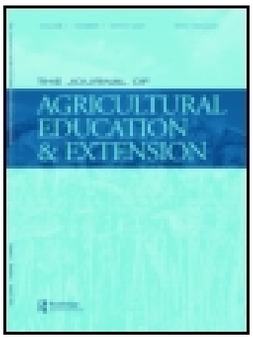

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Farmers' Adoption of Soil Conservation Technologies: A Case Study from Osun State, Nigeria

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ABSTRACT *The main objective of this study was to determine the attitude of farmers towards erosion and the adoption of appropriate soil conservation technologies (SCTs). For the survey, farmers were selected from the communities Esa Oke, Elwure and Owode-Ede and Akoda in Osun State in Nigeria. In the first three communities farmers did receive training on soil conservation, in the fourth not. About 60 farmers were interviewed to obtain information on personal and socio-economic characteristics, awareness of environmental problems, attitude towards erosion control and experiences with SCTs. Statistical data analyses (analyses of frequencies, correlation, t-test, χ^2-test) were made to examine possible relationships among parameters and the influence of factors on adoption.*

Most respondents were advanced in years, responsible for large households and characterized by low levels of income and literacy. Soil erosion was seen as a problem confronting agricultural production only to a small extent. The adoption rate of SCTs was low, as only mulching, cover cropping, contour tillage and cut-off drainage were practised and often rejected. Low labour-demand, the availability of common equipment, low costs of application, ease of practice and compatibility with the existing farming system influenced adoption.

The observed positive correlation between level of education, knowledge of appropriate technologies, farming experience and the number of SCTs adopted emphasizes the importance for farmers of education and training. Strengthening agricultural extension agencies for capacity building is an important tool for improving soil conservation in Nigeria.

The paper clarifies with specific examples the causes of the low rates of adoption of available technologies, with a reduced impact of research and of efforts to achieve food security and sustainable production at village level.

KEY WORDS: Assessment of adoption, Soil conservation, Soil erosion control, Nigeria, West Africa

Introduction

In Nigeria, West Africa, soil erosion is the most widespread type of soil degradation and has been recognized for a long time as a serious problem (Stamp, 1938). In 1989, runoff-induced soil loss already affected 693,000 km^2 in the south and 231,000 km^2

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were degraded, mainly by wind erosion, in the north. Sheet erosion dominates all over the country; rill and gully erosion are common in the eastern parts and along rivers in northern Nigeria (Igbozurike et al., 1989; Ologe, 1988). In recent decades, the loss of soil has been greatly accelerated. Some reasons are the intensification of agriculture to increase food production for feeding the rapidly growing population, inappropriate farming practices, deforestation and the shortening or elimination of fallow (Lal, 1995). The decline of soil productivity followed by food insecurity, low income of the rural population and poverty are common consequences of erosion. Hence, improved management and conservation of the soil by practising improved technologies or installing appropriate measures is important to maintain the soil and its functions and to contribute to the food security today and for future generations (Ehui and Pender 2005).

Soil conservation has a long tradition in Sub-Saharan Africa (SSA). Indigenous techniques, such as ridging, mulching, constructing earth bunds and terraces, multiple cropping, fallowing and the planting of trees, were performed in the pre-colonial era and combined erosion control with water conservation (Igbokwe, 1996; Scoones et al., 1996). In colonial times, the British Government focused on intensifying the production of cash crops in northern Nigeria. Projects on soil loss control were started on a larger scale, especially in areas of high agricultural potential. But many failed, as the imported technologies were originally developed for use in a temperate climate and therefore were not relevant to the tropics (Lal, 1988). Their introduction undermined the use of indigenous technologies, but local land users did not adopt them later (Critchley et al., 1994). Since independence in 1960, much research on soil conservation has been done in many institutions in different parts of Nigeria. For example by Lal (1976) and Salako et al. (2006) in the Southwest, Odunze (2002) in the North, and Igwe (1999) in the East. The studies resulted in a considerable number of on-farm strategies, including agronomic measures such as mulching or cover cropping, conservation tillage, mechanical methods such as contour bunds or terraces, and off-farm strategies with mechanical or biological soil conservation technologies (SCTs) (El-Swaify et al., 1982; Junge et al., 2008).

However, these widespread initiatives depended on farmers for installation and use in the field. Hence, questions are raised about the efficiency, the adoption levels and farmers' perceptions, as well as the costs and benefits of the SCTs. As adoption studies also seek the factors which influence the decisions farmers make during the introduction process (Bodnar and De Graaff, 2003), useful information for further technology transfer and educational programmes on soil conservation is collected (Anyanwu, 1996). Investigations on the acceptance of technologies for improving soil fertility are numerous. For example, Tarawali et al. (1999) and Muhr et al. (2001) focused on the adoption of improved fallows, and Adesina and Chianu (2002) on the adoption of alley farming to combat nutrient depletion. Adoption studies, including the improvement of soil productivity in combination with soil conservation by intercropping, were made by Arowojolu and Oladeji (2001) and by Douthwaite et al. (2002) on the cover crop *Mucuna pruriens*. Onu (1990) investigated factors associated with small-scale farmers' adoption of improved SCTs. Uzoigwe (1996) analysed the skills of farmers, and Osinem (1996) worked on the programme of school farms to

generate more knowledge on the adoption of SCTs. But studies with primary focus on the adoption of erosion control measures are rare in Nigeria. As soil loss is a common phenomenon in the country which needs to be combated, more knowledge on the effectiveness of SCTs and the acceptance by farmers is required.

