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Analysis of Farmers' Participation in Cocoa Agroforestry Systems in Abia State, Nigeria

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Abstract
This study analyzed farmers' participation in cocoa agroforestry systems in Abia State, Nigeria. It specifically; described socio-economic characteristics of farmers; ascertained their levels of participation and ascertained perception of farmers towards cocoa agroforestry systems attributes. Multistage random sampling procedure was used to select one hundred and twenty (120) cocoa farmers. Data were collected using a structured questionnaire and results analyzed with descriptive (such as frequency counts, mean scores and percentages) and inferential statistics (Tobit and multiple regression analyses). Results revealed that majority (96.7%) of cocoa farmers were males, acquired secondary education (93.33%) with mean annual farm income of ₦573, 500.00, mean monthly extension contact of 2.9 visits and mean years of social organization membership of 8 years. Farmers had favourable perception ($\bar{x}$=3.0) and high participation ($\bar{x}$=2.4) in cocoa agroforestry system attributes. Multiple regression result showed that coefficients for sex (β=0.0766), education (β=0.0439), farm income (β=4.72), extension contact (β=0.0999) and membership of social organization (β=0.0203), influenced farmers' participation in cocoa agro-forestry systems. However, climate change adaptation (β=0.0242), climate change mitigation (β=-0.1118), use of environmentally friendly measures (β=0.0066), disease and pest reduction measures (β=-0.0136) and soil conservation, reduced soil erosion and flooding (β=0.04251) influenced perceived attributes of farmers' participation in cocoa agroforestry systems. The study concluded that famers had high participation in cocoa agroforestry systems and its attributes. It is recommended that farmers should be introduced to other agroforestry-based climate change adaptation technologies in order to effectively build resilience through extension education, formation of farmer-based organizations for increased participation in cocoa agroforestry systems.
Key words: Participation, Cocoa, Agroforestry systems, Farmers

Introduction

Cocoa (*Theoboma cacao*) which is a tropical perennial tree crop is grown worldwide especially African countries as Ivory Coast, Ghana, Cameroun and Nigeria; Asia (Indonesia) which are rated as the highest producers of cocoa worldwide (Sustainable Tree Crop Programme (STCP) (2008; World Cocoa Foundation, 2020). The increasing global demand for cocoa has led to intensification of cocoa production systems. Consequently, cultivation of cocoa under tree shade is gradually being replaced with full-sun monocultures and the use of agrochemicals (Almeida and Valle, 2017; Schneider *et al*., 2016 and Schroth,

2014). In many areas, intensified cocoa production has led to deforestation, biodiversity loss, increased carbon emissions, reduction of energy efficiency, soil degradation, and contamination from pesticides (Takyi *et al*., 2019 and P´erez-Neira *et al*., 2020) as well as to socio-economic problems such as low productivity and vulnerability to cocoa price volatilities (Tothmihaly, 2017).

In Nigeria, where agricultural expansion and deforestation are major environmental concerns, agroforestry systems offer a promising approach for achieving sustainable development goals (Adegoroye *et al*., 2021). Agroforestry systems have emerged as a vital strategy for mitigating climate change, enhancing biodiversity, and promoting sustainable agriculture in tropical regions. By integrating trees into agricultural landscapes, agroforestry systems can sequester significant amounts of carbon dioxide, improve soil fertility, and enhance ecosystem services (Nair et al., 2021; (IPCC, 2022). Agroforestry systems, which grow timber, fruit and other trees together with cocoa trees, have the potential to increase the sustainability of cocoa production. Agroforestry systems can provide a variety of habitats and microclimates that support biodiversity conservation (Marconi and Armengot, 2020).

Niether *et al*., , (2020) in their study found that cocoa agroforestry system has attributes such as; adaptation of cocoa plantations to climate change, acceptability, contribution to climate change mitigation, adaptation or integration with other crops, conservation of land resource, environmental friendliness, biodiversity conservation, sustainable practice, improved soil chemical and physical properties, disease and pest reduction, sustenance of farmers' income, increase in cocoa productivity, soil conservation and reduced soil erosion/flooding which enhanced productivity of cocoa farms in comparison to cocoa monoculture, which is the cultivation of only cocoa trees on a piece of land.

