

## **AGROFORESTRY TECHNOLOGY: A CLIMATE CHANGE MITIGATION MEASURE FOR SUSTAINABLE FOOD SECURITY IN NIGER DELTA REGION OF NIGERIA**

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### **ABSTRACT**

*Oil and Gas production in Nigeria are domiciled in the Niger Delta. Agroforestry technologies were introduced as mitigation strategies against food insecurity as land management technique due to constant litigation on accusation of emissions, increase climate change and environmental devastation. Objectives were to determine reasons for agroforestry practice by rural women and identify effects of agroforestry technologies on income in the oil and gas rich Niger Delta. A total of 270 respondents in Bayelsa, Imo and Rivers States were selected using purposive and random sampling techniques. Data were collected with questionnaires and focus group discussion. Descriptive statistics and Discriminating index were used for analysis. Results showed a mean age of 51years, 38% completed secondary school, 77% married, household size of 6 and 3-4 years' experience. A discriminating index of 2.5, food production (2.8\*), Income generation (3.4\*), raw materials production (3.3\*), Nutrient replenishing (3.1\*) and soil quality (2.9\*) topped reasons for agroforestry practice. It was concluded that Agroforestry technology should be advocated through extension education to meet food needs of Niger Delta to addressing the reputations of Multinational Oil and Gas companies in Nigeria. This study recommends that Multinational Oil and Gas companies should assist primary stakeholders to establish agroforestry farms as part of its corporate social responsibility addressing food insecurity and unemployment.*

**KEYWORDS:** Agroforestry, Oil and Gas, Niger Delta, Food Security, women farmers.

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### **INTRODUCTION**

Sustainability of agricultural practices is the ability to manage available inputs and resources to satisfy changing human needs without compromising environmental quality and conservation of natural resources. According to Alao and Shuaibu (2013), Agroforestry is defined as a dynamic ecologically based natural resource management system that integrates trees on farms and in the agricultural landscape, diversifies and sustains production for

increased social, economic and environmental benefits for land users at all levels. Therefore, agricultural practices or farming systems that enhance environmental quality in addition to ensuring food security ought to be encouraged. A situation where environmental changes naturally occur without consideration to food security or creating rooms for exploitations of alternative means of livelihood through farming systems is not only worrisome but calls for urgent attention towards mitigating harmful effects of such environmental changes. Nigerian Oil and Gas

production hub, the Niger Delta region had been under serious attack of environmental pollution and degradation resulting from its operations. Awareness had been created by late duos of Dr Ken Saro-wiwa and Oronto Douglas of the region that had questioned constant emission of gases into the atmosphere in the Niger Delta region. Be it as it may, the multinational oil and gas production companies in the region, Shell Petroleum Development Company Nigeria Limited (SPDC), Total Exploration and Production Company (TEPNG) and Nigeria Agip Oil Company (NAOC) among others had tried significantly to clean up this accusation that has hunted the industry. Agriculture being the main stay of the people in the region towards enhancing food security, the multinational oil and gas companies looked away from their core mandate of exploration and production of hydrocarbons to embrace agricultural services under its corporate social responsibility (CSR). The CSR initially advocated on services that enhanced the production of staple foods like tuber crops, cereals and fisheries to meet local demands. This programme was very dear in the hearts of the multinational giants to change the mind-sets that oil and gas production emissions actually affect food production and invariably food security. Various demonstration farms and agricultural officers were engaged to cascade such information while interacting with research institutes to obtain improved varieties of high yielding crops and high performing animal species for distribution as inputs to farmers organized into co-operatives. It is on this basis that agroforestry as climate change mitigation measure for sustainable food security was researched in the 3 states (Bayelsa, Imo and Rivers) of oil and gas rich Niger Delta region of Nigeria.

The rural communities ignorantly would not be interested in measuring carbon emissions, rainfall intensity, draught capacity, soil nutrient leaching rates that could affect agricultural production yields, they went ahead to demonstrate against the multinationals, an exercise that grossly affected productions, facilities, reputation and income in both upstream and downstream operations. In order to counter effects of these accusations, experts in agriculture introduced Agroforestry as technology to mitigate climate change. What this means is that this study was not conducted to measure climate change variables or indices of food security, rather as operational activity to improve Availability, Accessibility and Affordability of major staple foods in the operational domain of the multinationals thereby enhancing acceptability of primary stakeholders in their operational environment. You may wish to classify it as perception study of rural women involved in agroforestry to ensure food availability to their households. Having defined the pathway of the study, it is imperative to understand the import of agroforestry.