The main objective of this study was to determine the attitude of farmers towards erosion and the adoption of appropriate SCTs. More specifically, the study determined (a) personal and socio-economic characteristics of the respondents, (b) awareness of erosion, its type and intensity on farmers' fields, (c) general overview of known SCTs, (d) effectiveness of implemented SCTs, (e) adoption rate of SCTs, and (f) factors influencing the adoption rate of SCTs.

Methodology

Study Area

The farm settlement at Esa Oke (7°44' N, 4°50' E), established by the Osun State Government in 1960, and the neighbouring communities, Elwure and Owode-Ede (7°42' N, 4°29' E), and Akoda (7°40' N, 4°26' E) in Osun State, Southwest Nigeria, were selected for the survey (Figure 1). These study areas are characterized by sheet erosion. Slopes with a gradient up to 10% are typical for the gently undulating landscape. The tropical climate is humid to sub-humid, with a bimodal rainfall distribution (mean annual rainfall 1,350 mm, mean annual temperature 26.8°C). The dominant soils are Lixisols, with a sandy topsoil and high clay content in the subsoil (Sonneveld 2005). Farmers prepare the land by using hoes or hiring tractors; and primarily cultivate food crops, such as cassava and maize. Livestock are of minor importance.

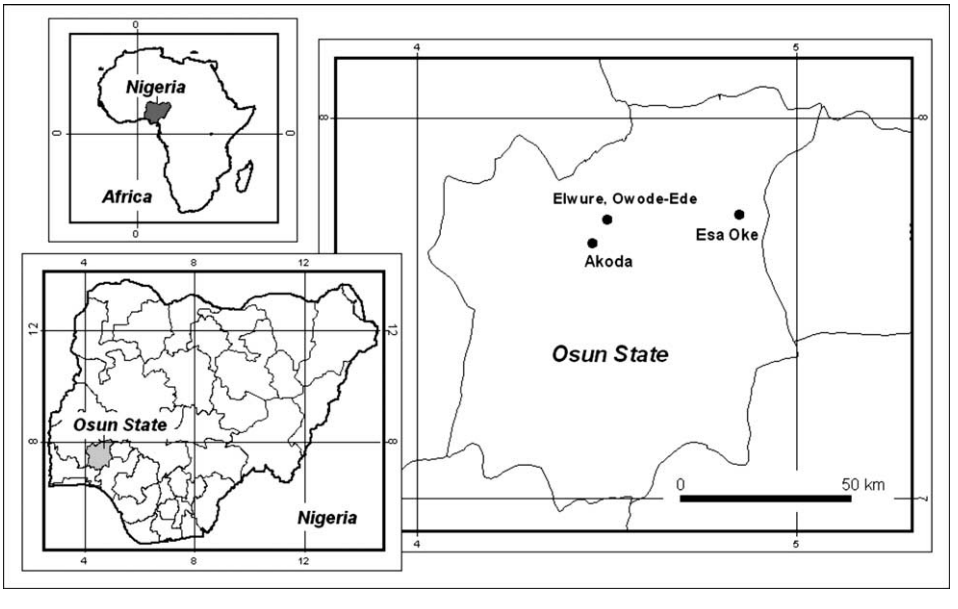

Figure 1. Location of the study areas in Osun State, Nigeria, West Africa, where the survey on soil conservation was made in 2007.

Sampling Design

The selection of survey villages was accomplished through a random sampling procedure. Sample villages were selected based on the farmers' attendance of training on soil conservation. The farmers of Esa Oke, Elwure and Owode-Ede (experimental group E) had been trained on farming issues since 1996 and on soil conservation since 2002 by the Rural Development Programme (RUDEP) of the Osogbo Diocese. This agency for rural development cooperates with the NGO Justice, Development and Peace, Ibadan, which is supported by Misereor, Germany. The overall goal was to enable poor peasant farmers to improve their farming and living conditions within a perspective of self-reliance, self determination and sustainability. The extension strategies on soil and water conservation included group training sessions in the communities, the installation of field demonstrations on the land of interested farmers and the practice of farmer-to-farmer exchange visits (Omodara and Alff 2006). The farmers of Akoda (control group C) did not participate in any similar training and therefore were regarded as land users without comparable knowledge on soil conservation.

