SUSTAINABLE LAND RESOURCE MANAGEMENT WITH AGROFORESTRY: EMPIRICAL EVIDENCE FROM THE SUNYANI WEST DISTRICT OF GHANA, WEST AFRICA

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Abstract

The concept of enhancing economic assets on community farms in order to maintain Sustainable Land Resource Management via the adoption of agroforestry land-use systems has not been tested widely in the Sub-Saharan African Countries. The end line survey revealed that households practicing various agroforestry technologies (AT) increased from 53.4% in 2007 to 155% in 2013. Top four AT that were adopted by the communities are farmland planting, livestock rearing, household plantings and fruit tree production. Results also suggested that a number of socio-economic factors such as age, primary occupation, skill training, material support / incentives, membership to livelihood groups, number of farmlands and access to extension services all significantly influenced the adoption of AT. The land-use land cove change map within the project catchment indicated that in the coming years there could be an increase in food availability, accessibility and utilization; the three pillars of food security.

Keywords: agroforestry technologies, land-use change, food security, Ghana, Sub-Saharan Africa

Introduction

Agroforestry is a recognized strategy for addressing sustainable management and development of the natural-resource base of rural communities. Agroforestry systems may be defined as land-use systems in which woody perennials (trees, shrubs, palms, and bamboos) are deliberately used on the same land management unit as agricultural crops (woody or annual), animals or both, in some form of spatial arrangement or temporal sequence (Huxley and Van Houten 1997). Agroforestry is considered a sustainable development model throughout the world due to benefits they bring not only to the economy and society but also to the ecosystem (Thanh et al. 2005).

However, the concept of enhancing potential economic value or assets on community farms in order to maintain Sustainable Land Resource Management (SLRM) via the adoption of agroforestry land-use systems has not been tested widely in the Sub-Saharan African Countries (SSA). Environmental goals alone do not result in sustainable land-use adoptions in SSA countries unless sustainable land-use systems also provide economic returns or build assets in the respective small-holder farms. In this context, in 2007, a Canadian government funded project entitled, “Agroforestry Practices to Enhance Resource-poor Livelihoods (APERL)” led to the introduction of various agroforestry technologies in six communities of Sunyani West in the Brong Ahafo Region of Ghana in furtherance of Ghana’s Growth and Poverty Reduction Strategy. The adoption of agroforestry practices were expected to reduce land degradation and reduce forest fire susceptibility in the six farming communities (Kwamekrakrom, Adoe, Ayakomaso, Mantukwa, Dumasua and Fiapre), while enhancing property assets in the respective small-holder farms. No studies have been carried out to-date to verify this hypothesis. In this abstract, we discuss how evidence from the communities support agroforestry land-use as a viable technology to achieving SLRM. In order to achieve the above, we (1) assessed farmers' awareness and adoption of agroforestry; and (2) related adoption of agroforestry to reduced forest degradation and forest fire susceptibility in the six APERL implementation sites.

Materials and methods

The selection of study sites

The six selected communities fall within the dry semi-deciduous forest zone of Ghana. With a bimodal rainfall pattern (ranging between 1000 mm – 1500 mm), the area also experiences a short dry season in August and the mean annual temperature and humidity are about 24 ^{o}C and 68%, respectively.

GIS analysis and socio-economic surveys

In order to assess land cover change, the following steps were executed: 1. use of GIS and remote sensing technologies to identify areas / communities of forest degradation and forest fire risk, 2. introduction of various agroforestry technologies to communities, 3. final assessment of change in forest cover and forest fire susceptibility using GIS and remote sensing technologies. A baseline socio-economic survey using questionnaires and focus group discussions was conducted in 2008 in the selected communities. In 2013, a final socio-economic survey was conducted using a sample size of 1475 households (one respondent per household; 1475 households) with questions consistent with the initial baseline survey to determine the overall impact of the introduced agroforestry technologies. The survey assessed the awareness and adoption potential of the introduced agroforestry technologies among farmers in the project catchment area. Satellite Images of 2013 were also acquired and classified using the same classification scheme developed for the baseline Land-use Land Cover (LULC) map (Figure 1). Post-classification analysis method of change detection was used to determine changes in LULC classes. Land cover change was detected as a change in land cover between the two image dates based on the independent true land cover classification, which was achieved by supervised classification.

