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Research
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Cost benefit analysis of soil conservation practices: A case study for Nigeria

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Abstract

The study examined profitability analysis of soil conservation practices and its determinants by arable crop farmers in Delta North Agricultural Zone, Delta State. A multistage selection procedure was applied for this study. A sample size of 332 respondents was used for the study and data were collected from them with the use of structured questionnaires. Data collected were analyzed using descriptive statistics, budgetary and multiple regression analyses. The results show that they had a mean age of 41 years and most of them were educated. They had a mean household size of 7 persons and average farm size of 1.69ha with farming experience of 13 years. Their mean farm income was $ 251.53. The finding revealed that the major soil conservation practices adopted by the respondents were irrigation, planting of different crop, planting of trees, use of fertilizer and crop rotation. Budgetary analysis revealed that a total cost (TC) of $9423.54 was incurred by the respondents per farming season while total revenue (TR) of $22746.08 was realized with a returning gross margin (GM) of $13322.54 and returns on every naira invested of $0.0062 were obtained from the use of soil conservation practices. This is an indication that soil conservation practices are profitable in the study area. The regression showed that education, farm size, farming experience, income, labour supply, access to credit, farmers perception and awareness contributed positively to profitability of soil conservation practices. The major challenges encountered by the farmers are inaccessibility to information, limited income, high cost of improved varieties, inadequate storage facilities, high cost of labour and unavailability of credit facilities. It is recommended that the government should create awareness on soil conservation practices.

Key words: Profitability, soil conservation, practices, farmers, crop, constraints

Toprak koruma uygulamalarının maliyet fayda analizi: Nijerya için bir vaka çalışması

Öz

Çalışma, Delta State'in Delta North Tarım Bölgesi'ndeki ekilebilir çiftçiler tarafından toprak koruma uygulamalarının ve belirleyicilerinin karlılık analizini incelemiştir. Bu çalışma için çok aşamalı bir seçim prosedürü uygulanmıştır. Çalışma için 332 katılımcıdan oluşan örneklem büyüklüğü kullanılmış ve yapılandırılmış anketler kullanılarak bu verilerden veri toplanmıştır. Toplanan veriler tanımlayıcı istatistikler, bütçe ve çoklu regresyon analizleri kullanılarak analiz edilmiştir. Sonuçlar ortalama yaşlarının 41 olduğunu ve çoğunun eğitildiğini göstermektedir. Ortalama hane halkı sayısı 7, ortalama çiftlik büyüklüğü 1.69 hektardı ve 13 yıllık tarım tecrübesi vardı. Ortalama çiftlik gelirleri 251.53 dolardı. Bulgu, katılımcıların benimsedikleri başlıca toprak koruma uygulamalarının sulama, farklı mahsul ekimi, ağaç dikimi, gübre kullanımı ve mahsul rotasyonu olduğunu ortaya koymuştur. Bütçe analizi, tarım sezonu başına katılımcılar tarafından toplam 9423.54 dolarlık bir maliyetin (TC) gerçekleştiğini, 22746.08 dolarlık toplam gelirin (TR) 13322.54 dolarlık bir brüt kar marjı (GM) ile gerçekleştiğini ve 0,0062 dolarlık yatırım yapılan her nairadan elde edildiğini ortaya koydu. toprak koruma

uygulamalarının kullanımından Bu, toprak koruma uygulamalarının çalışma alanında karlı olduğunun bir göstergesidir. Regresyon, eğitim, çiftlik büyüklüğü, tarım deneyimi, gelir, işgücü arzı, krediye erişim, çiftçilerin algı ve farkındalığının toprak koruma uygulamalarının karlılığına olumlu katkıda bulunduğunu göstermiştir. Çiftçilerin karşılaştığı en büyük zorluklar bilgiye erişilememesi, sınırlı gelir, iyileştirilmiş çeşitlerin yüksek maliyeti, yetersiz depolama tesisleri, yüksek işçilik maliyeti ve kredi imkanlarının bulunmamasıdır. Hükümetin toprak koruma uygulamaları konusunda farkındalık yaratması tavsiye edilir.

