



SOCIO-ECONOMIC IMPLICATION OF AGROFORESTRY PRACTICES IN SOUTHERN KADUNA, NIGERIA

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ABSTRACT: The study examined the socio-economic implication of adopting agroforestry farming in Southern Kaduna, Nigeria. Data were collected using structured questionnaire, which was administered to 319 respondents. A multistage sampling technique was employed in selecting the practitioners. The difference estimation model was used to achieve the objective. The difference of per capita income between before and after adoption of agroforestry practice was ₦595, 023.57, with Jema'a Local Government Area having the highest per capita income of N232, 102.85, followed by Zangon Kataf Local Government Area ₦182,161.27 and the least was Kaura Local Government Area with ₦180, 759.45. The result revealed that an average in per capita income of ₦595, 023.57, imply that agroforestry practice is effective in the study area. Age; education level; gender; farm size; farming experience; source of information and access to credit were all significant ($p < 0.05$) in influencing changes in income of agroforestry farmers in the study area.

Keywords: Agroforestry, Adopting, Difference estimation model, Income.

1. INTRODUCTION

In the past, soil fertility maintenance under the subsistence smallholder farmers level was long-term bush fallow, which was planned for regrowth of vegetation, improved accumulation of organic matter and plant nutrients. The increasing growth of human population resulting in severe soil erosion and reduction in yields forced farmers to reduce the length of fallow periods. The World Resources Institute (WRI) sets the global human population at 8.5 billion by 2025 and in 2050 the population is expected to hit 10 billion (Mackenzie 2004; World Bank 2005). If the high population growth rates, increasing poverty levels and scarcity of land must be properly addressed, then the need for technologies that would boost food production including crops and animals, forest and wood products as well as sustaining the use of land cannot be over emphasized (Zira 2014). International concern is to find alternative farming systems that are ecologically and economically sustainable as well as culturally acceptable to farmers.

One alternative is agroforestry, which is an integrated land-use management technique that incorporates trees

and shrubs with livestock on farms and has been suggested by experts as a new solution to rural development (Spencer 1986; Kang *et al.* 1995; Nkamleu 1999; Gockowski *et al.* 2000).

Franzel and Scherr (2002) reported as early as 1989 that more than 60 development projects promoting agroforestry in Africa were identified. Despite this impressive presence, agroforestry projects are known to suffer from inadequate rates of adoption and abandoned soon after adoption (Patanayak *et al.* 2003). Many researchers have lamented the fact that adoption and diffusion have lagged behind scientific and technological advances in agroforestry research, reducing the potential impacts of agroforestry-based development projects (Sanchez *et al.* 1998; Adesina *et al.* 2000). As argued by Patanayak *et al.* (2003), this situation explains the concern of researchers and policy-makers to see more socioeconomic research on agroforestry.

Unfortunately, in some areas and countries, including Nigeria, information on the socio-economic benefits and performance of agroforestry practices is scarce (Adesina *et al.* 2000; Mercer 2004), which makes it difficult for

policy-makers to implement proper interventions. It is in view of this that the study examined the socio-economic implication of adopting agroforestry farming in Southern Kaduna, Nigeria.

2. METHODOLOGY

2.1. Study Area

The study was carried out in the southern part of Kaduna State. It covers a land area of about 37,872km² which lies between latitude 9° N and 10°15'N of the equator and between longitude 7°00' and 9°00'E of the Greenwich meridian. The study area shares boundaries with Nassarawa State, Niger State, Plateau State and Abuja (Kaduna State Statistics Book, 1996). The climate is characteristic of Southern Guinea savannah. It has two seasons; rain and dry seasons. The rain season is between May to October and dry season is between November to April. The mean annual rainfall ranges from 1300 mm to 1700 mm. The annual mean temperature is 25 °C and humidity 63%. (Kaduna Development plan, 2008) The population of the Southern part of Kaduna State according to the 2006 population census stand as 2,587,900, using 3.18% growth rate as allowed by the National Population commission, the projected population of Southern Kaduna stand at 3,163,967 (2013 projection), therefore by the year 2018 the Southern Kaduna population would stand at 3,575,443. Farming is the main economic activity in the study area. Over 70 % of the active populations are farmers. The increased demand for land has led to shortening of fallow periods and consequently severe degradation of the farm (Kaduna Development plan 2008).