However, cocoa farmers' output in Abia State has suffered serious setback over the years, due to integration of the appropriate agroforestry system practices (Abia State Cocoa National Day Bulletin 2019). Low productivity in cocoa has also been blamed on poor maintenance practices, planting low yielding varieties and incidence of pest arid diseases ((Olubamiwa *et al.,* 2020; Shahandeh, 2020; Abia State Ministry of Agriculture, 2013; Orimogunje *et al*., 2019).

In an effort to increase cocoa production in the country, the National Cocoa Research Institute of Nigeria (CRIN) 2007 developed and disseminated Cocoa agroforestry systems aimed at enhancing yield and in turn reduce crop losses. Cocoa Research Institute of Nigeria (CRIN), (2017) and Sustainable Tree Crop Programme (STCP) (2008) identified these agroforestry systems to include; Shade Grown Cocoa, Alley Cropping with Timber Trees, Cocoa-Plantain Intercropping, Cocoa-Agroforestry with Fruit Trees, Live Fencing with Cocoa, Cocoa-Grains Intercropping: and Cocoa-Rubber as Cocoa Agroforestry Systems practiced by farmers in Nigeria

Most of the cocoa farms in Abia State were established over 40 years ago with an average of 2-6 hectares and production output of 5,000 metric tons annually. Although many studies on socio-economic studies of cocoa in the Abia State have been conducted (Odoemelam *et al*, 2020), it seems that there is paucity of information on the participation farmers in cocoa agroforestry systems and its attributes in the study area. In view of the above assertions this research sought to analyse the participation of farmers in cocoa agroforestry systems in Abia State, Nigeria.

The objectives were to: describe the socio-economic characteristics of farmers; ascertain levels of participation of cocoa agroforestry systems by farmers; and assess perception of farmers towards cocoa agroforestry systems attributes in the study area.

The following hypotheses were tested: there is no significant relationship between socio-economic characteristics of respondents and their participation in cocoa agroforestry production systems Farmers' participation of cocoa agroforestry systems is not influenced by its perceived attributes.

Methodology

Study Area and Description

The study was carried out in Abia State, Nigeria. Abia State is located in the south eastern part of Nigeria.

Sample and Sampling Procedure
The study adopted purposive and simple random sampling technique. Purposively, all the Bende, Ikwuano and Umuahia North Local Government Areas were chosen because they were the major cocoa producing areas in the State (Abia State Cocoa National Day Bulletin 2019). Two communities each, from the LGAs were randomly selected, namely; **Bende -** Okoroenyi and Isiala; **Ikwuano –** Iberenta and Itunta; **Umuahia North-** Okwueyi and Azueke, which gave a total of 8 communities. From the selected communities fifteen (15) farmers each, were randomly selected to give a total of 120 cocoa farmers Data for the study were analyzed using descriptive statistics (frequency counts, percentages and mean scores) and multiple regression analysis.

Measurement of Variables
Perception of respondents about cocoa agroforestry system attributes
This was measured and rated on a 4-point Likert rating scale of; Strongly Agree=4, Agree= 4, Disagree= 2, Strongly Disagree = 1. Based on the twelve (12) perception item statements, respondents mean scores was computed for each perception statement by adding the weights of 4+3+2+1 = 10/4=2.5. Mean score greater than or equals 2.5 implied favourable and otherwise, unfavourable perceptions of the cocoa agroforestry systems.

Levels of farmers' participation in cocoa agroforestry systems
The levels of par
ticipation in cocoa agroforestry systems in the study area were measured and rated using a 3-point type rating scale namely; always=3, occasionally = 2 and never = 1. Based on the seven (7) cocoa agroforestry systems available to the farmers, the scores were computed for each participation strategy by adding the weights of 3+2+1 = 6/3=2.0.
The following decision rules were obtained thus:
Mean scores between;
1.00- 1.50 (low)
1.51- 1.99 (moderate)
2.0 and above (high)

Model Specifications
Hypothesis 1: The hypothesis was tested with multiple regression analysis at 95% confidence level. The four functional forms of regression model viz: linear, semi-log, exponential and Cobb-Douglas were tried. The best fit was chosen as the lead equation based on its conformity with econometric and statistical criteria such as the magnitude of R^2, F-ratio and number of significant variables.
Hypothesis 2: The hypothesis was tested with multiple regression analysis at 95% confidence level. The four functional forms of regression model viz: linear, semi-log, exponential and Cobb-Douglas were tried. The best fit was chosen as the lead equation based on its conformity with econometric and statistical criteria such as the magnitude of R^2, F-ratio and number of significant variables.