Anahtar kelimeler: Karlılık, toprağın korunması, uygulamalar, çiftçiler, mahsul, kısıtlamalar

Introduction

The degradation of soils has been a pressing global problem because of its negative effect on food security in the globe (Eswaran et al. 2001; Lal 2009; Rickson et al. 2015).Soil degradation can be well-defined as a diminishing in the land's precise or probable uses. Soil degradation has been recognized as a factor which caused the gradual deterioration in agricultural productivity due to population pressure on land, land fragmentation, deforestation and infringement by smallholder's crop farmers on ecological fragile areas (Mutuli, 2002). Ohaeri (2000) said that soil conservation becomes indispensable due to the worsening agricultural milieus such as erosion, flood disaster, desert encroachment and drought, deforestation, loss of land to other uses; if not look at, the soil becomes degraded and if this happens, productivity will be affected. This scenario will amount to upsurge in the level of inputs use and hence, costs desirable to restore soil productivity. As a matter of fact, this hampers capacity to increase agricultural production to reduce poverty and food insecurity**.** Land depletion is one of the major problems many African countries face, notably soil erosion, soil nutrient degradation and soil moisture stress. Soil degradation is a worldwide ecological crisis that calls for urgent action. This accounts for 84% of degraded land (Blanco and Lal, 2010).

Soil erosion can result in severe loss of topsoil where organic matter and vital nutrients, which are necessary for the survival of crops, generally live. This loss affects agricultural land suitability and decreases water retention efficiency (Wall et al., 2003). This contributes to soil depletion and decreases crop fertility and production efficiency (Somda et al., 2002). Soil erosion is therefore a barrier to agricultural development by declining land productivity, agricultural production potential and harvests and thus reducing farm household income (Semgalawe and Folmer, 2000). The quality loss of soil biodiversity, structure and biological matter through the erosion and compaction process as well as the impairing functioning and services of ecosystems is linked to the degradation of soil (Lal, 2015).

It is estimated that approximately 40% of the land used in world agricultural production is severely degraded because of lack of management, and around 12 million hectares of land has been lost because of the increasing degradation, which is leading to lower production capacities (Rickson et al. 2015; Jie et al. 2002). In order to fight the negative consequences of soil degradation, the implementation of soil conservation practices is important over the long run (Claassen et al., 2004).

Soil degradation can be controlled by employing appropriate soil conservation measures such as physical/mechanical/ technical; biological/vegetative and agronomical/ management practices (Kruger et al., 1997). All these conservation measures can be used depending on existing situation and conservation objectives. The decision made by the farmers on the use of the different types of practices to improve on the soil quality and soil natural resource and agricultural production cannot be over emphasized (Lal, 2009; Lal, 2014). Bayard (2006) and Troeh et al.(2003) defined soil conservation as a conscious process by man to preserve and or to restore land to optimum conditions of productivity with major objective of maintaining the soil to its optimum productivity. Soil conservation measures include; crop rotation, reduced tillage, mulching, manure, cover cropping maintaining a vegetative cover, cultivation on contour lines and proper irrigation practices (Bashir et al., 1997).

Nevertheless, the patterns in food production have recently deteriorated, leading to low performance and household incomes. This decline perhaps is caused by inappropriate soil conservation strategies .The conservation of soil is the most important feature of sustainable development. Economic factors such as the return on different practices, financial efficiency, and cost-shared considerations play a major role in the conservation decision of

farmers under profit maximization (Honlonkou, 2004; Lichtenberg, 2004).

According to Olawoye (2000) farmers that planted vast area of land are constrained to small land leading to low returns. This is discouraged through adoption of available practices of that are affordable in the study area. Adoption can therefore be encouraged with financial incentives given to farmers.

Previous research has found that the economic benefits of land conservation practices are the main drivers of farmers ' decision to adopt (Van Herzele et al. 2013; Sastre et al. 2016; Wilson and Hart 2001; Sattler and Nagel 2010). Regardless of their promotion, the adoption of soil conservation approaches by farmers has been inadequate due to low profitability and other associated risks in land management technologies as such soil degradation has remained a main menace to agricultural production in the Delta State.

