IMPACTS OF AGROFORESTRY TECHNOLOGIES ON WATERSHED MANAGEMENT IN IMO STATE, SOUTHEASTERN NIGERIA

Ekwugha, U. E.

ABSTRACT

Department of Forestry and Wildlife Technology, Federal University of Technology, Owerri, Nigeria. E-mail: uggold2005@yahoo.com; Phone: +234(0)8037102357

This paper examined the effects of agroforestry technologies on watershed management in Imo State. A multi-stage sampling technique was adopted for the study. From each of the three agro-ecological zones of Imo State, communities, where farming activities were carried out along watersheds, were chosen for the study. A proportional allocation of the research instruments was done based on the sizes of each of the zones. A total of 100, 50, and 50 were administered in Owerri, Orlu and Okigwe zones, respectively. In addition, scheduled on-site visits to agroforestry plots around watersheds were done in the zones. Information on land areas covered by the practices was gathered through field measurements. Changes in productivities as a result of the new techniques adopted by the farmers were noted by collecting information on farm yields. Data on the yields from similar land units, where agroforestry were not practiced were also collected. Data were analyzed using descriptive statistics and Z-test for comparing the mean annual income from practices incorporating non-arable crop component and that from those without. Benefit-cost analysis was also done for the two kinds of farming. The result revealed that 74.7% of the farmers adopted agroforestry technologies, incorporating different non-arable crops, such as Dacryodes edulis, Persea americana, Pentaclethra macrophylla and Treculia africana on their farm plots. Other crops of likes include plantain/banana and Gnetum africanum. Some of the farms, where agroforestry technologies were adopted were laced with scattered Eleaiss guineensis. Only 25.3% of the farms encountered in the study area were mixed in arable cropping, devoid of tree species, indication of non-adoption or inclusion of agroforestry species in those areas. The result revealed that there was a significant difference in mean annual income generated by the two categories of farmers (P < 0.05). The highest mean annual income of ₦150,671.50 ± 24,373 was recorded by the adopters of agroforestry technologies. The result revealed that net productivity was better under agroforestry practices compared to the non-agroforestry practices. The benefit-cost ratios were 1.37 and 1.14 for the adopters of and non-adopters of agroforestry technologies respectively. The result of this study proved that incorporation of trees on agricultural farm plots is beneficial and economical.

Keywords: Agroforestry, soil erosion, degradation, fertility improvement, livelihood

INTRODUCTION

Watershed management has been variously defined as the process of organizing the use of natural resources on a watershed to provide necessary goods and services to people, while mitigating the detrimental impacts of land-use activities on soil and water resources (Brooks et al., 1997). This approach recognizes the intrinsic interrelationships among soil, water, and land-use and the connections between upland watersheds and larger downstream river basins. It incorporates soil and water conservation and land-use planning into a more holistic and logical framework. This more encompassing approach to land stewardship is achieved by recognizing both the positive and negative impacts on people that are caused by planned or unplanned interactions of soil and water with other natural or man-made resources. Food security and environmental degradation are two main challenges facing humanity. Protecting and strengthening watershed ecosystem is the main strategies to address these issues. Establishing agroforestry plots around watershed is important. It is also necessary to appreciate that the nature and severity of these interactions are influenced by how people use these resources and the quantities of resources they use. A watershed management approach to land stewardship must accommodate the interests of the widest possible number of people. It must weigh the benefits obtained from good land stewardship by optimizing production and maintaining environmental integrity. And it should facilitate more effective conflict resolution from a sustainability perspective. A sustainable management approach further recognizes that future generations of people deserve to inherit landscapes that are capable of producing the needed goods and services while maintaining ecosystem health and economic stability. With the geometric increasing human populations, and the corresponding pressure on land and water resources, it has been noted that small-scale, rain-fed sole cropping would be grossly inadequate to guarantee food security without sacrificing ecosystem integrity. Moreover, the impacts of shifting cultivation on biodiversity losses in the tropics have been considered to be deleterious (Myers, 1993; Lawrence and Mogoza, 1996; Riswan and Hartanti, 1996; Luoga, 2000; Holden, 2001; FAO, 2006; Zahabu, 2008; Mwandambwa, 2009; Rahman et al., 2011; Cairns, 2015), despite controversies about the ultimate causes of forest conversion. Hence, a tilt towards adoption of better and lasting technologies have been advocated in many countries. And one of the viable alternatives in Sub-Saharan Africa has been agroforestry in its different modifications.
Agroforestry practices, as system of land use where trees or other woody plants are grown on the same piece of land as agricultural crops, livestock, or a combination thereof, either sequentially or simultaneously (Buck et al., 1999), are effectively combined production systems and, therefore, have a bearing on sustaining the welfare of watershed inhabitants. Forestry and agricultural cropping activities often occur in varying combinations within watershed boundaries. Upland watersheds in many dryland regions are mosaics of these and other forms of land-use. Some of the best opportunities for people to match their desired land uses with the capacities of a watershed to achieve productivity and benefits and, at the same time, attain downstream protection from flooding, siltation, and other detrimental and cumulative effects involve the integration of agroforestry practices into a watershed management approach to land stewardship.