In each selected village, a survey on farmers' experiences with soil conservation was conducted in May 2007. A qualitative approach of focus group discussions (ten farmers per village), individual interviews (thirty farmers per village), and observations from field visits (six to ten per village) was used. The primary choice of sample farmers considered training/no training on STCs. A random sample of farmers was taken from each of the two groups ($E = 40$ farmers, $C = 20$ farmers). Structured questionnaires were used to obtain data on the personal and socio-economic characteristics of the farmers and the SCTs they implemented. Information on topics, such as the awareness of environmental problems, attitude towards erosion control and experiences with SCTs, was collected to explain the levels of adoption.

Statistical Analysis

Various statistical data analyses, including analyses of frequencies, correlation, t-test and χ^2-test, were made to examine possible relationships among different parameters and the influence of different factors on adoption (Koehler et al., 1996).

Results and Discussion

Personal and Socio-economic Characteristics of the Respondents

The study, which included more questionnaires with male than with female farmers, showed that more of the former adopted SCTs (Table 1). The majority of farmers interviewed were aged between 46 and 65 years. The respondents trained and the adopters of SCTs were insignificantly younger than farmers of group C and non-adopters (Table 2). The majority of group E and non-adopters had no formal education or post-secondary education, whereas a higher percentage of adopters attended a primary and secondary school. The experience in farming was less than 10 years' for most of the respondents trained on soil conservation, and between 10 and 20 years for farmers in group C. The households mostly contained between 7 and 12 persons in both groups, and there were more adopters with insignificantly larger

Table 1. Personal and socio-economic characteristics of group E (roman text: all respondents; italic: non-adopters (NA) and adopters (A) of SCTs) and group C

	Group E			Group C
Subject	All (n = 40) (%)	*NA (n = 22) (%)*	*A (n = 18) (%)*	(n = 20) (%)
Gender				
Male	57.5	*45.5*	*72.2*	85.0
Female	42.5	*54.5*	*27.8*	15.0
Age (yr)				
<25	2.5			
26–45	20.0	*22.5*	*13.6*	33.3
46–65	52.5	*52.5*	*63.6*	38.9
>65	25.0	*25.0*	*22.7*	27.8
Level of education				
No formal education	30.0	*40.9*	*16.7*	20.0
Primary school	22.5	*13.6*	*33.3*	40.0
Secondary school	12.5	*4.5*	*22.2*	25.0
Post-secondary education	35.0	*40.9*	*27.8*	15.0
Experience in farming (yr)				
<10	47.5	*54.5*	*38.9*	25.0
11–20	10.0	*4.5*	*16.7*	50.0
21–30	15.0	*18.2*	*11.1*	10.0
31–40	15.0	*9.1*	*22.2*	5.0
>41	12.5	*13.6*	*11.1*	10.0
Household size (person)				
<6	20.0	*18.2*	*22.2*	10.0
7–12	65.0	*72.7*	*55.6*	85.0
13–18	15.0	*9.1*	*22.2*	5.0
Number of labourers assisting on the farm (person)				
<5	60.0	*68.2*	*50.0*	65.0
6–10	35.0	*22.7*	*50.0*	36.0
>10	5.0	*9.1*		
Farm size (ha)				
<2	35.0	*31.8*	*38.9*	45.0
2–6	10.0	*13.6*	*5.6*	30.0
6–10	50.0	*50.0*	*50.0*	5.0
>10	5.0	*4.5*	*5.6*	20.0
Land security				
Very secure	70.0	68.2	72.2	25.0
Secure	27.5	31.8	22.2	75.0
Insecure	2.5		5.6	
Membership in agricultural associations				
No	2.5	*4.5*		60.0
Yes	97.5	*95.5*	*100.0*	40.0

Table 1 (*Continued*)

Subject	Group E All (n = 40) (%)	Group E *NA (n = 22) (%)*	Group E *A (n = 18) (%)*	Group C (n = 20) (%)
Membership in social organizations				
<2	62.5	*77.3*	*44.4*	80
>3	37.5	*22.7*	*55.6*	20
Contact with extension agents				
Never				60.0
Seldom	42.5	*50.0*	*33.3*	40.0
Often	47.5	*50.0*	*44.4*	
Very often	10.0		*22.2*	
Average annual income from farming (US$)				
No answer	47.5	*45.5*	*50.0*	85.0
<100	15.0	*22.7*	*5.6*	
101–250	17.5	*18.2*	*16.7*	5.0
251–500	12.5	*4.5*	*22.2*	5.0
>501	7.5	*9.1*	*5.6*	5.0

households than non-adopters. The average number of labourers additionally hired for field work was up to 5 in group E and C. The observed difference between the numbers of workers employed by farmers practicing soil conservation and non-adopters was not significant. Most respondents in group E had 6 to 10ha which significantly differed from the farmers in group C who mostly cultivated 2 to 6ha and less than 2ha. The respondents of both groups primarily acquired land by leasing, and the major source of

Table 2. Differences between personal and socio-economic characteristics of group E (n = 40) and group C (n = 20), and the adopters (A, n = 18) and non-adopters (NA, n = 22)