The Statistical Package for Social Sciences (SPSS) was used to analyze data and to generate the relevant information that could best describe the socio-economic profile and other characteristics of the communities.

Results and discussion

Two criteria, "able to remember" and "describe the technology", were used to assess farmers' awareness of agroforestry. A farmer was therefore regarded as being aware of an agroforestry technology when they were at least able to remember the technology and describe it. Farmers' awareness of introduced agroforestry technologies in the study area increased from 26% to 90% by the close of the project in 2013 with about 76% practicing the technologies. Households were classified to have adopted the agroforestry technologies if they were practicing any of the introduced technologies: boundary planting; planting N-fixing species in fields; fruit tree production; woodlot; taungya; alley cropping; alley farming; proka (slashing without burning); biomass transfer (fodder); household planting; farmland planting and livestock keeping. The end line survey revealed that households practicing various agroforestry technologies increased from 53.4% in 2007 to 155% in 2013 (Table 1). Top four agroforestry technologies that were adopted by the communities are farmland planting, livestock rearing, household plantings and fruit tree production (Table 1).

Table 1: Households practicing various agroforestry technologies, Sunyani west district, Ghana.

AF Technologies	Number of households (N = 1475)			
	Before APERL	Percentage	After APERL	Percentage
Boundary planting	41	2.8	124	8.4
Planting N-fixing species in fields	25	1.7	93	6.3
Fruit tree production	20	1.4	129	8.7
Woodlot	10	0.7	48	3.3
Taungya	21	1.4	54	3.7
Alley Cropping	84	5.7	108	7.3
Alley Farming	64	4.3	93	6.3
Proka	41	2.8	52	3.5
Biomass transfer	6	0.4	15	1.0
Household planting	34	2.3	316	21.4
Farmland planting	317	21.5	785	53.2
Livestock rearing	125	8.5	469	31.8

Adoption of the agroforestry technologies was measured against the following parameters: awareness of the technologies, age, sex (gender), educational level, social status, primary occupation, availability of market, membership to livelihood groups created by the project and number of farmlands. Tested parameters such as age, membership in local livelihood groups, skill training, material support, number of arable farmlands, size of farmland, main occupation that contributed to household income and access to agricultural extension services had significant effects on the likelihood of adoption of introduced agroforestry technologies (Table 2).

Table 2. Factors influncing the adoption of technologies, Sunyani west district, Ghana.

Factors of adoption	Chi^2	df	P value	Phi/Cramer's V
Age	21.974	9	0.009*	0.122
Sex	0.06	1	0.806	-0.008
Educational Level	14.439	8	0.071	0.099
Place of Origin	3.564	4	0.468	0.05
Awareness of AF Technologies	0.002	1	0.962	0.003
Ready Market	0.547	1	0.460	-0.022
Membership to Livelihood group	232.294	1	0.000*	0.413
Skill Training	10.442	1	0.001*	0.086
Material Support/Inputs	298.226	1	0.000*	0.479
Female Headed Household	1.436	1	0.231	0.034
Primary Occupation	63.627	8	0.000*	0.330
Number of farmlands	12.043	4	0.017*	0.791
Land Tenure Arrangement	9.015	8	0.341	0.084
Size of farmland	11.564	5	0.041*	0.077
Access to Agricultural Extension Services	23.89	4	0.000*	0.145

*means significant at $p \leq 0.05$

Local livelihood groups served as the main source of information and thereby increased awareness of the introduced agroforestry technologies. Community livelihood groups also offered effective communication channels on the long term benefits of agroforestry technologies. Among the households tested (n =1475), 70.8% belonged to livelihood groups and were practicing agroforestry technologies. This is in agreement with Parwada et al. (2010) who reported that the likelihood to adopt agroforestry technologies is influenced by the membership in a livelihood group as these groups serve as source of information on introduced agroforestry technologies.

