Transfer and adoption of soil and water conservation technologies in the Tolon-Kumbungu District of Northern Region of Ghana

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ABSTRACT

A descriptive research was carried out to determine the adoption and training needs of arable crop farmers and agricultural extension agents (AEAs) in soil and water conservation technologies in the Tolon-Kumbungu District of the Northern Region of Ghana. The stratified random sampling method, based on the types of crop cultivated by the farmers, was used to select the sample size of 120 respondents. Twenty-eight AEAs were involved in the study, and structured questionnaires and interviews were used as research instrument. The results, which were analyzed quantitatively and qualitatively, indicated that technologies that farmers used mostly were ridging, incorporation of organic matter, mixed cropping, alley cropping, row-crop cultivation, and crop rotation. They used mostly low cost technologies which conformed to the normal farming practices of the district. The most crucial limiting factors for the adoption of soil and water conservation practices included inadequate inputs, inefficient traditional farm tools, inadequate labour, poor land, and insufficient financial resources. The results also showed that AEAs in the Tolon-Kumbungu District generally had less than medium competence in soil and water conservation technologies. Their competencies were relatively low in irrigation, zero tillage, contour bunding, and earth bunding technologies. Generally, they need training in soil and water conservation technologies, particularly in irrigation, zero tillage, contour bunding, and earth bunding.

Research and development note. Received 01 Nov 01; revised 20 Aug 02.

RÉSUMÉ

OKORLEY, E. L., MENSAH, A. O. & AL-HASSAN, I. S.: *Transfert et adoption des technologies de conservation de sol et d'eau dans les districts de Tolon-Kumbungu de la région du nord du Ghana.* Une recherche descriptive se déroulait pour déterminer les besoins d'adoption et de formation des cultivateurs de culture arable et des Vulgarisateurs (Vs) agricoles des technologies de conservation de sol et d'eau dans le district de Tolon-Kumbungu de la région du nord du Ghana. La méthode stratifiée de prélèvement au hasard, basée sur les espèces de culture cultivées par les cultivateurs, était employée pour prélever la dimension d'échantillon de 120 personnes interrogées. Vingt-huit Vs étaient entraînés dans l'étude et les questionnaires et les interviews structurés étaient utilisés comme instrument de recherche. Les résultats quantitativement et qualitativement analysés indiquaient que les technologies que les cultivateurs employaient étaient la construction des crêtes l'incorporation de matière organique, la polyculturé, la culture en allées, la culture en lignes et la rotation des cultures. Les technologies utilisées étaient le plus souvent moins chères et conformaient à leurs pratiques normale de culture du district. Le plus important de facteurs restrictifs pour l'adoption des pratiques de conservation de sol et d'eau comprenaient les facteurs d'intrants inadéquâts, les outils agricoles traditionnels inefficace, l'insuffisance de main-d'œuvre, la terre infertile et l'insuffisance de resources financières. Les résultats révélaient également que les Vs dans le district de Tolon-Kumbungu avaient en général moins que la compétence moyenne dans les technologies de conservation de sol et d'eau. Leurs compétences étaient relativement faible en irrigation, tillage zéro, les technologies de levée de contour et de levée de terre. En général, ils ont besoin de formation en technologies de conservation de sol et d'eau, particulièrement en irrigation, tillage zéro, levée de contour et levée de terre.

Introduction

Agriculture plays an important role in the economy of Ghana. It contributes 45 per cent of gross domestic product (GDP) and employs 70 per cent of the population who are mostly rural folks. It serves as a source of raw material for industry and food for the population. There is the need to re-double efforts at increasing agricultural productivity and production. Low agricultural production, especially in the northern part of the country, has resulted in a high level of poverty among small-scale farmers, and this needs to be addressed in a holistic way. The need to rapidly transform Ghana's agriculture is further underscored by the fact that the population of Ghana is expected to increase from 17.7 million in 1996 to about 36 million by 2020. This may reduce agricultural land availability per capita from 0.77 ha in 1996 to 0.38 ha in 2020. Surely, agriculture will be unable to grow and be sustained if steps are not taken to ensure proper land and water conservation practices in addition to other production and utilization practices. The practice of shifting cultivation cannot continue forever in the Northern Region, because land will become scarce. There is therefore the need to conscientize farmers to begin to learn how to manage soil and water resources under continuous cropping in a sustainable way.