Various studies have been done on factors affecting the adoption of soil conservation measures worldwide (Jara-Rojas et al., 2012; Asfaw, 2010; Kessler, 2006; Chomba, 2004; Teng et al., 2004; Aberha, 2008). Empirical evidence of the contribution of soil conservation practices to reducing output variability across production seasons and in securing stable returns to farmers has received little thoughtfulness in the agricultural economics literature. To the Authors' knowledge, this is the first time that such a kind of research is carried out in Delta State to fill the gap. The study is further justified by the fact that the federal government of Nigeria is interested in the use of soil improvement techniques as a measure to alleviate poverty. A study such as this will help policy makers and farmers in conserving the environment for sustainable agricultural production. The purpose of this study was to analyze cost-benefit of soil conservation practices and its determinants among arable crop farmers in Delta State

Material and Methods

The study was conducted in Delta North Agricultural Zone, Delta State, Nigeria. The zone shares borderline with Anambra State in the East, North by Edo State, South by Delta central agricultural zone and Edo Benin. Delta North Agricultural Zone is made up of 9 Local Government Areas (LGAs) namely: Aniocha North, Aniocha South, Ika North East, Ika South, Ndokwa East, Ndokwa West, Oshimili North, Oshimili South and Ukwani Local Government Areas) .with a population of 1,229,371 made up of 620,517 males and 608,854 females (NPC, 2006). Delta North Agricultural Zone has tropical climate noticeable by two distinct seasons. The prevalent winds define the weather of the area; the north-easterly air mass which emanates and blows from the Sahara region between the months of November and March, is responsible for dry season while the southwesterly wind from the Atlantic Ocean which blows across the area between the months of April and October brings the raining season. The main occupation of the folks is farming and fishing. Their cropping systems are mainly mixed cropping; intercropping as well as sole cropping. The main crops cultivated are cassava, yam, okra, garden egg, cocoyam, rice, maize, palm, rubber and sweet potatoes.

Sampling procedure and data collection

Multistage random sampling was the method adopted, this consisted of three stages. The first stage was the selection of five LGAs out of the nine LGAs which fall within the zone because some elements are crucial to be included in the study. In the second stage twenty communities were selected and finally, twelve respondents were haphazardly selected from each community giving a sample of three hundred and thirty-six respondents through the administration of structured questionnaire.

Data analysis

The collected data were evaluated using descriptive statistics such as frequency counts, percentages, mean scores, cost and return analysis and multiple regression analysis.

The multiple regression models are explicitly specified as:

Linear function

$$Y= b_0 +b_1X_1+ b_2X_2+ b_3X_3+ b_4X_4+ b_5X_5+ b_6X_6 +ei \quad (1)$$

Semi-log function

$$Y= lnb_0 +b_1lnX_1+ b_2lnX_2+ b_3lnX_3+ b_4lnX_4+ b_5lnX_5+ b_6lnX_6 +ei \quad (2)$$

Exponential function

$$lnY= b_0 +b_1X_1+ b_2X_2+ b_3X_3+ b_4X_4+ b_5X_5+ b_6X_6 +ei \quad (3)$$

Double log function

$$lnY= lnb_0 +b_1lnX_1+ b_2lnX_2+ b_3lnX_3+ b_4lnX_4+ b_5lnX_5+ b_6lnX_6 +ei \quad (4)$$

where

Y=return of soil conservation practices (₦)

X_1= age (years)

X_2=educational level (years of schooling)

X_3=household size (number of persons)

X_4=farm size (ha)

X_5=farming experience (years)

X_6=income level ($)

X_7=labour supply

X_8=access to credit (yes=1, otherwise=0)

X_9= farmers perception (positive=1, otherwise =0)

