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ADOPTION OF CLIMATE SMART AGRICULTURAL PRACTICES AND FARMERS' WILLINGNESS TO ACCEPT INCENTIVES IN NIGERIA

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Abstract

Climate Smart Agricultural (CSA) practices has been identified as a key element in the successful response to the threats of climate change to sustainable agricultural production and food security in Africa. This study determines the extent of adoption of selected CSA practices and farmers' willingness to accept incentives for adoption of CSA practices in Nigeria. A multistage sampling procedure was used to select sample of farmers from four states in the North Western geopolitical zone of Nigeria. Data were collected through interview schedule using questionnaire. Descriptive statistics was used to analyze the data. The results showed that adoption of the selected agricultural practices was generally low (<50%). A larger proportion (ranging from 72% to 80%) of respondents indicated their willingness to accept appropriate incentives to shift to the selected CSA practices. The mean financial incentives an average farmer is willing to receive to shift from his/her production system to the specified CSA option, are: N36, 522.00, N85, 715.00, N56, 255.00 per hectare per season for adoption of Agro forestry, CSA with manure and CSA without manure respectively. Sensitization of farmers on the need to adopt climate smart practices towards reduction of adverse effect of climate change should continue. Financial incentives should be introduced to improve farmers' adoption of CSA practice.

Key words: Sustainable agriculture, Climate change, climate smart practices, adoption incentives, Nigeria

INTRODUCTION

Climate change has been identified as one of the great challenges affecting small scale farmers world-wide (IFAD, 2011). Since climate determines the pattern of vegetation, types and yields of crops and animals as well as the length of cropping seasons, any change in climate may affect the production and supply of food thereby enhancing or limiting the capacity of agriculture to play its major role as supplier of food. According to FAO, 2014 climate change is likely to cause considerable crop yield losses thereby adversely affecting small holder livelihoods in Africa. As a result, food security and income generation opportunities for the farming households that rely on agriculture may be in jeopardy (FAO, 2014). It is projected that crop yield in Africa may fall by 10-20% by 2050 or even up to 50% due to climate change (Jones, 2003, Nwaobiala and Nottidge, 2013). Given the severity of food insecurity in the world especially in Africa, it is important that measures are taken to minimize adverse effect of climate change on agricultural production. The recognition of this need was globally demonstrated through adoption of the Paris Agreement (UNFCCC, 2015). The challenges of how to turn the promises of that agreement into reality necessitates the need for agricultural practices that would address the threats pose by climate change. In response, the concept of Climate Smart Agriculture (CSA) was developed. FAO, 2013 defined CSA as any approach that addresses three pillars of food security (sustainable increase in productivity), adaptation (enhanced resilience to climate change), and mitigation (removal of Green House Gases emissions). improved crop and grazing land management (agroforestry, residue management, soil and water conservation etc.), restoration of areas drained for crop production, and restoration of degraded lands (Smith, et al 2007), direct seeding under reduced-tillage (Zheng et al., 2014); improved protective soil cover through cover crops, crop residues or mulch (Muzangwa et al., 2013); and crop diversification through rotations (Lin, 2011; Davis et al., 2012); integrated soil fertility management, which involves combining inputs of organic matter i.e. mulch, compost, crop residues and green manure with fertilizers to address or prevent macro- and micro-nutrient deficiencies (FAO, 2013). According to FAO, 2010, adoption of CSA practices by farmers has been relatively low globally, despite the promising benefits. Hence, a number of incentives have been introduced in some countries to promote adoption of CSA among farmers (Woelcke 2012; FAO, 2014; WorldBank, CIAT, CATIE, 2014; Ramachandran, 2015). Table 1 presents some current threats of climate change and possible CSA measures. Other CSA practices include:

Table 1: Climate change threats and required Climate Smart Agricultural Practices.