Results and Discussion
Selected Socio-economic Characteristics of Cocoa Farmers
The result in Table 1 revealed that majority (96.7%) of the cocoa farmers were males, The result suggests that men were involved in cocoa plantation farming than their female counterparts. More energy-demanding tasks such as spraying of agro-chemicals, pruning, and harvesting of ripe cocoa pods were men tasks in the study area. The mean household size of the farmers was 8 persons. Household size has shown to be a supplier of farm labour in any farming activity. The result shows that majority (93.33%) acquired secondary education. This implies that, cocoa farmers were literates and communication among them will be easier. The mean annual farm income of cocoa farmers was ₦573,500.00. Farm income realized from any farm is a major means of solving farmers' family needs and overcome implications in cocoa production activities. The mean monthly extension contact with cocoa farmers was 2.9 visits. The result suggests that extension

contact on cocoa agroforestry production systems were moderate. The mean years of social organization membership for the farmers was 8 years. Ibe *et al*., (2023) asserted that farmer cooperatives enhanced the advantages of economics of scale, overcome barrier to assets, manage available resources better and participation of cocoa agroforestry systems.

Table 1: Selected socio-economic characteristics of cocoa farmers (n=120)

Variables	Indices
Sex (%)	96.7% (males)
Household size (numbers)	8 persons
Education (years)	93.33% (secondary education)
Occupation	72.22%
Farm income (Naira)	₦573,500.00
Membership of social organization	8 years
Extension con tact (number of visits)	2.9

Source: *Field Survey, 2024*

Farmers' Perception on Cocoa Agroforestry Systems Attributes

The result in Table 2 indicated that cocoa farmers perceived that these agro forestry had the attributes that sustain of farmers' income and conserve soil nutrients with mean scores of 3.8 each. Furthermore, it encouraged sustainable practice ($\bar{x}$=3.7), helped in the adaptation to climate change effects ($\bar{x}$=3.6) and contributed to climate change mitigation. More so, these attributes climate change mitigation, enhances the conservation of land resources, were environmentally friendly and had the ability to conserve soil nutrients with mean scores of 2.8 each. The farmers perceived these attributes' ability to reducing pest and disease infestation ($\bar{x}$=2.7), enhanced biodiversity conservation ($\bar{x}$=2.5) as they had the tendency to reduce soil erosion/flooding incidences ($\bar{x}$=1.8). The grand mean perception score of 3.0 indicated that cocoa farmers had favourable perception of these cocoa agroforestry system attributes in the study area. The result was in consistent with the findings of Mustapha *et al*., (2023), Oluwalade *et al*., (2023), Kekong, (2023), as they reported that technology characteristics or attributes as perceived by farmers facilitates its adoption and utilization in the long run.

Table 2: Distribution of respondents according to farmers' perception on cocoa agroforestry system attributes

Perception about cocoa agroforestry systems attributes	SA	A	SA	DA	Total	Mean	Decision
Agroforestry systems have the attributes adaptable to effect climate change	57(228)	27(81)	5(10)	I(1)	320	**3.6**	**Favourable**
Its attributes contribute to climate change mitigation	9(36)	56(168)	25(50)	0(0)	254	**2.8**	**Favourable**
Its attributes encourage adaptation and integration with other crops	38(152)	8(24)	44(88)	0(0)	264	**2.9**	**Favourable**
Cocoa Agroforestry attributes enhance the conservation of land resources	39(156)	17(51)	14(28)	20(20)	255	**2.8**	**Favourable**
Cocoa Agroforestry attributes are environmentally friendly	30(120)	23(69)	26(52)	11(11)	252	**2.8**	**Favourable**
Cocoa Agroforestry attributes enhance biodiversity conservation	14(56)	31(93)	28(56)	17(17)	222	**2.5**	**Favourable**
Cocoa Agroforestry attributes encourage sustainable practice	72(288)	10(30)	6(12)	2(2)	332	**3.7**	**Favourable**
The attributes have the ability to reduce pest and disease infestation	18(72)	36(108)	28(56)	8(8)	244	**2.7**	**Favourable**