X_{10}= awareness of practices (awareness=1, otherwise=0)

ei= error term

b_0=intercept

b_1-b_n=estimated coefficients

Results and Discussion

Selected socio-economic characteristics of the respondents

Majority (54.8%) of the respondents were in the age bracket of 38-49years, 24.7% of the respondents aged between 28-37years, about 16.9% fell within 50-59years of age while 3.6% of them were above 59years, with a mean age of 41years. This indicates that the cultivation of arable crops was carried out by young farmers that are still in their active age to carry out strenuous farming activities. The result showed that majority (40.7%) of them had secondary education, follow by 32.5% of the respondents that had primary education ,9.6% of the respondents had tertiary education while 17.2% had no formal education, this suggest that majority of the respondents are educated and will be willing and ready to accept new technologies and this may contribute to an increase in production of the arable crops. The result as presented indicated that majority (47.6%) had household sizes between 5-7 persons, about 14.5% of the respondents had household sizes ranging from 2-4 persons, 27.7% of them had between 8-10 persons while only 10.2% of them had household sizes of above 10 persons. The average family size is 7 persons implying that there is considerable source of family labour available to do various farm operations. The outcome showed that majority (50.6%) of respondents had between 1.51-2.50 hectares, 28.9% of them had between 0.50-1.50 hectares, 7.2% of the respondents had a farm size of < 0.30 hectare, while only 13.3% of them had farm size above 2.50 hectares. This implies that greater part of the respondents fell within the category of small holder farmers. The average farm size in the study area was 1.69 hectare.

The result on farming experience revealed that 56% of the respondents had between 11-15 years, 19.6% had between 6-10 years of farming experience. The farmers that fell within the range of 16-20years of farming experience was 16.6% while only 4.2% of them had farming experience of above 20 years and about 3.6% of the respondents had 1-5years farming experience, with a mean farming experience of 13 years. The result in Table 6 indicates that majority (57.2%) of respondents earned farm income of $242.38- $310.08 per annum as 23.5% earned between $170.54-$239.79. About 13.0% of the respondents earned farm income of $47.80-$167.96, 4.2% of them earned between $312.66- $581.40 and only 2.1% earned farm income of above $581.40 per annum, with a mean of $251.53. This showed that they are small scale farmers with lesser income per annum.

Table 1. Selected socio- economic characteristics of the respondents (N = 332)

Variable	Frequency	Percentage	Mean
Age (Years)			
28-37	82	24.7	
38-49	182	54.8	
50-59	56	16.9	41 year
Above 59	12	3.6	
Education			
No- formal education	57	17.2	
Primary	108	32.5	
Secondary	135	40.7	
Tertiary	32	9.6	
Household Size			
2-4	48	14.5	
5-7	158	47.6	7 persons
8-10	92	27.7	
Above 10	34	10.2	
Farm Size			
< 0.30	24	7.2	
0.50-1.50	96	28.9	
1.51-2.50	168	50.6	1.69ha
Above 2.50	44	13.3	
Experience			
1-5	12	3.6	
6-10	65	19.6	
11-15	186	56.0	13 years
16-20	55	16.6	
Above 20	14	4.2	
Income level			
$47.80-$167.96	43	13.0	
$170.54-$239.79	78	23.5	
$242.38- $310.08	190	57.2	$251.53
$312.66- $581.40	14	4.2	
Above $581.40	7	2.1	

Soil conservation practices among arable crop farmers

The result as presented in Table 2 revealed that 86.9% of them adopted planting of different crop as strategy for soil conservation practice,71.4% adopted intensive manure application , 73.8% used mulching , another 71.4% of respondents applied planting of short growing crop varieties as measures for soil conservation, 78.6% of respondents utilized alternative measure of planting of trees. The result further showed that 75%, 73.8%, 75% and 89.3% applied use of fertilizer; cover cropping, crop rotation and irrigation as adaptation strategies respectively.

Table 2. Soil conservation practices among crop farmers

Conservation Practices	Frequency	Percentage	Ranks
Planting of different crop	73	86.9	2nd
Intensive manure application	60	71.4	8th
Mulching	62	73.8	6th
Plant short growing crop varieties	60	71.4	8th
Planting of trees	66	78.6	3rd
Use of fertilizer	63	75.0	4th
Cover cropping	62	73.8	6th
Crop rotation	63	75.0	4th
Irrigation	75	89.3	1st