Socio-economic characteristics	Mean E	Mean C	Sig. (2-tailed)	Mean NA	Mean A	Sig. (2-tailed)
Age (yr)	56.0	58.7	0.404	56.9	54.8	0.615
Experience in farming (yr)	20.3	20.9	0.886	19.0	21.8	0.565
Household size (no)	9.6	10.1	0.603	9.2	10.0	0.534
Labourer assisting on the farm (no)	5.7	5.3	0.655	5.4	6.1	0.591
Farm size (ha)	16.9	10.3	0.035*	17.0	16.7	0.948
Membership in agricultural associations (no)	2.0	1.6	0.001***	2.0	2.0	0.373
Membership in social organizations (no)	2.2	0.8	0.001***	1.9	2.6	0.018*
Total annual income (US$)	138.6	70.9	0.214	129.0	150.3	0.741
Income from other sources (US$)	209.0	147.2	0.001***	203.7	215.4	0.883
Distance home to farm (km)	2.4	1.8	0.153	2.6	2.2	0.605

Note: Independent t-test, ***significant at 0.001 level, *significant at 0.05 level.

credit was the family. But farmers differed in their perception of security over land: many of group E and adopters regarded land security as very high, whereas the respondents in group C regarded it as high. In all villages, most of the persons interviewed were commercial farmers who produce mostly food crops and fewer cash crops.

More of the respondents who adopted SCTs were commercial farmers compared to the group of non-adopters. Part-time farmers dominated in group E. They were occupied in trading or tailoring in addition to on-farm activities. The C group had more full-time than part-time farmers. The study showed that most of the respondents already travelled to other states within Nigeria but generally with less frequency. The membership in any agricultural or other social organization significantly differed between group E and C. Most of the farmers trained on soil conservation were members of appropriate groups and often had contact with extension agents. It was observed that adopters of SCTs exchanged information with agents more frequently than non-adopters. Respondents in group E and, especially, adopters also got much of the inputs required from the agency, whereas the major source of input for non-adopters was the market. Most of the respondents in the C group were not members of comparable associations and purchased their inputs from the market. The average annual income of the respondents belonging to both groups was estimated to be generally low: the majority earned less than US$500 per year from farming and other sources. But fewer adopters earned less than US$100 from farming per year than non-adopters. The revenues from other sources of respondents who adopted SCTs were insignificantly higher than the income of non-adopters. Accordingly, the money spent on inputs was also low in both groups. The distance between the homestead and the arable land of the farmers was below 5km in most cases. It insignificantly differed between the group E and adopters and C and noniadopters, respectively.

Awareness of Environmental Problems and Perception of the Impact of Other Factors Influencing Agricultural Production

The majority of all respondents in group E were generally aware of environmental problems due to the training sessions they attended (Table 3). This differed significantly from group C, which recognized similar problems only to a small extent. Among adopters, the awareness was much higher than among non-adopters. The former identified soil erosion, other factors, such as soil fertility decline and bush fire, or deforestation as these problems. They also stated that sheet erosion was the prevailing type of erosion in the area, followed by rill erosion, but its intensity was generally low or moderate. As only 5% of the non-adopters regarded soil erosion as an environmental problem, most of them did not differentiate any erosion type or degree of erosion intensity. Only one farmer in group C stated that sheet erosion of low intensity existed in Akoda.

The farmers were also asked about the general influence of other factors on agricultural productivity, from which the most important are presented in Table 3. Many of the respondents in group E and C stated that pest and diseases have a very high or high impact on the production. Similar answers were given by all farmers interviewed concerning economical and infrastructural issues. Most of them regarded

Table 3. Awareness of environmental problems and perception of factors influencing the agricultural production of group E (roman text: all respondents, italic: non-adopters (NA) and adopters (A) of SCTs) and group C

	Group E			Group C
Subject	All (n = 40) (%)	*NA (n = 22) (%)*	*A (n = 18) (%)*	(n = 20) (%)
Awareness of environmental problems				
No	37.5	*63.6*	*5.6*	80.0
Yes	62.5	*36.4*	*94.4*	20.0
Type of environmental problems				
Not applicable	35.0	*59.1*	*5.6*	80.0
Deforestation	10.0	*13.6*	*5.6*	
Soil erosion	42.5	*4.5*	*88.9*	5.0
Other	12.5	*22.7*		15.0
Type of erosion				
Not applicable	57.5	*95.5*	*11.1*	95.0
Sheet erosion	30.0		*66.7*	5.0
Rill erosion	12.5	*4.5*	*22.2*	
Intensity of erosion				
Not applicable	55.0	*90.9*	*11.1*	95.0
Low	37.5	*9.1*	*72.2*	5.0
Moderate	7.5		*16.7*	
Impact of pest + diseases on agricultural productivity				
Not at all				
Small	25.0	*31.8*	*16.7*	30.0
Medium	22.5	*13.6*	*33.3*	25.0
High	20.0	*22.7*	*16.7*	35.0
Very high	32.5	*31.8*	*33.3*	10.0
Impact of inadequate farm inputs/equipment on agricultural productivity				
Not at all	12.5	*13.6*	*11.1*	15.0
Small	10.0		*22.2*	25.0
Medium	20.0	*22.7*	*16.7*	15.0
High	50.0	*50.0*	*50.0*	45.0
Very high	7.5	*13.6*		
Impact of poor access to markets on agricultural productivity				
Not at all	12.5	*13.6*	*11.1*	
Small	5.0	*9.1*	*22.2*	10.0
Medium	20.0	*13.6*	*61.1*	35.0
High	52.5	*50.0*	*5.6*	55.0
Very high	10.0	*13.6*		
Impact of few economic resources on agricultural productivity				
Not at all	5.0	*9.1*	*11.1*	5.0
Small	10.0	*18.2*	*11.1*	10.0
Medium	15.0	*63.6*	*11.1*	10.0
High	65.0	*9.1*	*66.7*	30.0
Very high	5.0	*9.1*		