2.2. Sampling Techniques

A multi-stage sampling technique was employed in selecting the practitioners. The first stage involved using the list of agroforestry practitioners obtained from the reconnaissance survey conducted in 2008 by Kaduna State Agricultural Development Project (KADP) as shown in Table 1. The second stage was the selection of three Local Government Areas (LGAs) from southern part of Kaduna namely: Jema'a, Kaura and Zangon Kataf on their predominant role in agroforestry farming. The third stage involved the selection of four communities each from the selected LGAs known for agroforestry farming and accessibility and the fourth stage, thirty percent of the farmers were randomly selected from each of the 12 communities which constituted 319 practitioners out of 1,064 practitioners in the study area. A pretesting of the questionnaire was done in two communities in each Local Government Area before the actual enumeration. A structured

questionnaire was used to obtain information from agroforestry practitioners in the study area.

Table 1: Selected Local Areas and Locations of study

Selected Local Government	Community	Sample Frame	Sample
Zangon Kataf	Jankasa	100	30
	Tsohon Gidan	64	19
Kaura	Angwa Gaya	124	37
	Gora	68	20
	Malagum	67	20
	Agban	72	22
	Biniki	64	19
Jema'a	Tum	142	43
	Tuduwada-Kaningkon	100	30
	Godo godo	123	37
	Gidan Waya	98	29
TOTAL	Angwa Masara	42	13
		1064	319

Source: Field Survey, 2014.

2.3. Data Analysis

Difference estimation model was used. These include; (i) Simple version and (ii) Expanded version using Ordinary Least Square OLS

i. Simple version of the difference

The model can be specified as follows:

$$D = \sum (Y_{ia} - Y_{ib}) \quad (i)$$

Where :

Y_{ia} = Per capita income for i agroforestry farmer after adoption

Y_{ib} = Per capita income for i agroforestry farmer before adoption

ii. Expanded version of the difference using (OLS)

$$Y_{ia} = \alpha + \beta p_i + \gamma X_{ia} + \varepsilon_{ia} \quad (ii)$$

Where:

Y_{ia} = Per capita income for agroforestry farmer after adoption

P_i = indicator for practicing agroforestry

X_i = vector of observable characteristics of the individual

α and β = estimated effects of practicing agroforestry

γ = estimated effects from these characteristics

ε_{ia} = error term

The empirical equation after adopting agroforestry is presented as:

$$\Delta Y_{ia} = \alpha + \beta_{1a}X_{1a} + \beta_{2a}X_{2a} + \beta_{3a}X_{3a} + \beta_{4a}X_{4a} + \beta_{5a}X_{5a} + \beta_{6a}X_{6a} + \beta_{7a}X_{7a} + \beta_{8a}X_{8a} + \beta_{9a}X_{9a} + \beta_{10a}X_{10a} + \varepsilon_{ia} \quad (iii)$$

Where:

ΔY_{ia} = Change in income of individual after adopting agroforestry (N)

X_{1a} = Age (years)

X_{2a} = marital status (Dummy, 1 for married 0 for otherwise)

X_{3a} = household size (No)

X_{4a} = education status (No. of years spent in school)

X_{5a} = gender size (Dummy, 1 for male 0 for otherwise)

X_{6a} = farm size (Hectares)

X_{7a} = farming experience (years)

X_{8a} = sources of information (Dummy, 1 for extension agent and 0 otherwise)

X_{9a} = access to credit (Dummy, 1 acquired and 0 otherwise)

X_{10a} = membership of cooperative society (Dummy, 1 yes and 0 otherwise)