Cost and return of soil conservation practices

The estimated farm budgeting analysis for soil conservation practice is present in Table 3 the result shows that planting of different crop (PODC) constituted 18.65% of the total cost of soil conservation practice followed by the use of fertilizer (15.29) cost of crop rotation (CROROT) cover cropping (COCROP) and planting of trees (POT) account 12.83%, 10.35% and 10.11% respectively of the total cost of soil conservation practices. Planting short growing crop varieties (PSGCV), mulching (MUL), irrigation (IRRI) and intensive manure application (IMA) accounted for 22.91% of the total cost of soil conservation practices. The total revenue (TR) derived from soil conservation practices was found to be $22746.08 with gross margin of $13322.54. The operating ratio was 0.0011 while return on every dollar was 0.0062 indicating that for every one naira invested, a return of $0.0062 is obtained. Thus, soil conservation practices are profitable venture to improve the farming activities of arable crop farmers.

Table 3. Cost and return of soil conservation practices

Cost/ Revenue Items ($)	Dollar	Percentage
Variable cost		
Planting of different crop	1757.83	18.65
Intensive manure application	630.41	6.69
Mulching	814.83	8.65
Planting short growing crop varieties	928.17	9.85
Planting of trees	953.15	10.11
Use of fertilizer	1441.21	15.29
Cover cropping	975.35	10.35
Crop rotation	1209.35	12.84
Irrigation	713.23	7.57
Total Variable Cost (TVC)	942.350	
Revenue		
Planting of different crop	3519.04	15.47
Intensive manure application	1286.93	5.66
Mulching	1568.63	6.90
Planting short growing crop varieties	1632.87	7.18
Planting of trees	2000.41	8.79
Use of fertilizer	5428.20	23.86
Cover cropping	2265.92	9.96
Crop rotation	3649.84	16.05
Irrigation	1394.24	6.13
Total Revenue(TR)	22746.08	
Gross Margin(GM)	13322.54	
Return per naira invested(RPNI)	0.0062	
Operating ratio(OR)	0.0011	
Benefit/cost ratio	0.0062	

Influence of socioeconomic factors on returns

The result as presented in Table 4 showed that the double-log function was found to have the best fit and therefore chosen as the lead equation. The R^2 of the function was found to be 0.8373. This implies that about 83.7% of the variation in output of the respondents was accounted for by joint action of the explanatory variable while the rest 16.3% variation was due to the factor not captured and error. The overall regression result was significant with F-statistic value of 14.92 at 1% probability level. The coefficient of education was positively significant at 5% level, implying that a unit increase in educational level of the respondent will lead to an equivalent increase in farm returns from soil conservation practices by 1.10424 units. Farm size was positively significant at 5%. This means that a unit increase of farm size in adopting soil conservation practices will positively contribute to profitability of the farmer. The likely reason is that larger farms are associated with grander wealth and increased accessibility of capital, which increase the probability of investment in soil conservation measures .This agrees with Nwachukwu et al., (2009) that the larger the farm size, the more output a farmer realizes from his farm. Farming experience has positive and significant relationship with profitability of soil conservation

practices at 5% level, implying that a unit increase in years of farming experience will increase return of adopting soil conservation practices by 0.66931 units. Income was positively significant with a production elasticity value of 0.38397. This denotes that a unit increase in income of respondents will lead to an increase from soil conservation practices for increase returns. The labour supply coefficient (0.36489) was positively significant at 5% level. This infers that any upswing in labour supply will lead to consistent increase in the probability of investing in soil conservation practices which are known to be labour intensive to generate farm returns. This result is in consonance with findings of Nwaobiala (2013) who found a positive relationship between labour and output.

The coefficient for credit accessibility was positive and highly significant at 1% likelihood level. This suggests that any increase in credit accessibility will lead to increase in probability of return from soil conservation practices.

The coefficient of farmers perception (1.24241) was positive and significant at 5% level. This means that farmers' acumen of soil erosion challenges will influence them to adopt soil conservation practices .The implication is that farmers who feel that their farmlands are susceptible to soil erosion are more likely to adopt soil conservation practices than those who do not perceive soil erosion problem. This will lead to same increase in the return from soil conservation practices. The coefficient of awareness of soil conservation practices (ASCP) (1.35643) was positive and statistically significant at 1% level. This indicates that any intensification in ASCP would lead to increase in probability of return from soil conservation practices. This finding conforms to Nwaru (2004).