Agroforestry is land utilisation system and technology where perennial tree crops are deliberately intercropped with agricultural crops and or animals in some form of spatial or temporal arrangement so that each will economically survive on its own without jeopardizing chances of survival of the other. Leakey (2015) revealed that over 1.3 million people worldwide practicing agroforestry has seen it as emerging best phenomenon towards achieving sustainable agriculture and food security. The reason behind this was that agroforestry as a system of land management is recommended due to increased deforestation and ecological degradation, shortages of fertilizers and reawakening of scientific interest in the farming systems since

it increases species diversity within farming systems. It also provides human needs while supporting wildlife, soil micro-organisms, rural communities, economic interests, watersheds, biodiversity and lots more (Elevitch and Wilkinson, 2003). Most agroforestry systems of the world combine various intensities of traditional agricultural practices with modern accessible low-cost technologies towards achieving its objectives. In the face of continued reduction of soil fertility occasioned by constant leaching among others from increased annual rainfall in Nigeria, none availability and high cost of fertilizers, low arable land availability and deforestation as a result of urbanization, food insecurity had continued to be the problem of Nigeria. This phenomenon had also led to increased social vices like kidnapping, armed robbery, cyber fraud, prostitution, cultism, militancy, among others.

Agroforestry systems provide income to the practitioners, improve soil fertility, enhance local climate conditions and reduce anthropogenic pressure on the soil and biodiversity. It provides direct benefits like ecosystem services and indirectly contribute to mitigate global issues of climate change such as carbon sequestration and micro-climate modification. Agroforestry can be seen as a child of necessity, born out of the urge for societal response to fulfil immediate basic human needs of food security, fuel, fodder, shelter and ecosystem sustainability. Mbow et. al., (2014) correctly frowned at most countries that focus on reforestation and forest protection initiatives to mitigate climate change as these efforts were conflicting with requirement of expanding agricultural production to feed the ever growing population of Nigeria in particular and Africa in general. Intensification of agriculture and farming systems through agroforestry by integrating trees into intensive agricultural

land use underlines the importance of achieving sustainable food security and biodiversity goals simultaneously. According to Mbow (2013) agroforestry is moving food security issue beyond a purely agronomic focus to embrace a more comprehensive view of socio-ecological systems. Agroforestry practices can provide pathways to ecological intensification and contribute significantly to reduce the yield gap. It offers a safe and environmentally sound approach to address rural communities' food and fuel shortages. Growing trees increase soil fertility, fuel sources and production of nutritious fruits. Fortunately, it had been recognized that agroforestry farms and landscapes in most part of African rural communities provide increased income, serves as wind brakes, improves soil fertility and other environmental outcomes and range of other ecological services.

Economic situation in Nigeria has not been encouraging in recent times regardless acclaimed efforts of all tiers of the government. The major reason behind this was that Nigeria operates a mono-economy that is dependent on Oil and Gas. Prices of these resources were determined at the international market scene. Debt servicing and inflation have reduced Nigerian economy and the worth of her currency internationally has left much to be desired. To this effect, food insecurity has become a major problem in the face of ever increasing population. Climate change of heavy rainfall has caused tremendous leaching where soil nutrients have been depleted with a resultant effect of low yield and invariably, low income. Urbanization or quest for development has encroached on agricultural arable lands thereby stimulating hunger in the country. Multinational oil and gas activities of exploration and production of hydrocarbons have increased emissions and ozone layer

depletion. Air pollution through gas flaring is a daily occurrence. More worrisome is pollution that destroys agricultural lands even after remediation. The question that bogs the minds are how long to wait before remediated land would regain its nutrient for continued agricultural production. Unfortunately, various agricultural development programmes of the government (past and present) have not guaranteed food security in the face of tremendous climate change. It became imperative to research on a farming system that attempts to solve food security problem while addressing scarcity of available arable land with a view for optimal utilization to enhance sustainable food security. To address this gap that has the potentials of increasing insecurity in the Oil rich Niger Delta in particular and Nigeria in general, a research on agroforestry as climate change mitigation measure for sustainable food security became very inevitable. Specifically, the objectives were to determine reasons for practicing agroforestry in the study area and identify the effects of agroforestry practice on food security in oil and gas rich region of Nigeria.