So far, limited efforts have been reported in the area of agroforestry technologies, especially as it concerns watershed management in the southeast geopolitical zone of Nigeria, and there is paucity of information on the success or failure of the systems in the area. Therefore, this study examines the impact of agroforestry technologies on watershed management with emphasis on previous initiatives, success stories of community-based integrated projects, if any, as well as the benefits of the techniques.

MATERIALS AND METHODS
The study was carried out in Imo State, south-eastern Nigeria. It lies between latitudes 5°12' and 5°56’ N and longitudes 6°38’ and 7°25’ E. Imo State is made up of three agro-ecological zones including Owerri, Okigwe and Orlu zones, and it covers an area of 5,530 km², with Owerri zone occupying over 60% of the State (Fig. 1). The location of Imo State in the heart of south-east zone makes it a strategic commercial centre. The people are known for their traditional hospitality, revered as the cradle of peaceful co-existence and famed for their cultural affinity.

A multi-stage sampling technique was adopted for the study. From each of the agro-ecological zones, communities, where farming activities were carried out along watersheds were chosen for the study. A proportional allocation of the study instruments was done based on the sizes of each of the zones. A total of 100, 50, and 50 were administered in Owerri, Orlu and Okigwe zones respectively. In addition, scheduled on-site visits to the areas where agroforestry techniques are adopted during crop production activities around watersheds in the three agro-ecological zones of the state were done. The information on land areas covered by the practices was gathered through field measurements. Also, changes in productivities as a result of the new techniques adopted by the farmers were noted by collecting information on the yields from the practices and those from the previous farming activities in the area. In the same vein, information on the yields from similar land units, where agroforestry was not adopted into farming activities were also collected in the course of the study. Data were
analyzed using descriptive statistics and Z-test for comparing the mean annual income from practices incorporating non-arable crop component and that from those without. Benefit-cost analysis was also done for the two kinds of farming.

RESULTS AND DISCUSSION

Table 1 presents the adoption of agroforestry technologies as well as various non-arable crop inclusions on farm plots in the study area. Most (74.7%) of the farmers adopted agroforestry technologies, incorporating different non-arable crops, such as *Dacryodes edulis* (local pear), *Persea Americana* (Avocado pear), *Pentaclethra macrophylla* (oil bean tree) and *Treculia africana* (African bread fruit) on their farm plots. Other crops of likes include plantain/banana and *Gnetum Africanum*. Some of the farms, where agroforestry technologies were adopted were laced with scattered *Eleais guinensis*. Only 25.3% of the farms encountered in the study area were mixed in arable cropping, devoid of tree species, indication of non-adoption or inclusion of agroforestry species in those areas. Maize, vegetables and yam are a common occurrence on such farm plots. This result is in line with the finding of Orisakwe and Agomuo (2011), who noted that over 70% of farmers in Imo State adopted agroforestry technologies involving the cultivation of plantain/banana and *Gnetum africanum* in most cases. Umeh (2012) also confirmed the persistent presence of *Pentaclethra macrophylla* and *Eleais guinensis* on agroforestry plots in southeast Nigeria, indicating that 59.5% and 62.5% of the farms sampled were with *Pentaclethra macrophylla* and *Eleais guinensis* respectively. Some other tree species, not know for fruit productions are also retained in farms for other benefits like yam and pumpkin (*uguru*) staking. A couple of the farmers also incorporated bee keeping on their farm plots. The individual farm plots in the area ranged between 100 m² and 2,000 m² with an average of 870 m².

