculate the likely costs and benefits of any action before deciding on them (Scott, 2000). Further, the behaviour of farmers is motivated by the possibility of making gains (Barungi & Maonga, 2011). Similarly, Roberts, English, and Larson (2002) maintain that the key to farmers' adoption of site-specific farming (and perhaps other technologies) is the profitability of the technology. This means that profitability propels adoption tendency. Supporting also, Muyanga and Jayne (2006) agree that there is a general view that extension services, if well designed and implemented, improve agricultural productivity (Muyanga & Jayne, 2006).

Although findings above are negative, there might be other factors responsible. One of them could be the problem of subsistence farming which exists in the study area, as is common with most developing rural communities. Most farmers only farm for extra food for the home, not for profit, and as such are not too concerned about the long term gains of adopting improved soil technologies and advises from extension officers. The descriptive statistics also reveal that most farmers are old and inadequately educated. It is a general belief that older and uneducated people or farmers (especially in rural areas) are more closed to change and very

conservative, traditional and less innovative as such they may not be too concerned about extension services on soil erosion control (Bembridge, 1991; Ighodaro, 2010).

3.4.3 Impact of Soil Erosion on Food Security

Based on results, soil erosion relates positively with the age of farmers with a statistical significance of 0.024, which is 5% significance level (Table 8). This means erosion impact increases with age in the study area. In other words, the more of old people residing in the area, the more the problem of erosion. This result seems congruent with findings of the descriptive statistics of this study. According to findings, the study area consists more of older people; very few of the farmers use extension officers' advice on erosion control regularly; and even extension officers hardly talk about erosion control during their visits to the study area; as such, the problem of erosion is on the rise in the area.

According to the literature survey conducted, age as a factor in adoption decision-making can be positive or negative. For example, a study done in Burkina Faso indicates that age was found to influence adoption of sorghum positively (Bonabana-Wabbi, 2002). However, it was also stated in the same study that age has been found to be either negatively correlated with adoption, or rather not significant in farmers' adoption decision making process.

Table 8. Results of variables' relationship in the study area-regression analysis

Variables	Farmers' adoption behaviours		Extension behaviours		Soil erosion impact	
	B	Sig.	B	Sig.	B	Sig.
Age	0.048	0.7	0.164	0.2	0.333	0.024**
Gender	-0.081	0.536	0.135	0.297	-0.105	0.444
Marriage	-0.021	0.874	0.088	0.508	0.042	0.766
Education	0.143	0.301	0.223	0.107	0.133	0.360
Yield	0.343	0.021**	-0.301	0.043**	0.044	0.772
Product quality	0.064	0.657	0.191	0.189	0.285	0.065*
Sustainability	0.193	0.205	0.160	0.290	-0.290	0.074*
Profitability	0.071	0.642	-0.477	0.003***	0.031	0.845
Accessibility	0.292	0.027**	-0.076	0.550	0.063	0.637
Availability	0.049	0.710	0.208	0.115	-0.156	0.261
	R = 0.597		R = 0.615		R = 0.537	

Note. ***: 1% significance level (P < 0.01); **: 5% significance level (P < 0.05); *: 10% significance level (P < 0.10).

4. Conclusion

Soil erosion is a major farming problem in any society, especially for the fact that food, which is chiefly grown on the soil, is the greatest human need. The literature review of this study indicated that, in South Africa, erosion affects over 70% of the land space, and the Eastern Cape which constitutes the study area is one of the three most degraded Provinces in the country. Therefore this should make soil attrition as it relates to food security and rural livelihoods a thing of great concern to all stakeholders. Nevertheless, the findings of this study are alarming. This is because as obvious as problems resulting from erosion (such as high crop losses and negative impact on farmers' crops and livestock, as well as their household feeding) are in the study area, farmers' and extension officers' (who are two key stakeholders with respect to agricultural improvement in rural communities) behaviours were found negative. Farmers do not adopt extension advices or recommended soil management practices, and the little percentage that do, use them arbitrarily or inappropriately. Notwithstanding the above, extension officers hardly talk about the problem and its control.

On a similar note, farmers' adoption behaviour regarding the control of erosion was positively related with farm yield and accessibility, indicating that if yield and accessibility can be increased, farmers will be willing to adopt extension recommendations for erosion control. Additionally, agricultural extension behaviour relates negatively with farm yield and profitability, which are unexpected. There is however certain factors that can be responsible for this. One of them could be the problem of subsistence farming which exists in the area, as is often the case in

most developing rural areas. Moreover, erosion impact relates positively with age of farmers, indicating also that older people have a higher tendency to cause soil erosion. This is as supported in literature. Thus, old people often tend to be more conservative and resistive to change. They find it more difficult to adopt new innovations as such.