The production of food, fiber, shelter, and to some extent energy for the sustenance of the ever-increasing population and for feeding the agro-based industries depends directly or indirectly on soil and water. Population pressure and the use of inappropriate soil and crop management techniques in producing the basic necessities of life are causing serious accelerated soil erosion, a major factor responsible for the loss of soil productivity (FAO, 1965). This can substantially constrain agricultural productivity, which is the cornerstone for the socio-economic development of Ghana (Bonsu & Quansah, 1992). The Tolon-Kumbungu District is among the first three districts described as having the severest soil erosion and land degradation in the Northern Region of Ghana. Consequently, food production has diminished over the years due to declining soil fertility (Land and Water Management Project, 1995).

Effective soil and water conservation practices essentially promote land use systems which retain a permanent vegetative cover over the land surface. This protects the soil from wind and water erosion, improves the organic matter content of the soil, and maximizes water penetration, resulting in improved soil fertility. Food crops grown under such systems inevitably benefit, and farmers realize increased productivity and profit.

Inefficient land clearing either by manual or mechanical means can have an immediate adverse effect on the soil. For example, when trees are cleared from the land a large biomass is removed. Nutrient, hydrologic, and biological cycles are broken. Ultimately, the climate is changed. The soil is exposed to the direct impact of raindrops and erosion becomes severer.

Droughts combine with poor soils to reduce productivity, thereby contributing to food shortages and famine over wide areas. The livelihood of the population is at risk as a result of low agricultural yields, water shortages, frequent flooding, and a shortage of natural resources such as fuel wood and fodder. According to the World Commission on Environment and Development (1987), to ensure global food security, the resource base for food production must be sustained, enhanced, and where it has been diminished or destroyed, restored. In the Northern Region of Ghana, where extremes of weather prevail to adversely affect soil productivity, it is important to promote appropriate soil and water conservation methods to sustain food production.

The overall purpose of the study was to determine the adoption of and training needs of arable crop farmers and local extension agents in soil and water conservation technologies in the Tolon-Kumbungu District of the Northern Region of Ghana.

The specific objectives of the study were as follows:

1. To identify the types of soil and water

conservation technologies transferred by AEAs to farmers in the district.
2. To determine the types of soil and water conservation technologies that farmers have adopted (currently using) in the district.
3. To identify the constraints associated with the adoption of soil and water conservation technologies in the Tolon-Kumbungu District.
4. To determine the competence of AEAs in soil and water conservation technologies available in the district.

Methodology

A descriptive survey was used for the study. Questionnaire and interview schedule were used to collect data. The target group was arable crop farmers in the Tolon-Kumbungu District of the Northern Region. The district , which is located in the central part of the Northern Region, has the characteristics of all the other districts in the Northern Region. The district has a unimodal rainfall pattern which normally begins in May and ends in October. The annual average rainfall is 1000 mm, and the average minimum and maximum temperatures are 25 and 30 °C, respectively. Tolon-Kumbungu District occupies an area of 99000 km^2, and a greater part of it is under arable crop cultivation. The main occupation of the people is farming, with maize, groundnut, vegetables, and cowpea as the common crops. Yam and rice are also grown, but on a smaller scale (MOFA, 1998).

A stratified sampling approach was used to select four towns to reflect the four major crops grown in the district. The towns were selected by the intensity of a particular crop grown there. Based on the proportion of registered farmers in each selected town, 120 were randomly chosen (Table 1).

A validated questionnaire and interview schedule were used to collect data from AEAs and farmers, respectively. The data were analyzed by descriptive statistics including means, percentages, frequencies, and standard deviations.

TABLE 1

Population Sample of Farmers from District Based on Locality and Major Crops Grown

Town	*Crops grown*				
	Maize	*Groundnut*	*Vegetables*	*Cowpea*	*No. of farmers*
Lingbung	-	28	-	-	28
Bontanga	-	-	35	-	35
Chang-naa	-	-	-	25	25
Kumbungu	32	-	-	-	32
No. of farmers	32	28	35	25	120

Results and discussion

Soil and water conservation technologies transferred by AEAs to farmers

The study showed that AEAs transferred all the technologies (Table 2). The most transferred were crop rotation, incorporation of organic matter, windbreaks, and ridging. These were followed by mixed cropping, row-crop cultivation, alley cropping, mulching, and contour planting. The least transferred technologies were earth bunding, strip cropping, contour planting, irrigation, green manuring, spot clearing, and zero tillage.