α and β = estimable effects of agroforestry practice

ε = error term

The value of variables before adopting agroforestry was modeled as:

$$Y_{1b} = \alpha + \beta_{1b} + \varepsilon_{1b} \quad (\text{iv})$$

The empirical equation before adoption of agroforestry is also presented as:

$$\Delta Y_{iagfa} = \alpha + \beta_{1b}X_{1b} + \beta_{2b}X_{2b} + \beta_{3b}X_{3b} + \beta_{4b}X_{4b} + \beta_{5b}X_{5b} + \beta_{6b}X_{6b} + \beta_{7b}X_{7b} + \beta_{8b}X_{8b} + \beta_{9b}X_{9b} + \beta_{10b}X_{10b} + \varepsilon_{ib} \quad (\text{v})$$

Where:

ΔY_{ib} = Change in income of individual after adopting agroforestry (N)

X_{1b} = Age (years)

X_{2b} = marital status (Dummy, 1 for married 0 for otherwise)

X_{3b} = household size (No)

X_{4b} = education status (No. of years spent in school)

X_{5b} = gender size (Dummy, 1 for male 0 for otherwise)

X_{6b} = farm size (Hectares)

X_{7b} = farming experience (years)

X_{8b} = sources of information (Dummy, 1 for extension agent and 0 otherwise)

X_{9b} = access to credit (Dummy, 1 acquired and 0 otherwise)

X_{10b} = membership of cooperative society (Dummy, 1 yes and 0 otherwise)

α = intercept

ε = error term

The error term consists of two parts

$$\varepsilon_{it} = \eta_i + \mu_{it} + \varepsilon_{ib} \quad (\text{vi})$$

where

η = time invariant unobserved individual specific effect allowed to correlated with practice indicator.

μ_{it} = innovation error assumed to be uncorrelated with all explanatory variables.

Hence, to obtain the change in outcome variable between two periods (after and before) the difference over the two periods was taken as:

$$Y_{it} - Y_{ib} = \beta_{Pi} + \Upsilon(X_{ia} - X_{ib}) + \varepsilon_{ia} - \varepsilon_{ib} \quad (\text{vii})$$

If equation (vii) is estimated by Ordinary Least Square (OLS), the resulting estimates of β and Υ are unbiased, because the potential bias from correlation between the unobservable and observables is eliminated because of the first- differencing. The estimate of β is then the difference estimate of the effects of agroforestry practice taking into accounts both observable and time invariant unobservable heterogeneity.

Therefore, the following model is estimated:

$$Y_{it} = \beta_{pb}BA_{it} + \beta_{pa}AA_{it} + \Upsilon X_{it} + \varepsilon_{it} \quad (\text{viii})$$

Where:

Y_{it} = Per capital income

β_{pb} = { 1 if P=1 and t=b, 0 otherwise }

β_{pa} = { 1 if P=1 and t=a, 0 otherwise }

BA =Before adopting agroforestry

AA =After adopting agroforestry

Υ = estimated effects from these characteristics

X_i = Vector of explanatory variables

t = time

a = after

b = before

ε = error term

Random Effect Model

Random effects model was used to develop empirical attenuation relationship between intra and inter-event variability. Detail regarding application of the random effects model are described by Pinheiro and Bates (2000). The model can be estimated by including additional explanatory variables, which would capture difference in time among the farmers using the equation below:

$$Y_i = \alpha + \Upsilon X_i + \varepsilon_i \quad (\text{ix})$$

The Hausman test, which is often used to evaluate the consistency of the estimate from random effects models, was used for this study. The model of the random effects is empirically specified as:

$$Y_{it} = \beta_b BA_{it} + \beta_a AA_{it} + \Upsilon X_{it} + \varepsilon_{it} - \varepsilon_{it} \quad (\text{x})$$

Where:

Y_{it} = Per capital income measured in naira

X_i = vector of observable characteristics of the individual
 BA =Before adopting agroforestry
 AA =After adopting agroforestry
 a = Coefficients after adoption of agroforestry
 b = Coefficients before adoption of agroforestry
 β and Υ = Constant term
 t = time period between before and after
 ε_i = random disturbance characterizing the i th observation and is constant through time.

3. RESULTS AND DISCUSSION

3.1 Household Incomes

The household income derived from agroforestry is summarized in Table 2. The incomes involve the money that accrued from the sales of both food crops and tree crops/products.