Therefore if the above behaviours of farmers and agricultural extension officers were allowed to continue, farming which is the chief source of food security and rural livelihoods in sub-Saharan Africa is at great risk. Hence efforts need to be accelerated to overturn this trend. The following suggestions below strive to address this. Firstly, education should be improved, as level of education was found to be low in the area. Studies have indicated that education is one independent variable which impacts greatly on farmers' behaviour. This can be by mass education campaign or through adult education programmes. Similarly, since farm yield and accessibility increase adoption tendencies of farmers, efforts should be given to increase yield and accessibility. This can be by providing more incentives and soft loans for farmers and providing farmers with more access to lands for farming and better roads to their communities. Farmers can as well be assisted with a ready market to easily dispose their farm produce with no difficulty. In order to encourage younger people into farming, adequate infrastructural facilities should be ensured in rural areas of South Africa, to limit rural-urban drifts of young people, and motivate them to take up farming as a main source of livelihood.

Furthermore, efforts are needed by the government to train and retrain extension officers in practical and more modern ways of soil erosion control in rural communities. This is why the suggestion is that extension curriculums need to be reviewed, and properly tailored towards more practical erosion control programmes. Finally, to assist efficiency of extension practice, an independent monitoring body is recommended to monitor extension programmes and activities in rural areas.

References

Annor-Frempong, C., & Duvel, G. H. (2011). The comparative role of intervening variables in understanding farmers' adoption behaviour. *Journal of Agricultural Science and Technology, 5*(3), 290-297.

Anthoni, J. F. (2000). *Soil erosion and conservation* (Part 1). Retrieved June 27, 2013, from http://www.seafriends.org.nz/enviro/soil/erosion1.htm

Bank, L., Minkley, G., & Kamman, E. (2010). *The Eastern Cape basic services delivery and socio economic trends series on poverty, vulnerable groups and basic service delivery*. East London: Fort Hare Institute of Social and Economic Research (FHISER).

Barkai, H., & Levhari, D. (1973). The impact of experience on Kibbutz farming. *The Review of Economics and Statistics, 55*(1), 56-63. http://dx.doi.org/10.2307/1927994

Barungi, M., & Maonga, B. B. (2011). Adoption of soil management technologies by smallholder farmers in central and southern Malawi. *Journal of Sustainable Development in Africa, 13*(3), 28-38.

Bembridge, T. J. (1991). *The practice of agricultural extension: a training manual*. Development Bank of Southern Africa.

Bonabana-Wabbi, J. (2002). *Assessing factors affecting adoption of agricultural technologies: the case of integrated pest management (IPM) in Kumi District, Eastern Uganda*. Blacksburg: Virginia Polytechnic Institute and State University.

Chris Hani District Municipality. (2010/11). *Draft Integrated Development Plan (IDP) Review*. Eastern Cape, South Africa.

Commission for Environmental Cooperation. (2008). *The North American mosaic: an overview of key environmental issues*. North America: Commission for Environmental Cooperation. Retrieved June 9, 2013, from http://www.cec.org/Storage/32/2358_SOE_landUse_en.pdf

COST. (2008). *Technical annex to COST Action 623: Soil erosion and global change*. European cooperation in the field of scientific and technical research. Retrieved June 9, 2013 from http://www.soilerosion.net/cost623/annex.html

Dahl, A. (2013). *Environment: Soil*. International Environment Forum. Retrieved July 23, 2014, from http://iefworld.org/spsoil.htm

Department of Environmental Affairs, RSA. (2007). *State of the environment: environment affairs*. Republic of South Africa: Department of Environmental Affairs (Updated on 13th November, 2007). Retrieved December 11, 2010, from http://soer.deat.gov.za/47.html

District of Whittlesea. (1966). *The data of reclamation and settlement of Lower Didimana Location* (No. 4). Eastern Cape, South Africa.

Duvel, G. H. (1991). Towards a model for the promotion of complex innovations through programmed extension. *S. Afr. J. of Agric. Extension, 20*, 70-86.

Eswaran, H., Lal, R., & Reich, P. F. (2001). Land degradation: an overview. In E. M. Bridges, I. D. Hnnam, L. R. Oldeman, F. W. T. Pening de Vries, S. J. Scherr, & S. Sompatpanit (Eds.), *Responses to land degradation*. Proceedings of 2nd International Confernce on land degradation and desertification, KhonKaen, Thailand. New Delhi: Oxford Press.

Hoffman, M. T., Todd, S., Ntshona, Z., & Turner, S. (1999). *Land degradation in South Africa*. South Africa: South African National Biodiversity Institute. Retrieved July 7, 2014, from http://www.sanbi.org/landdeg

Ighodaro, I. D. (2010). *The role of agricultural extension in the control of soil erosion in Sheshegu Community, Eastern Cape, South Africa*. Alice: Department of Agricultural Economics and Extension, University of Fort Hare.

Ighodaro, I. D. (2012). *The role of agricultural extension in the control of soil erosion in Sheshegu community, Eastern Cape, South Africa (dissertation)*. Alice: University of Fort Hare.