Table 1: Adoption and distribution of agroforestry technologies in the study area

<table>
<thead>
<tr>
<th>Variable</th>
<th>Response</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adoption</td>
<td>Adventurer</td>
<td>149</td>
<td>74.7</td>
</tr>
<tr>
<td></td>
<td>Non-Adventurer</td>
<td>51</td>
<td>25.3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>200</td>
<td>100</td>
</tr>
</tbody>
</table>

| Non-arable crop incorporated | *Treculia Africana*, *Dacryodes edulis*, *Gnetum Africana*, *Pentaclethra macrophylla* | 140 | 70.1 |
|                            | *Persea Americana*, *Dacryodes edulis*, *Gnetum africanum* | 150 | 75  |
|                            | Plantain/banana, *Treculia Africana*, *Eleais guinensis* | 130 | 65  |

Average individual farm plot size = 870 m²

The result of Z-test (for comparing significant differences in mean income generations by the adopters and non-adopters of agroforestry technologies) is presented in Table 2. The result revealed that there was a significant difference in mean annual income generated by the two categories of farmers (P < 0.05). The highest mean annual income of N 150,671.50 ± 24,373 was recorded by the adopters of agroforestry technologies. The result revealed that the overall productivity in terms of mean yield was better under agroforestry practices compared to the non-agroforestry farm plots. This is in line with the observation by Nair (1993), who stated that agroforestry is a sustainable and management system, which increases the overall yield of the land, combines the production of crops (including tree crops) and forest plants and/or animal simultaneously or sequentially, on the same unit of land.

Table 2: T-test for incomes generated by adopters and non-adopters of agroforestry

<table>
<thead>
<tr>
<th>Category</th>
<th>Average cost</th>
<th>Mean annual income (N)</th>
<th>± SD</th>
<th>df</th>
<th>tcal</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adopter = 149</td>
<td>110,000.00</td>
<td>150,671.50 ± 24,373</td>
<td>198</td>
<td>2.33</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Non-adopter = 51</td>
<td>110,000.00</td>
<td>125,304.00 ± 893.00</td>
<td></td>
<td>1.98</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

α = 0.05, Z_{sub} = 1.98

The common practice in the area is to cultivate plots of land for about three (3) to five (5) years and move to other areas when the fertility of a particular farm plot appears to be depleting, or when productivities become worthless or fail. However, where there are intercropping with tree species, the farming activities seem perennial. This is probably due to the improved fertility in those plots as a result of build-up of organic matters provided by the accumulation of litters in the areas. It may have also resulted from the fact that fruit production on such plots extends beyond the regular years of arable cropping, providing additional returns. As attested to by one of the
farmers in *Owerri* zone, “although, there are slow initial growths under agroforestry techniques, where some already-established useful fruit trees were retained during land preparation for farming, due to the shade cast by the tree canopies, the cassava and maize stems still grew well with encouraging yields”. Another farmer in the area pointed out that, besides the production of fruits by most of the tree crops, especially, *Persea americana* and *Dacryodes edulis*, prolonged farming activities are carried out on such plots, where tree species are present, compared to lands under arable farming.