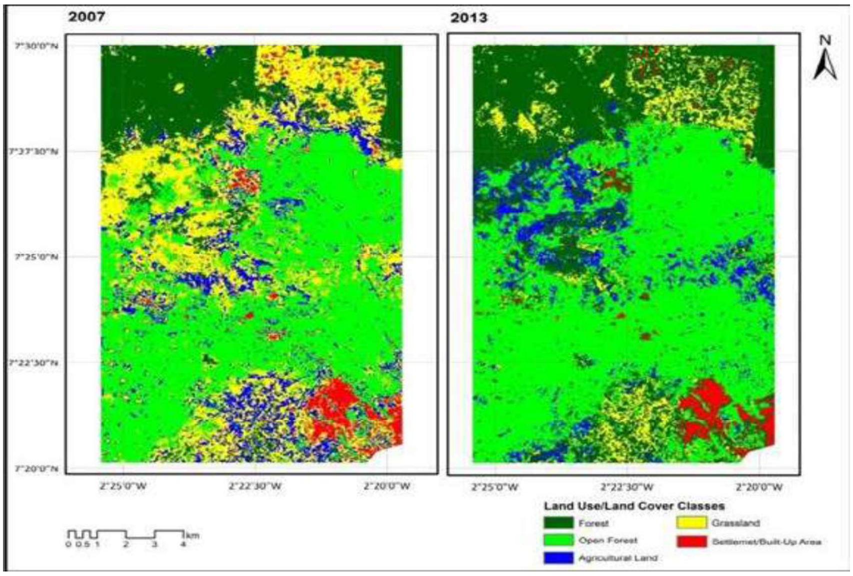

Figure 1: Classification of LULC map in 2007 before the APERL project interventions and a LULC map in 2013, after the project interventions.

The land use land cover classification for 2007 from MSS satellite image showed that majority of the study area was under open Forest and Grassland, accounting for 7861.41 ha (41.21%) and 5047.47 ha (26.49%), respectively. Closed Forest, Agricultural land and Built-up area amounted to about 3375.54 ha (17.71%), 2195.46 ha (11.52%) and 575.78 ha (3.02%), respectively. The land use land cover classification for 2013 from TM satellite image showed open Forest, closed Forest and Agricultural land accounting for 8037.96 ha (42.18%), 4202.22 ha (22.05%) and 4224.9 ha (22.17%), respectively, while Grass land and Built-up area amounted to about 1819.99 ha (9.55%) and 770.59 ha (4.04%), respectively. The slight improvement in forest cover may be due to the significant reduction ($p<0.05$) in forest fire within the project catchment from 40 forest fire occurrences per year in 2007 to one in 2013. The second possible reason for the increase in forest cover is the increase in adoption of the introduced agroforestry technologies thereby contributing to enhanced environmental sustainability. Many studies around the world have shown enhanced environmental sustainability through the adoption of agroforestry technologies. For example, FAO in 2013 recommended that all Sub-Saharan African Countries (SSAC) should incorporate agroforestry land-use into their national agricultural policy in order to derive food and income securities and environmental stability in the respective SSACs. According to Hoekstra (1983), the adoption of agroforestry has the potential to halt land degradation, improve soil fertility and solve fodder problems among smallholder farmers. Adoption of agroforestry provides an alternative means of addressing land degradation since it offers opportunities for improving the quality of life of resource poor farmers, from products derived from these systems, while ensuring the sustainability of the natural resources base and the environment (Parwada et al. 2010).

Conclusion

Results from this study demonstrate that a number of socio-economic factors that hinder wider adoption of agroforestry land-use among smallholder farmers need to be addressed appropriately. To induce adoption among farming households, there is the need to use existing community livelihood groups or form active livelihood groups for each agroforestry initiative and also enhance networking amidst these groups. From the trend and dynamics of LULC change within the project catchment, it is obvious that in the coming years we will see a substantial increase in food availability, accessibility and utilization; the three pillars of food security.

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