## **MATERIALS AND METHODS**

The study area for the research was Bayelsa, Imo and Rivers States, located in the South East and South - South zones of Nigeria. These are part of the states that make up the Niger Delta region which is the oil and gas hub of Nigeria that are constantly accused of environmental degradation resulting from oil and gas exploration and exploitation. Thus, the effect of climate change supposedly should be significant in the Niger Delta region as it hosts numerous oil and gas facilities and assets that have also increased human presence in the state. However, agricultural production is always taken seriously as the states are agrarian where agricultural production scarcely meets demand for food

(for those that can afford ever increasing prices of commodities). In this area also, women are mostly sentimentally attached to their children who eventually form major percentage of the household members that consume more food, hence food insecurity is taken seriously. To this effect, women crave for ways of battling food insecurity in the households and collectively in these states. Multistage sampling technique was adopted. Purposively, Bayelsa, Imo and Rivers States of Nigeria were chosen based on Multinational oil and gas companies presence and facilities that could readily stimulate climate change. Heavy rainfalls and other climatic change effects are show more presence in the region. Purposively chosen also as effects of climate change cannot be confined in a particular state while agricultural development efforts cut across the whole states in order to cushion effects of food insecurity. However, 3 local government areas (LGAs) were randomly selected from each state to produce a total of 9 LGAs involved in the study. Randomly also, 3 communities were selected from each of the LGAs to have 27 communities involved in the study. Finally, 10 women that practice agroforestry were purposively selected from each community with the aid of Extension Officers of the states' owned Agricultural Development Programme assigned for the zones. The reason for purposive selection of women that practice agroforestry was because the technology was not yet popular with farmers in the area. In fact, in practice, some cut down the perennial (tree) crops to provide sunlight for the annual crops. A practise that typified ignorance that calls for increased extension education in the use of agroforestry. Therefore, a total of 270 respondents were involved in the study.

Four major instruments were deployed in primary data collection for the study. They

were Questionnaire, Semi structured interview (SSI), Focused Group Discussion (FGD) and Personal Observation (PO). In addition, secondary data from relevant journals and books were reviewed to align or otherwise with the thought and pathways of this research work. Descriptive and inferential statistical tools were used to analyse data collected for the study. Descriptive statistical tools such as frequency, percentages and means were used to obtain expected results.

## **RESULTS AND DISCUSSION**

### **Socio-economic parameters**

Table 2 showed that young women, age range of 41 – 50 (37.8%) and mean age of 51 (50%) had moved to the rural areas to practise agroforestry perhaps due to accommodation problems in the cities. Government in a bid to restore the ecstatic nature of urban cities have demolished most properties thereby forcing people to return to rural communities. In this regard, such households could have moved to the rural communities to explore alternatives to meeting household food needs through agroforestry for optimally land use.

### **Marital Status**

Most women farmers that engage in agroforestry are married (77%) (Fig 1) and do so to cushion the effects of climate change on dwindling food production. Therefore, strategies would need to be developed in order to meet household food needs to prevent the family from going into starvation.

### **Educational levels**

Table 3 implied that a total of 34% of agroforestry farmers in Imo State, Nigeria can boast of completing secondary education as this scenario did have positive extension implication as it was easier to understand related agroforestry technologies disseminated to the farmers. It means that most rural women are literate farmers, which

is expected to stimulate their involvement in agroforestry practices in conformity with assertion of Ani (2007) that literacy promotes farmers' involvement and productivity in agriculture. By implication, it could mean increased food production from agroforestry farms and subsequent understanding of reasons behind agroforestry practice.