An additional four to five years of farming was confirmed to be possible by most agroforestry farmers in *Okigwe* zone. It was attributed to the possibility of soil improvement under agroforestry practices. This finding corroborates the reports by previous workers. Ramesh *et al.* (2007) and Ramesh *et al.* (2008), who noted that management practices such as those incorporating trees on arable farm lands helped in improving nutrients status in soil and enhanced the growth of the trees. An important contribution of agroforestry systems is towards organic matter (Young, 1991). Young (1991) emphasized that agroforestry systems have the potential to control both water and wind erosion, which ultimately reduces the loss of soil organic matter and nutrients. Soil organic matter has many roles in maintaining soil fertility. These include the beneficial effects on soil physical properties, comprising water-holding capacity, slow release of nutrients, particularly significant in low input farming systems, enhancement of cation exchange capacity, which is significant where fertilizers are applied, and the provision of a favourable environment for soil faunal activities (Sharma *et al.*, 2005).

Out of the several benefits accrued from agroforestry systems in terms of soil quality, nutrient cycling is the most predominant. In a soil-plant system, plant nutrients are in a state of continuous dynamic transfer. Plants take up nutrients from the soil and use them for metabolic activities. In-turn, these nutrients are returned back to the soil either naturally as litter falls in unmanaged systems, deliberately as pruning in some agroforestry systems or through root senescence in both managed and unmanaged systems. These plant parts are decomposed as a result of microbial activities and release the nutrients held in them into the soil. The nutrient then becomes available for plant uptake once again (Nair *et al.*, 1999). The nutrient cycling in general has been defined as continuous transfer of nutrients that are already present within a soil-plant system such as farmer’s field (Nair *et al.*, 1995; Sanchez and Palm, 1996; Buresh and Tian, 1997).

Table 3 presents the benefit-cost ratios under agroforestry and non-agroforestry practices. The benefit-cost ratios were 1.37 and 1.14 for the adopters of and non-adopters of agroforestry technologies respectively. This implies that for every naira spent under agroforestry and non-agroforestry practices, 37 kobo and 14 kobo were gained respectively. The benefit-cost ratio value recorded under agroforestry practices in this study was lower than 2.06 as reported by Obasi *et al.* (2014). He noted that for every one naira (₦1.00) spent in agroforestry business, two naira six kobo was returned (₦2.055), implying a gain of one naira six kobo (₦1.06). Based on his finding, he concluded that agroforestry practice is viable in Imo State. However, the result of this study has further proved the viability and/or profitability of the adoption of agroforestry technologies as against non-adopter of the practice. Moreover, the disparity in the results may be due to the fact that the present study concentrated only on the practices along watersheds in the state. Nevertheless, there are other noticeable positive impacts of the agroforestry technologies. Among such are water quality improvement, prevention of siltation and sediment accumulation in the water bodies.

Table 3: Benefit-cost ratios under agroforestry and non-agroforestry farm practices

<table>
<thead>
<tr>
<th>Category</th>
<th>Average cost (₦)</th>
<th>Mean annual income (₦)</th>
<th>Mean profit</th>
<th>Benefit-cost ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adopter</td>
<td>110,000.00</td>
<td>150,671.50</td>
<td>40,671.50</td>
<td>1.37</td>
</tr>
<tr>
<td>Non-adopter</td>
<td>110,000.00</td>
<td>125,304.00</td>
<td>15,304.00</td>
<td>1.14</td>
</tr>
</tbody>
</table>

**CONCLUSION**

Conservation of natural resources are constantly threatened by agricultural activities, especially shifting cultivation, adoption of agroforestry technologies offer sustainable options for perpetual farming practices while ensuring food security. The result of this study is a proof that incorporation of trees on agricultural farm plots is beneficial and economical as the benefits derived therein was higher for the adopters of agroforestry than the non-adopters of the practice. The findings suggest economic and environmental viability of agroforestry practices. It is therefore recommended that goal-oriented awareness about the technologies be advocated. There should also be more investments in this direction, especially from the governments and the organized private sector of the economy. Possibility of giving incentives to the interested adopters should also be considered while motivating the laggards. It is imperative, therefore, that the inhabitants or farmers of watershed lands adhere strictly to the best possible form of land stewardship, incorporation agroforestry practice as typified by the findings of this study.
REFERENCES