The per capita income of the respondents is presented based on December 2014 price, taking into

Table 2: Average Per Capita Income

Local Government Area	Change in Per Capita Income (₦)		
	Before	After	Difference
Zangon Kataf	108,294.56	290,455.83	182,161.27
Jema'a	143,943.25	376,049.10	232,102.85
Kaura	355,920.21	950,943.78	595,023.57

Source; Field survey, 2014

3.2 Socio-economic Influencing Changes in Income of Agroforestry Farmers

The factors influencing changes in income of the practitioner are presented in Table 3. The result of income was estimated by OLS using the data obtained from the agroforestry farmers. The findings revealed that age, educational level, gender, farm size, farming experience and access to credit were positive and significant ($p < 0.05$).

Age tend to determine how active and productive the head of the household would be since most production was carried out using manual labour. Often there is a positive correlation between age and farming experience. Age and farming experience has also been found to affect the rate of household adoption of innovations, which in turn, affects household productivity, income and livelihoods. The results tend to indicate that age has significant influence on the income of the respondents. This may suggest that age influences decision-making process of farmers with respect to risk aversion, adoption of agroforestry practice, and other production-related decisions. The predominance of

consideration was the average inflation rate estimated to be 12.07. The difference per capita income between before and after adoption of agroforestry practice was ₦595,023.57, with Jema'a Local Government Area having the highest per capita income of ₦232,102.85, followed by Zangon Kataf Local Government Area ₦182,161.27 and the least was Kaura Local Government Area with ₦180,759.45. The result revealed that an average in per capita income of ₦595,023.57, imply that agroforestry practice is effective. The positive mean differences of the per capita income indicate a positive effect on the income of the farmers. The sharp increase in the per capita income (Table 2) could be as a result of the benefit of the agroforestry project with its policy thrust of input, such as planting of trees to improve soil fertility. This finding is in agreement with Jain and Singh (2000) which showed that the difference per capita income between before and after adoption of agroforestry practice in Uttar Pradesh, India was positive.

active and productive heads of households in the project area as earlier observed may have a direct bearing on increased availability of able-bodied labour for primary production; Ease of participation in new projects; reduction in the degree of risk aversion. All these have great potential for increasing agroforestry productivity and production hence, improving household livelihoods and reducing poverty. This finding is in agreement with Stephen and Mshelia (2008) in which they found that, age has significant influence on the income of farmers in Adamawa.

The variable education has positive and significance at 10 % relationship with income of the agroforestry farmer. This implied that the per capita income is higher among the highly educated compared to those that are less educated. The large proportion of respondents who have attained formal and higher education means that, it will be possible to provide information about the benefits of agroforestry practice in the study area. Furthermore, education is an important factor that likely influences the decision-making, efficiency of resource utilization and better understanding of the importance of new technology. Under agroforestry project, farmers

acquired agroforestry knowledge through various training, such as crop management practices, seed production techniques, and marketing. These have contributed in improving the livelihood of the practitioners. In addition, agroforestry had also increased farmers' yields considerably, leading to an increased marketable surplus, which in turn contributed to increased income and ability to improve their living standard. This result is in agreement with the findings of Mohammed *et al.* (2007) who stated that income is higher among educated farmers compared to the less educated in Nassarawa State.

Gender is another variable that showed significant relationship with income of the practitioners. The status of agroforestry tends to encourage more male compared to their female counterparts. This finding is in agreement with Jongur (2006) who reported that Male farmers obtain more income than their female counterparts in Adamawa State.

Farm size is significant at 1% and has a positive coefficient showing that it is an important indicator variable in assessing the change in per capita income of the practitioners. The size of land cultivated by farming households has influence on their farm output. It has been earlier shown that those farmers with larger areas of land harvest more produce than those with small area of farm size. The implication is that farmers are increasingly adopting agroforestry production, with more farmers planting tree crops and existing producers increasing the land area under cultivation. Increased in demand for agroforestry products by industrial processors and attractive market prices, among other reasons, are major factors that motivate farmers to increase their farm size and to grow more crops in the study area. This finding agrees with Kareemulla (2005) who stated that farm size is significant in determining per capita income in agroforestry farming in Western Uttar Pradesh.