### **Household Size**

The study revealed that probably as a result of effects of climate change in a dwindling economy of Nigeria, most households could no longer meet the regular food requirement of household members. Land also being scarce; it becomes imperative that women with average household of 6 as a matter of urgency had to tilt to agroforestry in attempt to be food secured. A total of 62% of women in agroforestry had household size of 5 – 8 meaning strategic planning to ensure that households were not malnourished. Similarly, Egwuonwu and Onyeaka 2020 opined that organic farming has mostly females who had small farms, enough farming experience, were educated. These women (mothers) that spent more hours at home with children would naturally feel uncomfortable given such scenario.

### **Agroforestry Practice Experience (APE):**

Unfortunately, a total of 33% of women that practise agroforestry had only 3 – 4 years' experience in the enterprise. This would justify the fact that they were probably returnees from the urban areas as a result of hardship occasioned by recent political wrangling and insecurity. Having returned home and agricultural yield had nose-dived due to climatic changes, the best possible alternative is to engage in agroforestry to maximize land resource.

### **Income from Agroforestry farming**

Monthly income from Agroforestry practise averaged ₦34, 000 (\$100 approximately)

which is translated to mean ₦1, 133 (\$3) per day. This means that Agroforestry farming practice when commercialized will certainly take farmers out of poverty as poverty line was pegged at earnings of \$2 per day. It means that it is lucrative to meet family food requirement and probably generate additional earnings (Idumah and Akintan, 2014). If practiced professionally as enterprise, agroforestry has the potentials not only to meet household food requirements but could also provide employment and improve perceived stakeholders' relationship with multinational oil and gas companies in the Nigerian Niger Delta.

### **Reasons for Practising Agroforestry**

In Table 7, Food Security was being considered based on Availability, Accessibility and Affordability based on other sub-variables like soil quality improvement, raw materials, home nutrition, health improvement among others, this is consistent with the finding of Dawson et al., (2013) which opined that agroforestry supports food and nutrition through direct provision of food and raises farmers income. Thus, ten (10) out of fourteen (14) identified associated Food Security reasons were significantly positively above average mean of 2.5. The implication here is that rural communities in Oil and Gas producing communities in Nigeria especially women engage in agroforestry to meet demands for food security in the face of grossly reduced agricultural production resulting from climate change occasioned by oil and gas exploration and production activities amongst others. Agroforestry practices are designed primarily to benefit agriculture, which always appeal to farmers (Dosskey and Schoeneberger, 2012). These reasons could be harnessed towards using agroforestry as intervening programme towards oil and gas conflict resolution

mechanism and reputation management strategy.

### **CONCLUSION AND RECOMMENDATIONS**

Research on Agroforestry as climate change mitigation measure for food security was timely not only as land resource management technique but as melting point for household food requirement and income generation above poverty line. Rural women had significant reasons for engaging in agroforestry.

It was concluded that agroforestry though not a panacea to food security should be advocated through extension education to meet food needs of Niger Delta in particular and Nigeria in general while strategically addressing the reputations and image of Multinational Oil and Gas companies in Nigeria. It was recommended that Multinational Oil and Gas companies should assist its primary stakeholders to establish agroforestry farms as part of its corporate social responsibility. There should be deliberate policy framework by Federal Government of Nigeria to provide incentives for innovators and early adopters of Agroforestry technology to address food security and unemployment amongst vulnerable groups - women and youths as part of its contributions towards achieving Sustainable Development Goals (SDGs).

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**APPENDICES**

**Table 1: Sampling procedure**

Niger Delta (Oil & Gas producing) States of Nigeria	LGAs	Communities	Women agroforestry farmers	Total Respondents
Bayelsa State	3	3	10	90
Imo State	3	3	10	90
Rivers State	3	3	10	90
Total Respondents				<b>270</b>

Source: Field data, 2019

**Table 2: Farmers distribution according to age**

Age (yrs.)	Frequency	Percentage	Mean
21 – 30	10	3.7	
31 – 40	23	8.5	
41 – 50	102	37.8	51
51 and above	135	50	
Total	270	100	