Cocoa Agroforestry attributes aid in the sustenance of farmers' income	82(328)	3(9)	3(6)	2(2)	345	**3.8**	**Favourable**
Cocoa Agroforestry attributes increase cocoa productivity	77(308)	7(21)	5(10)	1(1)	340	**3.8**	**Favourable**
The attributes have the ability to conserve soil nutrients	23(92)	26(78)	39(78)	2(2)	250	**2.8**	**Favourable**
The attribute has the tendency to reduce soil erosion/flooding incidences	5(20)	8(24)	37(74)	40(40)	158	1.8	**Unfavourable**
Total						**36**	
Grand Mean ($\bar{x}$)						**3.0**	**Favourable**

Source: *Field Survey, 2024*
Key: Strongly Agree =SA, Agree=A, Disagree Agree=DA, Strongly Disagree=SD

Levels of Participation Farmers in Cocoa Agroforestry Systems

The result in Table 3 revealed that farmers had high participation of Cocoa-Plantain Intercropping ($\bar{x}$=3.0), Alley Cropping with Timber Trees ($\bar{x}$=2.9), Cocoa-Agroforestry with Fruit Trees ($\bar{x}$=2.8), Cocoa-Grains Intercropping ($\bar{x}$=2.2) and Live Fencing with Cocoa agroforestry systems ($\bar{x}$=2.1). Furthermore, the cocoa farmers had moderate participation in Cocoa-Rubber Agroforestry and Shade Grown Cocoa systems with mean rating of 1.8 each. The result revealed that farmers had high ($\bar{x}$=2.4) participation in cocoa agroforestry systems. This result corroborates with the findings of Oluwalade *et al*., 2023, Odoemenam *et al*., (2020) as they affirmed that Farmers' Field School programme played an important role in facilitating the adoption of cocoa technologies among farmers in Abia State, Nigeria.

Table 3: Distribution respondent according to levels of participation in cocoa agroforestry systems

Cocoa Agroforestry Systems	Always	Rarely	Never	Total	Mean	Decision
Alley Cropping with Timber Trees	83(249)	7(14)	0(0)	263	2.9	High
Cocoa-Plantain Intercropping	87(261)	3(6)	0(0)	267	3.0	High
Cocoa-Agroforestry with Fruit Trees	73(219)	13(26)	4(4)	249	2.8	High
Live Fencing with Cocoa	13(39)	72(144)	5(5)	188	2.1	High
Cocoa-Grains Intercropping	40(120)	27(54)	23(23)	197	2.2	High
Cocoa-Rubber Agroforestry	9(27)	52(104)	29(29)	160	1.8	Moderate
Shade Grown Cocoa	11(33)	51(102)	28(28)	164	1.8	Moderate
Total					**16.54**	
Grand Mean ($\bar{x}$)					**2.4**	

Source: *Field Survey, 2024*

There is no significant relationship between socio-economic characteristics of respondents and their participation in cocoa agro-forestry production systems

The results in Table 4 showed that coefficient for sex was positive and significant at 5.0% level of probability. This implied that more participation of male farmers in cocoa farming will lead to increase in participation in coco agro-forestry practices than their female counterpart. This result is in consonance Amerino *et al*., (2024) as they revealed that male dominant in cocoa production and thus will affect the utilization of its technology. The coefficient for household was also positive and significant at 5.0% 5.0% level of probability. This indicates that increase in the number of household size of cocoa farmers will lead to an increase in participation in cocoa agro-forestry production system. Thus, larger farm households have higher chance to adopt technologies to improve the productivity and income (Kyere (2018). Coefficient for education was positive at 5.0% level, indicating that increase in years of education will increase participation in cocoa agro-forestry production system. This affirmed that farmers can to understand and