Climate change indicator	Impact on Agriculture	CSA practices required
Higher temperatures	Reduced crop yields	New crop varieties with greater heat tolerance
Less precipitation	Reduced crop yields in rain-fed agriculture	New crop varieties with lower water requirements Improved irrigation techniques Improved water collection, storage and distribution techniques
Reduced availability of irrigation water	Reduced crop yields in irrigated agriculture	Improved irrigation efficiency New crop varieties with lower water requirements
Salt water intrusion	Reduced irrigation water	Barrier to salt water intrusion New crop varieties with greater salinity tolerance Improved water collection, storage and distribution techniques
Increased flooding or water logging	Reduced crop yields or loss of crops	New crop varieties with higher moisture tolerance Improved drainage or flood control techniques
Increased incidence of pests and diseases	Reduced crop yield	New crop varieties with improved pest and disease resistance Improved pests and disease management techniques
Extreme weather events	Loss of crops	Improved techniques to increase resilience of crops to extreme weather events. Improved extreme weather events prediction and early warning systems

Source: Ramachandran, 2015.

The summary of relevant climate funds available for agriculture in developing countries is presented in Table 2. Nigeria is expected to benefit from such fund. However, the willingness of Nigeria farmers to accept incentives for shifting to CSA practices if eventually introduced to them is yet to be documented. Such information is necessary to guide policy makers on the right steps to take whenever attempt is made to incentivizing adoption of CSA. The goal of this study therefore, is to provide such information. In Nigeria, several studies have been carried out on climate change and agriculture. Some of them focused on the effect of climatic variables on agricultural production (Ogbuene, 2010; Olanrewaju, 2010; Ogundele and Jegede, 2011; Akpenpuun and Busari 2013; Nwaobiala and Nottidge 2013; Oluyole, et al, 2013; Tiamiyu, et al, 2015) while some reported farmers' perception of climate change and adaptation strategies (Ayanlade, et al 2017). From these studies it is obvious that climate change is real and has significantly impacted on agricultural production. Although studies have shown that various adaptation strategies were adopted by farmers against the effect of climate change, little is specifically known about farmers' level of awareness and adoption of CSA as a package in Nigeria. It is against back drop that this study seeks to determine CSA adoption among farmers. Although the concept of CSA is new in Nigeria, and still evolving, many of the practices that make up CSA already exist and were introduced to farmers to cope with various production challenges. Better understanding of the CSA adoption among agricultural producers in Nigeria would guide policy makers to formulate appropriate policies in response to the threat of climate change to sustainable food production. The objective of this study therefore, is to determine extent of adoption of CSA and farmers' willingness to accept incentives for adoption of CSA in Nigeria. The findings will serve as baseline information to guide decision of policy makers in formulating effective programmes to mitigate adverse effect of climate change in general and specifically on policy of incentivising adoption of CSA in Nigeria.

Table 2: Summary of multilateral climate funds potentially relevant to Agriculture

Funds	Description	Size pledged ($)	Secretariat and trustee	Thematic Focus	Regional Focus
Adaptation Fund	Under KP. Financed by 2% levy on CERs issued under Clean Development Mechanism (CDM),	273.87m	Global Environmental Fund (GEF)	Adaptation	No
Continued table 2					

GEF Trust Fund	Climate change is one of 6 focal areas supported by the GEF Trust Fund. Objective is to help developing countries and economies in transition to contribute to the overall objective of the UNFCCC (United Nations Framework Convention on Climate Change)	1.14bn	GEF	Mitigation, Adaptation	No
Global Climate Change Alliance (EU)	Objective is to build an alliance on CC between EU and poor developing countries	226.12m	EuropeAid	Adaptation, Mitigation	SIDS and LDCs
Least Developed Countries Fund	Focused on preparation and implementation of National Adaptation Programmes of Action (NAPA)	414.95m	GEF	Adaptation	LDCs
Pilot Program for Climate Resilience	Focus on integrating consideration of climate resilience in national development planning	982 m	World Bank	Adaptation	SIDS and LDCs
Special Climate Change Fund	Objective is to implement long term adaptation measures that increase the resilience of national development sectors to climate change impacts. Technology transfer and capacity building also important goal.	216.55m	GEF	Adaptation	No