Source: Field data 2019

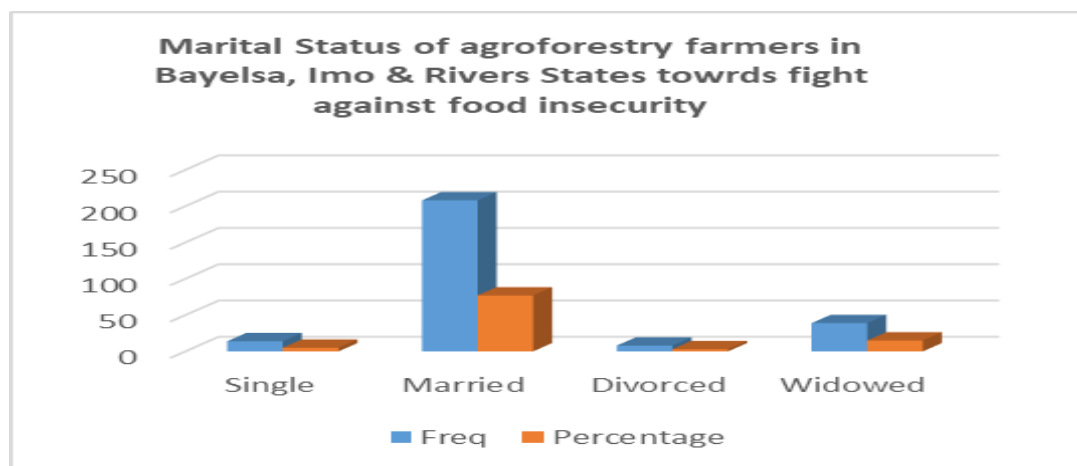


Fig 1. Marital status of agroforestry farmers in the oil and gas Niger Delta region of Nigeria.



**Table 3: Educational attainment of agroforestry farmers in the study area**

<b>Level of education</b>	<b>Frequency</b>	<b>Percentage</b>
No formal education	18	7
Primary school attempted	33	12
Primary school completed	42	16
Secondary school attempted	24	9
Secondary school completed	93	34
Tertiary Institutions attempted	27	10
Tertiary institutions completed	33	12
Total	270	100

Source: Field data, 2019

**Table 4: Household size of Agroforestry farmers**

<b>Size</b>	<b>Frequency</b>	<b>Percentage</b>	<b>Mean</b>
1 – 4	67	25	
5 – 8	168	62	6
9 – 12	31	11	
13 – 16	4	2	
Total	270	100	

Source: Field data, 2019

**Table 5: Agroforestry farming experience of respondents**

<b>Farming experience (yrs.)</b>	<b>Frequency</b>	<b>Percentage</b>
1 – 2	54	20
3 – 4	88	33
5 – 6	66	24
7 – 8	40	15
>8	22	8
Total	270	100

Source: Field data, 2019

**Table 6: Monthly Income of agroforestry farmers**

Monthly Income (N)	Frequency	Percentage
1,000 – 10,000 (\$3 - \$29)	12	4
11,000 – 20,000 (\$31 - \$57)	32	12
21,000 – 30,000 (\$60 - \$86)	53	20
31,000 – 40,000 (\$89 - \$114)	49	18
41,000 - < (\$117)	124	46
Total	270	100

Source: Field data, 2019

**Table 7: Farmers' distribution based on reasons associated with agroforestry practice**

Associated Food Security Reasons	Strongly agreed	Agreed	Disagreed	Strongly disagreed	Mean	SD
Household food production	127	51	12	80	2.8*	0.3
Income generation	146	96	17	11	3.4*	0.4
Raw materials	119	116	24	11	3.3*	0.4
Shelter/shade for man & animals	113	105	37	15	3.2*	0.5
Soil quality improvement	94	120	32	30	2.9*	0.5
Home nutrition	74	132	34	30	2.9*	0.5
Wind breaker	119	103	26	22	3.2*	0.3
Nutrient replenishment	101	107	44	18	3.1*	0.3
Economic growth	73	120	67	10	3.0*	0.4
Human health improvement	74	141	31	24	3.0*	0.4
Reduce rural-urban migration	65	111	58	24	2.7*	0.4
Food consumption only	42	33	80	115	2.0	0.5
Meet local food demands	62	54	23	131	2.2	0.3
Meet family food item choice	56	31	53	130	2.0	0.3

Source: Field data, 2019

Discriminating index = 2.5