inadequate farm inputs, poor access to markets and small economic resources as factors with a high impact on the production rate. The factors irregular rainfall, low soil fertility, soil erosion, as well as inadequate farmland, and unfavourable land tenure system were not regarded as factors seriously reducing crop yields.

Awareness and Adoption of Technologies Focusing on Soil Conservation

Awareness of SCTs. All respondents of the survey made in group E knew several SCTs, including mulching, cover cropping, fallowing, intercropping, agroforestry, contour tillage and cut-off drainage (locally called water-way). The majority of farmers in group E significantly knew more technologies for conserving the soil of their farmland than respondents of Akoda located nearby (Table 4). This indicates that the training by RUDEP obviously increased the knowledge of the farmers in Esa Oke, Elwure and Owode Ede, as the participants of group C were less aware of these issues. And it also shows that dissemination of information on improved technologies is very low in rural areas when the project work focuses on a limited number of study sites. The knowledge of adopters was generally more comprehensive than that of non-adopters but without significance. The major sources of information were the ancestors, schools and RUDEP. Most of the respondents regarded mulching and crop management, and many farmers saw contour tillage, as indigenous practices, as they had known these technologies for decades. They also stated that tree plantation, the use of mulch and cover crops and contour farming were abandoned in the past and disseminated again as on-farm soil erosion control technologies through RUDEP. This shows the importance of agricultural agencies to rediscover traditional measures usually practised in the region. Cut-off drainage was a measure that was taught at schools and distributed by the extension agency, as most of the respondents had worked on it in the last three to seven years.

Adoption of SCTs. Less than half of the farmers in group E adopted the following SCTs to a deceasing extent: contour tillage (94%); cut-off drainage (22%); cover cropping (17%); and mulching (6%). Most of the adopters practised one measure and only a few adopted two or three technologies at the same time (Table 4). The level of adoption, as expressed in the continuation of a new technology, was generally low. Most farmers started using SCTs for the first time, even though training on soil conservation had already began in 2002. A minority of adopters completed and maintained the installed measures, and some rejected the technologies after implementation. Bodnar and De Graaff (2003) described comparable results from a survey on the adoption of soil and water conservation measures in Southern Mali. The acceptance of soil conservation apparently required some time, as some years passed before farmers practised it continuously. The head of the family usually selected the site for installing the SCT and chose the type of technology. The family members and hired labourers prepared the field and established and maintained the measure. The study also revealed that female farmers adopted less erosion control measures than male farmers. A similar observation was also made by Franzel (1999), who explained this with the fact that dissemination mechanisms of new technologies are often biased towards males. Cut-off drainage, cover cropping and mulching were performed only on areas that were smaller than one hectare, whereas ridging across

Table 4. Awareness and adoption of erosion control measures of group E (roman text: all respondents, italic: non-adopters (NA) and adopters (A) of SCTs) and group C

Subject	Group E			Group C
	All (n = 40) (%)	*NA (n = 22) (%)*	*A (n = 18) (%)*	(n = 20) (%)
Number of SCTs aware				
0				55.0
1	37.5	*59.1*	*11.1*	35.0
2	30.0	*13.6*	*50.0*	5.0
3	22.5	*13.6*	*33.3*	5.0
4	7.5	*13.6*		
≥5	2.5		*5.6*	
Number of SCTs adopted after training				
0	55.0	*100.0*	*77.8*	–
1	35.0		*11.1*	–
2	5.0		*11.1*	–
3	5.0			–
Level of adoption				
No installation	55.0	*100.0*		–
First installation	15.0		*33.3*	–
Installation completed	2.5		*5.6*	–
Installation rejected	22.5		*50.0*	–
Installation maintained	5.0		*11.1*	–
Time of continuous adoption (yr)				
<5	85.0	*100.0*	*66.7*	–
5–10	2.5		*5.6*	–
>10	12.5		*27.8*	–
Distance farm-installed SCTs (km)				
<1	50.0	*54.5*	*44.4*	–
1–4	45.0	*45.5*	*44.4*	–
>4	5.0	*0.0*	*11.1*	–
Size for land covered with SCTs (ha)				
<2	80.0	*100.0*	*55.6*	–
2–3.5	12.5		*27.8*	–
>3.5	7.5		*16.7*	–