adopt available innovations which encourage participation in cocoa production system (Okoye, *et al*., 2020). The coefficients for farm income and number of extension contact were positive at 10% each and significantly related with participation of cocoa production system. This indicated that any increase in farm income (Naira) and number of extension contact will lead to increase in participation of cocoa agro-forestry production system and vice visa. It is usually hypothesized that the adoption of agricultural technologies requires sufficient financial wellbeing (Amerino *et al*., 2024). Number of extension contacts indicates relatively probability of access to information about new and modern agricultural practices from the extension agents Uduma and Nwaobiala, 2024). Membership of social organization was also found to be significant and positive at 5% level of probability. This showed that those who do not belong to any social organization are more likely to participate in agro-forestry production system (Nwaobiala *et al*., 2024; Obadimu *et al*., 2020).

Table 4: Multiple regression estimates of socio-economic factors influencing participation in cocoa agroforestry production system

Variables	Linear	Exponential +	Double log	Semi-log
Constant	1.7709(0.28)	1.8589(4.71)***	0.7697(0.70)	-14.521(-0.83)
Sex	1.1935(3.20)**	0.0766(2.36)*	0.0761(1.81)*	1.1820(2.43)*
Age	0.0177(0.50)	0.0011(0.51)	0.0920(0.80)	1.4779(0.81)
Marital status	-0.0572(-0.05)	-0.0096(-0.13)	0.0010(0.01)	0.1178(0.10)
Household size	0.2956(2.66)**	0.0176(2.53)**	0.1055(2.56)**	1.7588(2.68)**
Education	0.6820(2.96)**	0.0439(2.57)**	0.5541(3.19)**	8.5817(2.92)**
Farming experience	-0.0250(-0.90)	-0.0014(-0.83)	-0.0349(-0.96)	-0.5923(-1.02)
Farm size	0.1081(0.86)	0.0076(0.97)	0.0056(0.69)	0.0769(0.59)
Occupation	-0.2690(-0.65)	-0.0177(-0.68)	-0.0177(-0.68)	-0.2689(-0.65)
Farm income	6.9807(2.70)**	4.72e-08(2.31)*	0.0217(1.08)	0.3177(2.64)**
Non-Farm income	-6.80e-07(-0.55)	-4.22e-08(-0.52)	-0.0131(-0.61)	-0.2068(-0.61)
Amount of credit	-6.40e-07(-0.32)	-2.33e-08(-0.19)	-0.0097(-0.43)	-0.1936(-0.54)
Social organization membership	0.3186(2.55)**	0.0203(2.58)**	-0.0197-2.61)*	-0.3099(-2.58)**
Extension contacts	1.5934(1.84)*	0.0999(1.84)*	0.2185(3.94)***	3.475(1.61)
F value	7.45	7.98	7.01	7.39
R-squared	0.4920	0.5020	0.4537	0.4858
Adjusted R- squared	0.3938	0.4105	0.3558	0.3623

Source: *Field survey, 2024*

STATA 13 Results

* p≤ 0.10, ** p≤ 0.05 and ***p≤ 0.01 + = lead equation

Farmers' Participation in Cocoa Agroforestry Systems is not influenced by Its Perceived Attributes in the Study Area

The result in Table 5 showed that coefficient for climate change adaptation was positive and significant at 5.0% level of probability with farmer's participation of cocoa agro-forestry (AF) system. This indicated that increase in climate change adaptation measures will increase participation in cocoa agro forestry system by the farmers. Nair *et al*., (2021) noted that the key components of AF systems include trees, shrubs, pasture, crops, and livestock as well as the environmental aspects of soil, climate and landform. The coefficient for climate change mitigation negative and highly significant at 1.0% level of probability. This was an indication that increase in climate change mitigation will lead to decrease in utilization of cocoa agro-forestry production system in the study area. Climate change mitigation measures such as carbon pricing and certification schemes can increase the costs of cocoa production, making it harder for farmer to adopt new technologies following the studies of (Amponsah-Doku *et al*., (2022). The coefficient for use of environmentally friendly measures was also found to be positive and significant 10.0% with participation in agro-forestry system among the farmers in the study area. Ruf *et al*., (2004) noted that cocoa agro-forestry production system is one of the best examples of sustainable agriculture practices that protects the tropical