Farming experience is another important factor which positively influenced the per capita income of the respondents. Thus, it determines both the productivity and the production level of the farmers in the study area. This suggests that agroforestry farmers are relatively young; active; likely to be more productive and have better experience of improving soil fertility. The probable reason could be as a result of their experience in agroforestry farming. This finding is in agreement with Adebayo (2005) who reported that experience is very important, and that the longer a person stays on a particular job, the better the job performance tend to be.

The coefficient of the source of information variable is statistically significant ($p < 0.05$). This indicates that households with access to agroforestry extension services tended to have higher probabilities of having higher income than those without access to agroforestry extension. This is because contact with extension services tends to enhance the chances of a household having access to better crop production techniques, improved inputs, as well as other production incentives that positively affect farm productivity and production. Other determining factor, which is also significant as well as very important, is the availability of credits and improved farm inputs (especially improved seed and fertilizers). This finding agreed with Olukosi and Atala (1991) who reported that access to agricultural extension, credit and improved farm input has been one of the approaches used to improve income in agricultural productivity in Nigeria since colonial era.

The random effect model, however, does not differ much from the result obtained from OLS in Table 3. The result showed that age; education level; gender; farm size; farming experience; source of information and access to credit were all significant ($p < 0.1$). Although the Breauch and Pagan LM-test (Table 3) indicates that there was unobserved diversity in the model, the conclusion from the random effects model is not valid due to inconsistency in parameters. The Hausman test statistic (which is often used to observe the consistency of the estimates from random effects models) is significantly different from zero ($p < 0.05$). This agrees with the findings of Ajibefun and Aderinola (2003) which stated that age; education level; gender; farm size; farming experience; source of information and access to credit were all significant in generating farmers income in Nigeria.

4. CONCLUSION

From this study, the following can be concluded:

1. Agroforestry practice is effective in the study area.
2. Most of the practitioners had ₦595, 023.57 differences in per capita income after adopting agroforestry per annum.
3. Those in Jema'a Local Government Area had the highest per capita income of ₦ 232, 102.85 per annum, followed by Zangon Kataf Local Government Area ₦182, 161.27 per annum and the least was Kaura Local Government Area with ₦180, 759.45 per annum.
4. Age; education level; gender; farm size; farming experience; source of information and access to credit had significant effect on changes in income of agroforestry farmers. The result implies that agroforestry practice is effective in the study area.

Table 3: Socio-economic Factor Influencing Changes in Income of Agroforestry farmers.

Variables	Ln (income)					
	OLS			Random effects		
	Coef.	SE	P> z	Coef.	SE	P> z
(Constant)	8.917	0.319	0.000	9.186	0.282	0.000
Age (x ₁)	0.011	0.003	0.001*	0.012	0.003	0.001*
Marital status (x ₂)	0.103	0.104	0.327	0.056	0.103	0.589
Household size (x ₃)	0.001	0.010	0.895	0.004	0.10	0.703
Education status(x ₄)	0.014	0.007	0.042**	0.014	0.007	0.038*
Gender(x ₅)	0.241	0.120	0.045	0.290	0.119	0.015*
Farm size (x ₆)	0.145	0.042	0.002*	0.023	0.012	0.051*
Farming experience(x ₇)	0.031	0.004	0.000*	0.033	0.004	0.000*
Source of information(x ₈)	0.239	0.096	0.013*	0.261	0.968	0.007*
Access to credit (x ₉)	0.339	0.103	0.021**	0.056	0.093	0.512
Cooperative membership(x ₁₀)	0.116	0.107	0.280	0.123	0.010	0.010*
BA	0.390	0.156	0.013**	0.056	0.093	0.512
AA	0.459	0.127	0.000*	0.453	0.127	0.000*
AA-BA=0	1.222	0.131	0.000*	1.083	0.108	0.000*
B&PLM-test	231.2		0.000*			
Hausman-test	45.31		0.000*			

Source: Field survey, 2014. **=Significant at (p<0.05). *= Significant at (p<0.1). BA= Before Adoption, AA= After Adoption.

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