Note: Independent t-test: *Group E and C:* A significant difference was determined between the means of the number of SCTs aware (E: 2.1, C: 0.6) at 0.001 level. *Nonadopters and adopters:* A significant difference was determined between the means of the number of SCTs adopted after training (NA: 0.0, A: 1.3), time of continuous adoption (NA: 0.0, A: 10.0), and size of land covered with SCTs (NA: 0.0, A: 19) at 0.001 level.

the slope was done to a larger extent. The farmers might reduce any risk at the beginning by testing SCTs on relatively small areas. In general, many farmers interviewed in group E did not adopt any conservation measures despite training. One reason for this low rate might be the fact that sheet erosion was not regarded as a serious problem and therefore not worth being combated. Anyanwu (1996) also found that farmers generally considered sheet erosion less serious than rill and gully erosion, as it was less obvious in the field.

Table 5. Farmers' assessment of SCTs adopted (– low, + high, ++ very high)

SCT adopted	Labour demand	Costs	Complexity	Compatibility	Equipment availability	Additional benefits
Mulching	–	–	–	+	++	+
Cover cropping	–	–	–	++	++	+
Contour tillage	–	–	–	++	++	++
Cut-off drainage	++	+	+	–	–	+

Farmers' Assessment of SCTs adopted. In group E, the respondents were asked to assess the SCTs practised on the basis of labour demands, costs, complexity, compatibility with the existing farming systems, availability of equipment, and to give their impression of additional benefits (Table 5). Mulching and cover cropping were mostly regarded as not labour-intensive, highly cost-effective, compatible and easy and cheap to adopt. The farmers had a positive impression of the effectiveness as erosion control measures and also mentioned additional advantages, such as the increased soil fertility from the decomposition of organic material and the release of nutrients. A disadvantage of mulching was seen in the amount of grass required, the main material used as mulch in the area. Farmers recognized the value of cover crops as additional sources of food for man and animal. But they also saw these crops as competitors for soil nutrients and as providing shelter for insects, pests and diseases which might be transmitted to the main crops. Some farmers also mentioned that cover crops overgrow the main crops and could decrease the yield. Contour tillage was accepted as a compatible methodology that was easy and cheap to adopt and to practice, as the equipment, a common hoe, was available. Respondents also installed cut-off drainage on the fields to get rid of surplus water, but many of them regarded this SCT as highly labour-intensive, time-consuming, tedious and costly as hired labourers had to maintain the channels regularly. Spades, the main tools for establishing and maintaining the drainage, are often not available. The interviews also showed that women regarded this technology as not gender sensitive, since preparing the soil with tools generally belongs to the work domain of male farmers. Another issue that reduces the adoption of this erosion control measure is its low compatibility with the culture. Digging holes was associated with burying the dead and was believed to lead gradually to the deaths in the community without a cause until the holes were closed. Hence, farmers who practised cut-off drainage were compelled by others to abandon the method.

These results are comparable with research on factors influencing the adoption of technologies in other African locations. For instance, Muhr et al. (2001) studied the acceptability of forage legumes in Oyo State, Nigeria, and found that ease of establishing the innovation was important to local farmers. Obeta and Nwagbo (1991) explained the preference for less complex technologies by the general low level of education among farmers. Mandiringana et al. (2006) investigated the acceptance of conservation tillage in South Africa and recorded that high labour input requirements generally reduce the adoption rate of techniques, even if their potential for soil and water conservation was high. The importance of labour demand for the acceptance of an innovation also was stressed by Degrande (2001), who analysed agroforestry-based technologies for soil fertility improvement in the humid forest

areas of Cameroon. Also, the great relevance of compatibility with the existing farming system is mentioned by Nweke and Akerhe (1983), the importance of cultural acceptance by Franzel (1999), and the availability of equipment required for performing soil conservation by Bodnar and De Graaff (2003).

Farmers' Attitude towards Soil Conservation

Willingness to Persevere with Technologies. The farmers in group E were asked about their willingness to expand the area covered with SCTs on their farms. Most adopters were interested and gave reasons, such as preventing erosion and soil fertility loss and conserving water. The ease of use and low costs of the favoured measures and their effectiveness were other reasons for expanding their application. Contour tillage was the favoured technique, followed by cover cropping, but the area covered with cut-off drainage would be expanded only by a few farmers. Most of the non-adopters rejected the idea of increasing the size of farm land covered with SCTs and mentioned their inapplicability. But a majority in both groups showed an interest in participating in further projects on soil conservation, even if the purposes were different. Adopters primarily had more interest in increasing the farm productivity and income; non-adopters first thought of income increase and erosion control. Contributing to the costs of further soil-conserving projects was seen in different ways. Most of the adopters agreed to provide their own financial support and would take over the half or all of the costs, whereas 59% of the non-adopters agreed on this issue and would pay half of the costs or less.

Responsibility for Performance. The survey also included some questions about responsibility to react to erosion damage. All farmers interviewed agreed that every land user should be worried about soil loss in his own field, and more than 80% of both groups allocated the responsibility to a farmer when he caused damage to his neighbour's land. Hence, the respondents concluded that land users had the moral obligation to conserve the soil. The role of the government was discussed in addition. All farmers in the survey agreed that the government did not pay enough attention to the seriousness of erosion on farmland in the region.