Table 4. Influence of Socioeconomic factors on returns

Variable	Linear	Exponential	Semi-Log	Double-Log
Age	205.5381	11305.4	25.03419	0.05027
	(0.65)	(0.14)	(0.33)	(0.89)
Education	29.43462	-17877.52	-334.4825	1.10424
	(2.07)**	(-0.39)	(-1.90)*	(3.85)**
Household size	28.30788	53181.86	157.312	0.06682
	(1.93)*	(1.15)	(0.63)	(0.51)
Farm size	434.435	0.33635	76.49585	0.24981
	(2.74)**	(3.13)**	(2.33)**	(2.78)**
Experience	-582.23483	0.01145	1447.173	0.66931
	(-0.23)	(0.32)	(2.85)**	(2.45)**
Income	0.2039647	70928.48	5.56e-07	0.38397
	(9.80)***	(3.44)***	(4.58)***	(2.96)**
Labour supply	8.66674	88743.06	19.84382	0.36489
	(0.59)	(2.32)**	(0.23)	(2.09)**
Access to credit	22941.81	0.03433	0.2551989	0.10325
	(0.89)	(3.12)**	(1.71)	(4.26)***
Farmers perception	-27941.42	-0.52424	1085.522	1.24241
	(-1.07)	(-4.27)**	(2.94)**	(3.31)**
Awareness of SCP	175.0617	0.0000194	167.9016	1.35643
	(2.94)**	(2.99)**	(2.34)**	(5.31)***
Constant	2078.912	3.20729	15675.38	9.846698
	(1.34)	(2.68)**	(3.98)***	(4.33)***
R^2	0.8047	0.8276	0.7974	0.8373
F-ratio	11.95	13.92	11.41	14.92

*** ** and * =significant at 1%, 5% and 10% probability level respectively

Constraints to soil conservation practices

Table 5 showed that 78.6% of the farmers indicates unavailability of credit facilities as a constraints to conserve the soil, 82.1% showed high cost of improved varieties, 84.5% revealed limited income,78.6% showed high cost of labour, 77.4% confirmed high cost of irrigation facilities, 85.7% indicated inaccessibility to soil conservation practices information, 77.4% showed high cost of farm inputs, 82.1% indicated lack of storage facilities, 78.6% revealed lack of extension agent and 77.4% confirmed that limited availability of farm land hampered soil conservation.

Table 5. Constraints to soil conservation practices

Constraints	Frequency	Percentage	Rank
Unavailability of credit facilities	66	78.6	4th
High cost of improved varieties	69	82.1	3rd
Limited income	71	84.5	2nd
High cost of labour	66	78.6	4th
High cost of irrigation facilities	65	77.4	7th
Inaccessibility to information on soil conservation practices	72	85.7	1st
High cost of farm input	65	77.4	7th
Lack of storage facilities	69	82.1	3rd
Lack of extension agent	66	78.0	6th
Limited availability of farm land	65	77.4	7th

Conclusion

The respondents had a mean age of 41 years and this their highest level of formal education attained was secondary education. They had an average household size of 7 persons and means farming experience of 13years with average farm size of 1.69 ha indicating small holdership. The finding revealed that the major soil conservation practices adopted by the respondents are irrigation, planting of different crop, planting of trees, use of fertilizer and crop rotation. The result established that the soil conservation practices engaged by the arable crop farmers are profitable. The policy variables that contributed positively to farmers returns includes education, farm size, farming experience, income, labour supply, access to credit, farmers perception and awareness of soil conservation practices. However, the farmers encountered various problems such as inaccessibility to information on soil conservation practices, limited income, high cost of improved varieties, lack of storage facilities, high cost of labour and unavailability of credit facilities. In order to make efficient use of soil-conservation practices in farming in the economy, the government and credit institutions in Nigeria need to continue to pay attention to the financing of soil conservation practices they deserve. Based on the finding of the study, the following recommendations are made:

- The government should create awareness on soil conservation practices.

Incentives should be provided to the farmers

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