Source: Climate Funds Update, GCCA. http://www.gcca.eu/pages/41_2-GCCA-Beneficiaries.html

METHODOLOGY

The study was conducted in four states (Kaduna, Kano, Kebbi, Sokoto) in Northern part of Nigeria. Major vegetation strata of the area are guinea savannah, Sudan savannah and Sahel savannah which are suitable for production of various kinds of crops including: cereals (maize, millet, rice, sorghum, sugarcane, acha), oilseeds (castor, cotton, sesame, soybean), grain legumes (cowpea, bambara nut, groundnut, melon), roots and tubers (cassava, yam, ginger), tree crops (cashew, citrus, gum Arabic, mango, neam, oil palm, shea) as well as fruits and vegetables (carrot, garden egg, onions, pawpaw, tomato, water melon). Primary data was collected through interview schedule with structured questionnaires. The interview was conducted by the researchers in conjunction with trained enumerators chosen from among the staff of Agricultural Development Programmes (ADPs) of the selected states. Multistage sampling technique was used to select farmers that provided information for this study. The first stage involved purposive selection of one zone (North West) from the list of six geo-political zones in Nigeria. The second stage involves selection of four states from the list of states in the selected zone based on predominant vegetation strata. The third stage of sampling was the selection of villages from each Agricultural Development zones of the selected states. In the fourth stage, 10 to 15 farmers were randomly selected from each selected villages on the basis of probability proportionate to size. A total of 577 respondents across three vegetation strata were interviewed.

Data were analyzed using descriptive statistics. The following Climate Smart Agricultural Practices (Branca, et al., 2011; Ramachandran, 2015; Saguye, 2017) were examined:

i. Agronomic practices (Improved seed varieties, crop rotation, intercropping, cover crop);

ii. Fertilization (Organic fertilizer, efficient use of nitrogen fertilizer);

iii. Tillage and residue Management (Conservation tillage, incorporation of crop residues);

iv. Water Management (Irrigation, bunds, terracing, Contouring, water harvesting);

v. Integrated Pest Management (blend of cultural, biological and chemical control)

vi. Agro-forestry (Inte;rcropping crops and trees, Live fencing);

Adoption rate was estimated based on the percentage of adopters in the total sample (Saguye, 2017).

The following criteria were used to rank the rate of adoption:
Adoption rate greater than 70% = very high,
Adoption rate within 60 to 70% = high,
Adoption rate within 50 to 59% = fairly high,
Adoption rate within 40 to 49% = fairly low
Adoption rate below 40% = very low.
Farmers' willingness to accept incentives for adoption was analyzed using choice experiments in which opinion of those who are willing to accept financial incentives were given array of options to make their choices based on the quantity of carbon sequestered and prevailing price of carbon in international carbon markets as shown in Table 3 and Table 4. Terms and conditions attached to available options were explained to farmers. Data were analysed using descriptive statistics such as arithmetic means and percentages.

Table 3: Levels of incentives for selected CSA practices in Guinea Savannah

	CSA Scheme	Price ($/tCO$_2$)	Carbon Sequester (tCO$_2$/ha)	Incentives(N/ha)
1.	Agro forestry Only	10, 20, 30, 40, 50	4.5	22,500, 45,000, 67,000, 90,000, 112,000
2.	CSA with manure	10, 20, 30, 40, 50	2.2	11,000, 22,000, 33,000, 44,000, 55,000
3.	CSA without manure	10, 20, 30, 40, 50	1.0	5,000, 10,000, 15,000, 20,000, 25,000
4,	Status quo	**0**	0	0

Table 4 Levels of incentives for selected CSA practices in Sudan and Sahel Savannah