Suggestions for Future Improvements. The farmers in group E were trained on SCTs by attending meetings and by providing labour. The questionnaire offered the opportunity to suggest ways to improve the adoption of innovations. Many adopters preferred more inputs, more encouragement, an increase in farmers' participation, and more involvement by the village head. Many of the non-adopters primarily preferred an increase in awareness of soil erosion and encouragement for its control. Other ideas included the installation of more demonstration plots at several locations, regular visits by extension agents, more financial support and the organization of more workshops. Franzel (1999) also regarded farmers' demand for more participation to increase the acceptance of innovations. Enyong et al. (1999), who investigated the adoption of soil fertility-enhancing technologies in Burkina Faso, Mali, and Niger, also stated that introducing new technologies requires the involvement of the government and the local community leaders to highlight the importance of the project. Frequent contact with extension agents and

regular field visits was mentioned by Vissoh et al. (1997) as a key strategy for disseminating technologies.

Influence of Personal and Socio-Economic Characteristics on the Adoption Behaviour

Correlation Between Personal and Socio-Economic Characteristics of the Respondents and the Adoption of SCTs. Elder farmers apparently accept new technologies less frequently than the younger ones, as the correlation between the age and the number of SCTs adopted is negative (Table 6). Obeta and Nwagbo (1991) and Kristjanson et al. (2005) recorded comparable results from their studies on the adoption of improved cassava technologies and cowpea varieties introduced in eastern and northern Nigeria. This phenomenon is explained as a common behaviour of human beings who are generally more flexible and adventurous when young. Another reason might be the high number of elderly people interviewed within this study. They dominate the villages due to the prevailing rural—urban migration of the youth. Many young people noted for agricultural work have left the villages in the study area for the city, where they can earn quick money, for example, by investing in an *okada*, a motorbike taxi (Omodara and Alff, 2006). The awareness of appropriate measures and the number of memberships in social organizations significantly increases the adoption of SCTs. Meetings probably improve the exchange of information on innovations among farmers, emphasize advantages and minimize doubts (Obeta and Nwagbo 1991). The positive but negligible correlation between the farm size and the adoption of SCTs might indicate that the larger the size, the earlier the farmer tends to adopt new practices, as observed by Osinem (1996). The availability of more farm land makes it possible for land users to test innovations without compromising the usual crop production. Farmers with larger households obviously adopted less SCTs, probably to avoid the risk of an eventually reduced income for feeding and supporting their dependants. This result is unexpected, as it is known that family members primarily perform the field work to save extra costs for labour, and that farmers with large families generally tend to adopt innovations earlier than heads of smaller families (Obeta and Nwagbo 1991). An explanation might be the prevailing number of elderly and retired relatives in the families in group E who are less or no longer productive, and hence oblige the family head to be less interested in

Table 6. Correlation between personal and socio-economic characteristics of the respondents and the number of SCTs adopted

Characteristics	R_S
Age (yr)	−0.081
Experience in farming (yr)	0.079
Awareness of SCTs (no)	0.319*
Membership in social organisations (no)	0.396*
Farm size (ha)	0.008
Household size (no)	−0.004
Labourer assisting on the farm (no)	0.363*
Income from farming (US$)	0.000
Income from other sources (US$)	0.121
Total annual income (US$)	0.061

Note: n = 40, * significant at 0.05 level.

experiments. By contrast, the general availability of labourers is obviously a more important factor influencing the decision of farmers than the family size, as the correlation between the number of people assisting on the farm and the adoption of SCTs is positive and significant. Ajayi et al. (2003) recorded a comparable result, which is somewhat unexpected, as hiring labourers causes additional costs. Wealth is another important factor positively influencing the adoption rate. The study showed that farmers with increased income spend more money on new measures and can afford the needed number of hired labourers for installing and maintaining new measures on the field. Daramola (1989) who investigated fertilizer adoption decisions in Oyo State, Nigeria, and Kristijanson et al. (2005) also mentioned the relevance of this economic factor for the adoption of new technologies. Wealthy farmers are also generally known for being less timid about taking risks (Franzel 1999).

Relationship between Personal and Socio-economic Characteristics, Attitude of Respondents and Adoption of SCTs. Further analyses of the adoption behaviour have shown that the level of farmers' education is positively related to the adoption of SCTs (Table 7). The better education among adopters might have influenced their positive disposition towards soil conservation, as literates are usually more experienced than illiterates and aware about the significance of new technologies to livelihood (Voh 1982). Training on soil conservation, membership in agricultural associations and frequent contact by farmers with extension agents also increase the adoption rate of technologies, as they are more informed about new measures and can discuss advantages and possible disadvantages (Obeta and Nwagbo 1991). Njoku (1991), who worked on the adoption of improved oil palm production technologies in Imo State, Nigeria, and Adesina and Chianu (2002), who investigated the acceptance of alley farming in the country, recorded similar results and emphasized the importance of a high intensity of extension contact for technology transfer. Minor occupations of farmers, such as trading or tailoring beside the farm activities, are positively related to the adoption of SCTs. This may be explained by the increased amount of income from other jobs, which makes it possible for farmers to test a new