forest ecosystem and promotes higher levels of biodiversity. Coefficients for Disease and pest reduction measures were negative and significantly related with participation in cocoa agro-forestry production system at 5.0% level. This implied that increase in disease and pest reduction strategies will lead to reduction in participation of cocoa agro-forestry measures in the study area and vice versa. This is also expected as reduced pest and disease pressure can promote ecological balance and biodiversity, hence increase utilization of agro-forestry production technology following the studies of (Kouassi *et al*., 2021). The coefficient for soil conservation and reduced soil erosion measures had an indirect relationship with participation in cocoa agro-forestry production technologies at 10.0% level of probability. This indicated that farmers reduced number of soil conservation and reduced erosion measures will increase participation in cocoa agro-forestry production system probably to save and protect the farm (Amponsah-Doku *et al*., 2022).

Table 5: Multiple regression estimates of cocoa perceived attributes influencing farmers' participation of cocoa agro-forestry production systems

Variables	Linear	Exponential +	Double log	Semi-log
Constant	19.8630(6.24)***	3.0281(15.21)***	2.8854(16.38)***	17.6132(6.26)***
Climate change adaptation	-0.3961(-4.05)***	0.0242(3.03)**	0.0337(0.66)	-0.5589(-1.92)*
Climate change mitigation	-0.1713(-2.89)**	-0.1118(-3.74)***	-0.0389(-2.25)*	-0.5993(-0.65)
Integration with crops	-0.0963(-0.43)	-0.0068(-0.49)	-0.0389(-0.29)	-0.1486(-0.23)
Land resource conservation	0.0791(0.51)	0.0049(0.51)	0.0190(2.05)*	0.3092(3.22)**
Environmental friendly	0.1193(2.61)**	0.0066(2.11)*	0.0218(3.74)***	0.3876(3.77)***
Bio diversity conservation	0.0606(0.31)	0.0043(0.35)	0.0335(0.51)	0.1937(0.46)
Sustainable practices	-0.0042(-0.02)	-0.0009(-0.06)	-0.0039(-0.11)	-0.0354(-0.06)
Improved soil chemical properties	-0.0323(-0.15)	-0.0039(-0.28)	-0.0055(-0.17)	-0.0248(-0.05)
Disease and pest reduction	-0.2072(1.91)*	-0.0136(-2.99)**	-0.0135(-0.27)	-0.2007(-0.25)
Sustenance off farm income	-0.1204(-0.39)	-0.0086(-0.43)	-0.0059(-0.11)	-0.0583(-0.07)
Increase in productivity	0.0588(0.26)	0.0024(0.17)	0.0116(0.30)	0.2347(0.38)
Soil conservation,	-0.4251(-1.99)*	-0.0265(-1.98)*	-0.0431(-2.67)**	-0.6889(-3.17)**
F value	6.73	7.75	5.51	5.59
R-squared	0.4017	0.4222	0.3736	0.3789
Adjusted R- squared	0.3383	0.3577	0.3008	0.3105

Source: *Field survey, 2024*
STATA 13 Results
* p≤ 0.10, ** p≤ 0.05 and ***p≤ 0.01
+ = lead equation

Conclusion and Recommendations

The study concluded that cocoa farmers had favourable perception and high participation in cocoa agroforestry system. The coefficients for sex, education, farm income, number of extension contacts and membership of social organization, influenced farmers' participation of cocoa agro-forestry production systems in the study area. More so, coefficients for climate change adaptation, climate change mitigation, use of environmentally friendly measures, disease and pest reduction measures influenced perceived attributes of farmers' utilization of cocoa agroforestry systems in the study area. The study therefore recommended the need to introduce farmers to other agroforestry-based climate change adaptation technologies in order to effectively build resilience, investment in education and encouraging them to join farmer-based organizations and other social networks for peer learning to enhance participation of cocoa agroforestry.

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