Ighodaro, I. D., Lategan, F. S., & Yusuf, S. F. G. (2013). The impact of soil erosion on agricultural potential and performance of Sheshegu community farmers in the Eastern Cape of South Africa. *Journal of Agricultural Science, 5*(5), 140-147. http://dx.doi.org/10.5539/jas.v5n5p140

Kumar, R., & Ramachandra, T. V. (2003). *Water soil and sediment investigation to explore status of aquatic ecosystem*. Bangalore: Centre for Ecological Sciences, India Institute of Science.

Lal, R. (2003). Soil erosion and the global carbon budget.*Environment International, 29*, 437-450. http://dx.doi.org/10.1016/S0160-4120(02)00192-7

Lategan, F. S., & Van Niekerk, P. D. U. P. (2007). An analysis of perceived prominent decision making areas in commercial springbuck (*Antidorcas marsupialis*) production decision making. *S. Afr. Tydskr. Landbouvoorl./S. Afr. J. Agric. Ext., 36*, 249-268.

Le Roux, J. J., Newby, T. S., & Sumner, P. D. (2007). Monitoring soil erosion in South Africa at a regional scale: review and recommendations. *S. Afri. J. Sci., 103*(7-8), 329-335.

Melusi, S. (2012). *Market potential and profitability of improved maize Open Pollinated Varieties in the Eastern Cape of South Africa*. Alice: Department of Agricultural Economics and Extension, University of Fort Hare.

Mukarumbwa, P. (2000). *Potential of sorghum and finger millet to enhance household food security in Zimbabwe's semi-arid regions: A case study of communal areas in Masvingo Province*. Alice: Department of Agricultural Economics and Extension, University of Fort Hare.

Muliban, N. E. (2001). *Analysis of Synthesis of data or relationship between soil factors and soil erosion in South Africa.* Pretoria: Faculty of Agricultural Sciences, University of Pretoria.

Muyanga, M., & Jayne, T. S. (2006). *Agricultural extension in Kenya: practice and policy lessons*. Egerton: Tegemeo Institute of Agricultural Policy and Development, Egerton University, Working Paper 26.

Odendo, M. O., Obare, G., & Salasya, B. (2010). *Determinants of the speed of adoption of soil fertility-enhancing technologies in western Kenya*. Cape Town: African Association of Agricultural Economists (AAAE) 3rd Conference/ AEASA 48th Conference, September 19-23, 2010.

Oladele, O. I., & Tekena, S. S. (2010). Factors influencing agricultural extension officers' knowledge on practice and marketing of organic agriculture in North West Province, South Africa. *Life Science Journal, 7*(3), 91-98.

Parlimentary Office of Science and Technology. (2006). *Food security in developing countries*. POST note 274.

Pender, J., & Hazell, P. (2000). *Promoting sustainable development in less-favoured areas overview*. Washington D.C.: International Food Policy Research Institute (IFPRI).

Pimentel, D. (2006). Soil erosion: a food and environmental threat. *Environmental Development and Sustainability, 8*, 119-137. http://dx.doi.org/10.1007/s10668-005-1262-8

Pimentel, D., & Kounang, N. (1998). Ecology of soil erosion in ecosystems. *Ecosystems, 1*, 416-426. http://dx.doi.org/10.1007/s100219900035

Roberts, R. K., English, B. C., & Larson, J. A. (2002). Factors affecting the location of precision farming technology adoption in Tennessee. *Journal of Extension, 40*(1).

Rural Urban Consultant. (2001). *Zonyokwe Irrigation Scheme Final Report*. Provincial Land Reform Office (LDA).

Scott, J. (2000). Rational choice theory. In G. Browning, A. Halcli, & F. Websteer (Eds.), *From understanding contemporary society: Theories of the present*. Sage Publication. http://dx.doi.org/10.4135/9781446218310.n9

Shaw, M. E., & Constanzo, P. R. (1970). *Theories of social psychology*. New York: McGraw Hill.

Statistics South Africa. (2002). *Statistics South Africa annual report 2002/2003*. Pretoria.

Tiwari, K. R., Sitaula, B. K., Nyborg, I. L. P., & Paudel, G. S. (2008). Determinants of farmers' adoption of improved soil conservation technology in a middle mountain watershed of central Nepal. *Environmental Management, 42*, 210-222. http://dx.doi.org/10.1007/s00267-008-9137-z

Tsolwana Local Municipality. (2010/2011). *Draft Integrated Development Plan Review, Eastern Cape, South Africa*. Retrieved March 25, 2016, from http://www.tsolwana.co.za/tsolwana/index.php

Young, A. (1989). *Agro forestry for soil conservation*. Wallingford, UK: C.A.B.

Notes

Note 1. Attrition is synonymous with erosion.

Note 2. Erosion is equal to soil erosion in this study.