Soil and water conservation technologies that farmers used in the Tolon-Kumbungu District of Northern Region of Ghana

The study showed that the respondents' usage of the various technologies followed the same pattern as was transferred to them. That is, many of them were using technologies that had been transferred by the AEAs. A Spearman's Rank Correlation showed a positive relationship between the kinds of technologies transferred and the kinds of technologies used by farmers.

Table 3 indicates that farmers mostly used ridging, incorporation of organic matter, and mixed cropping. The possible reasons for the use of these technologies could be that the technologies could be easily integrated into their farming

TABLE 2

Technologies in Soil and Water Conservation Practices AEAs Transferred to Farmers (n=28)

Technology	*Frequency of AEAs who claimed to have taught farmers*	*%*
Crop rotation	28	100.0
Incorporation of organic matter	26	92.9
Windbreaks	26	92.9
Ridging	26	92.9
Mixed cropping	24	85.7
Row-crop cultivation	24	85.7
Alley cropping	20	76.9
Mulching	20	71.4
Cover cropping	20	71.4
Contour planting	18	64.3
Earth bunding	12	42.9
Strip cropping	10	35.7
Contour bunding	8	28.6
Irrigation	8	28.6
Green manuring	4	14.3
Spot clearing	4	14.3
Zero tillage	2	7.1

Source: Survey Data, 2000

TABLE 3

Soil and Water Conservation Technologies Used by Farmers (n =120)

Technologies	*Frequency of farmers who are aware and using a technology*	*%*
Ridging	118	98
Incorporation of organic matter	108	90
Mixed cropping	101	84
Row-crop cultivation	89	74
Crop rotation	89	74
Mulching	62	52
Alley cropping	62	52
Windbreaks	62	52
Earth bunding	41	34
Irrigation	31	26
Green manuring	22	18
Zero tillage	17	14
Spot clearing	14	12
Cover cropping	14	12
Contour bunding	7	6
Contour planting	7	6
Strip cropping	2	2

Source: Survey Data, 2000

practices, and were also less expensive. These were followed by crop rotation, mulching, alley cropping, windbreaks, and earth bunding. Alley cropping and windbreaks were reported to disturb farmers' farm operations by shading their crops. Mulching was observed to harbour insects, pests, and weeds. These were technologies that were used by 52 per cent of the farmers, despite their low input requirements.

Many farmers did not use zero tillage because it was considered to be capital intensive. This technology, according to them, required much technical skill and capital which farmers did not have. Spot clearing, cover cropping, contour bunding, contour planting, and strip cropping also recorded low adoption because less than 43 per cent of AEAs (average of 22.3) communicated those technologies to farmers. The AEAs had very low competencies in these technologies. Moreover, the technologies were not common or indigenous to the farmers.

The study showed clearly that technologies that did not demand relatively high technical skills and high capital inputs were used very highly, while the usage of those that required high technical skills and high capital inputs was very low.

It was also noted that most of the AEAs lacked competence in these less-used soil and water conservation technologies (Table 4).

Factors that constrained the adoption of soil and water conservation technologies in the Tolon-Kumbungu District

Constraints associated with technologies like irrigation, earth bunding, green manuring, and zero tillage were inadequate capital (money), difficulty in their use (tedious), and high operational cost. Constraints associated with technologies like mulching, crop rotation, alley cropping, and wind breaks were unfavourable land acquisition procedures, high demand for time and space, shading of food crops, and harbouring of reptiles and weeds. The use of cover cropping and mulching also tends to disrupt work on the field, as some of them spread or trail to cover crops or portions of the field.

Other constraints were that the farmers had no idea of some of the technologies, and some were inapplicable in their operational areas. These technologies were spot clearing, contour bunding, contour planting, and strip cropping. The study showed that farmers lacked information and ideas in those technologies which had no applicability in their locality, and were not communicated to them by AEAs. The study showed that over 78 per cent of the farmers mentioned inadequate labour, land, and lack of adequate working inputs like cutlasses, watering cans, and shears as crucial limiting factors.