Table 7. Relationship between different factors and the adoption index

Factor	Sig.
Level of education	0.218
Training on soil conservation	0.704
Membership in agricultural associations	0.550
Contact with extension agents	0.061
Participation at installation of SCTs during training	0.550
Minor occupations	0.264
Land security	0.455
Extent of travelling	0.764
Frequency of travelling	0.271
Willingness to bear responsibility for soil loss due to erosion	0.391
Willingness to continue soil conservation	0.019*
Willingness to pay for training on SCTs	0.538
Willingness to contribute to costs of further projects on SCTs	0.038*

Note: Chi-square test, n = 18, *significant at 0.05 level.

measure without risking a reduction or loss of the total annual income. The positive relation between land security and the adoption of SCTs might be caused by the fact that farmers generally invest more in farm land when their land tenure is secure (Vissoh et al. 1997). Travelling outside the community and frequent travel seem to increase the adoption rate of SCTs. Farmers visiting other areas might see measures installed in the field or contact farmers who already implemented SCTs, and hence develop new ideas on resource management. Mijindadi and Njoku (1986) also recorded such positive influences on farmers' adoption behaviour from their studies in Kano State, Nigeria. The willingness of land users to contribute to soil conservation is another main factor positively related to the adoption behaviour. Farmers who bear responsibility for soil loss due to erosion invest in its control, and those who are willing to pay for further projects on soil conservation significantly adopt more technologies.

Conclusions and Recommendations

The adoption survey made in Osun State, Nigeria, has shown that farmers trained on soil conservation were more aware of environmental problems and their impact on agricultural production than farmers without any training. Sheet erosion, a common type of soil degradation in the area, was regarded as less serious as recognition of the damages in the field was low. Accordingly, the acceptance of different SCTs was generally low in the study sites. Farmers' prevailing criteria for adopting a technology are easy implementation, low labour demand, low costs, availability of common equipment and compatibility with the existing farming system. The farmers therefore practised mulching, cover cropping and contour tillage, and mostly rejected cut-off drainage. The adopters of SCTs usually had a higher education level and a higher income, employed more labourers and had more contact with extension agents than non-adopters. Thus, improved knowledge and the availability of labourers obviously increased the acceptance of improved technologies. The lessons learnt from this study include the need for increasing the awareness of farmers of the erosion problem and its consequences, as well as improving the farmers' knowledge on soil conservation. Hence, strengthening of training on innovations, frequent contact with extension agents and researchers and decentralization of field trials for disseminating measures are necessary for improving soil conservation in Nigeria.

The results of the survey should be used to improve future adoption of soil conservation technologies in Nigeria. First of all, the awareness of environmental problems including soil loss and its negative influence on agricultural production should be increased among farmers. The earlier erosion is recognized in the field, the easier and more effective its combat will be. Appropriate campaigns through governmental and non-governmental organizations and school lessons might be a possibility.

As knowledge on soil conservation is an important factor influencing the adoption of SCTs, greater emphasis on exposing farmers to new technologies by improved dissemination is needed. Strengthening farmers' training on innovations, frequent contact by farmers with extensionists, as well as membership in agricultural cooperatives as source of information on new technologies are necessary. Decentralization of field work and the involvement of farmers from many villages who serve

as transmitters of information to other farmers are also advisable to enhance the adoption rate of SCTs. This requires sufficient funds to provide transportation of the agents to the villages and equipment for the training sessions. Another approach is strengthening the cooperation between researchers and farmers while investigating erosion and possible solutions. On-farm trials will attract farmers' attention to the problem and improve the development of innovations, as possible impracticability and incompatibility will be recognized and changed at an early stage. And as farmers already know the erosion control measures by assisting in field trials, the period for testing the technologies on their own land will be reduced and the adoption rate increased. To keep farmers from rejecting the SCTs implemented in the field, long-term monitoring and regular evaluation of adopters by field visits of extension agents is another important recommendation.

To meet the increasing demand for food due to the rapidly growing population in Nigeria (146.3 million people, annual growth rate 2.03% [CIA, 2008]), the agricultural production has to be increased, for example, by improved soil conservation. As the adoption of innovations is generally higher among younger farmers than among elder people, it is important to halt the migration of young people to cities and to keep them as farmers in the villages instead. The improvement of living conditions in rural areas, for example, by providing electricity area-wide, the change of the land tenure system or the credit system to facilitate the achievement of land, or the purchasing of appropriate equipment, etc., are some ideas to counteract this problem. Another important issue is to overcome the gender inequality which still exists in rural areas and to encourage more female farmers to adopt new technologies. Possibilities include the increase of the rate of female participants at training sessions, to develop dissemination mechanisms especially biased towards female farmers, or to employ female extensionists for introducing improved measures in addition to male agents.

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