According to CIMMYT (1993), the availability of material resources may influence farmers' ability to adopt technology. If inputs needed for a technology are unavailable, the technology may be rejected. FAO (1994) also noted that lack of

TABLE 4

Specific Training Needs of AEAs in Soil and Water Conservation Practices (n=28)

Training needs in technology	*Competency needed (mean)*	*Competency possessed (mean)*	*AEAs who had transferred the technology to farmers [freq. (%)]*
Irrigation	4.31	2.29	8 (28.6)
Zero tillage	3.92	1.93	2 (7.1)
Contour bunding	3.77	2.50	8 (28.6)
Earth bunding	3.77	2.36	12 (42.9)
Strip cropping	3.46	2.36	10 (35.7)
Green manuring	3.38	2.36	4 (14.3)
Cover cropping	3.31	2.86	20 (71.4)
Alley cropping	3.31	2.86	20 (71.4)
Contour planting	3.15	2.64	18 (64.3)
Spot clearing	3.08	2.79	4 (14.3)
Windbreaks	2.92	3.22	26 (92.9)
Ridging	2.85	3.64	26 (92.9)
Row-crop cultivation	2.77	3.36	24 (85.7)
Mulching	2.77	3.43	20 (71.4)
Crop rotation	2.70	3.57	28 (100)
Incorporation of organic matter	2.54	3.64	26 (92.9)
Mixed cropping	2.38	3.64	24 (85.7)
Overall	3.25	2.84	

NB. *Scale: 1 = very low; 2 = Low; 3 = Medium; 4 = High; 5 = very high
Source: Survey Data, 2000

materials might make it difficult for farmers to adopt recommended technologies. The results of the study also indicated that the farmers needed capital to enable them overcome some of the constraints. Another major constraint was time spent in conserving the soil and water. The farmers believe too much of their limited time is spent in conserving the soil and water. They think they need more time for their crops. The farmers also complained that they face the problem of crop shading when they use technologies such as alley cropping and cover cropping.

Other equally important constraints identified were that some of the technologies were too expensive, and most of the farmers mentioned irrigation as an example. Some innovations such as cover cropping and alley cropping are traditionally incompatible with farmers' farming systems because of their shading effect on crops. Farmers also viewed technologies with long gestation periods, but long lasting benefits, e.g. alley-cropping (agro-forestry), as time consuming and waste of resources.

Competencies of AEAs in specific knowledge and skill in soil and water conservation technologies

The results show that the Agricultural Extension Agents have an enormous task at hand if they are to make any meaningful impact on the lives of farmers and also improve on their own skills in soil and water conservation practices.

From the results (Table 4), the overall mean value for the AEAs competencies was 2.84, indicating that AEAs in the Tolon-Kumbungu District of the Northern Region of Ghana fell below medium competence in overall knowledge and skills in soil and water conservation technologies. However, they showed more than medium level of competence in the following technologies: ridging, incorporation of organic material, and mixed cropping.

The highest mean competency possessed by AEAs was 3.64 and the average was 2.84. The results indicated the overall competence of AEAs in soil and water conservation technologies to be below medium. It was particularly low in technologies such as zero tillage, contour bunding, contour planting, and irrigation. The AEAs confirmed this by expressing a greater need for the technologies in which their competencies were low.

The results indicated that many AEAs had transferred technologies in which they perceived their competencies to be higher. This suggests that the adoption of soil and water conservation technologies can be improved in the Tolon-Kumbungu District if AEAs are given adequate training in soil and water conservation technologies in areas where their competencies are low. They should be supported to communicate these technologies to farmers through appropriate training programmes.

Conclusion

Farmers in the Tolon-Kumbungu District mostly use ridging, incorporation of organic matter, mixed cropping, row-crop cultivation, and crop rotation as soil and water conservation measures. Technologies used are those which are perceived to be less costly, and are easily integrated into their farming system.

The major factors limiting the adoption of soil and water conservation practices, according to the farmers, were inadequate inputs, labour, land, and financial resources. AEAs in the Tolon-Kumbungu District are generally low in competence in soil and water conservation technologies, especially in irrigation, zero tillage, contour bunding, and earth bunding. There is the need to train AEAs and farmers in these areas for effective soil and water conservation practice. The requisite schemes could be integrated into the on-going regular training in land water management. The inclusion of on-the-job training and farmer field schools in such programming would be beneficial to farmers.

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