	CSA Scheme	Price ($/tCO$_2$)	Carbon Sequester (tCO$_2$/ha)	Incentives(N/ha)
1.	Agro forestry Only	10, 20, 30, 40, 50	4.2	21,000, 42,000, 63,000, 84,000, 105,000
2.	CSA with manure	10, 20, 30, 40, 50	1.3	6,500, 13,000, 19,500, 26,000, 32,500
3.	CSA without manure	10, 20, 30, 40, 50	1.0	5,000, 10,000, 15,000, 20,000, 25,000
4,	Status quo	**0**	0	0

RESULTS AND DISCUSSION

Adoption of Selected Climate Smart Agricultural Practices

Table 5 presents the distribution of sample respondents according to the level of adoption of CSA practices. Generally rates of adoption were very low. This is attributed to low awareness, inadequate technical knowledge and low capital. Agronomic practices such as: cultivation of early maturing and drought tolerant, disease/pest resistant varieties, intercropping cover crops with main crops as a way of improving soil fertility and growing appropriate mix of crops in rotation on same parcel was fairly adopted. The reason for high adoption of short duration and drought tolerant varieties was traced to the need to provide adaptation measure against short rainfall duration in the zone. The high adoption of agronomic practices in general was based on the realization of its yield enhancing potential which has made dissemination of the practice widespread.

Table 5: Level of awareness and adoption of selected CSA practices

Climate Smart Agricultural Practices	Not aware (%)	Aware but not adopted (%)	Adopter (%)
1. Agronomic practices			
Cultivation of early maturing and drought tolerant varieties	13	24	63
Cultivation of disease/pest resistant varieties	20	25	55
Intercropping cover crops with main crop(s) to improve soil fertility	20	24	56
Growing appropriate mix of crops in rotation on same parcel	17	34	49
2. Fertilization			
Deliberate cultivation and ploughing in of certain leguminous plants into the soil as ***green manure***	44	22	34
Preparation and use of Farm Yard Manure and/or Compost	17	22	61

Efficient application of fertilizers in split - small but repeated -dosages based on assessments of crop needs – ***micro-dosing***	42	22	36
3. Tillage and Residue Management			
Retention / incorporation of refuse into the soil rather than burning	22	29	49
Minimizing tillage operation to conserve soil moisture and health	33	34	33
4. Water Management			
Construction of terraces on sloppy / hilly farm land	35	26	39
Use of Drip or Sprinkler Irrigation in upland/dryland conditions	51	25	24
Use of controlled flooding before & during cultivation – i.e. alternate wet and dry systems - in flooded rice / lowland production systems	48	22	30
Water harvesting and conservation by construction of bounds	42	28	30
Mulching to conserve soil water	34	28	38
Optimizing irrigation (e.g. using drip/sprinkler method)	55	22	23
5. **Integrated pest and/or weed management**			
Good blend of biological, chemical and other control measures	49	22	29
6. A**groforestry** Integration cultivation of appropriate tree species along with crops on farm land either by block planting, alley cropping, etc.	46	29	25

Source: Survey data 2017

As fertilization is expected to enhance the capacity of improved seed varieties to express yield potential optimally, farmers are expected to use fertilizers. Excessive use of nitrogen fertilizers leads to Green House Gases emissions (WorldBank, CIAT, CATIE, 2014). To be climate smart, the blend of both organic manure and inorganic fertilizer is recommended (FAO, 2013). In the study area, farm yard manure was the most adopted among the CSA fertilization components. This is attributed to mixed farming practices adopted by large proportion of farmers which make farm yard manure relatively cheaper than other source of manure in the study area. However, farmers apply the farm yard manure based on availability, there was no standard rate. The adoption of green manure and inorganic fertilizer micro-dosing was very low. The low adoption of green manure is attributed to scarcity and lack of knowledge on composite preparation and low awareness of the agro-forestry practices that would have enable them to generate green manure cheaply on farmers‟ fields. The low adoption of fertilizer micro-dosing was due to lack of training facilities and lack of access to soil testing equipments.

Adoption of Tillage and Residue Management practices was low due to generally low awareness. The practice of incorporating plant residues into the soil instead of burning during land preparation was very low. This is because, average farmer believe that busy burning practice provide cheap source of potash fertilizer. However, farmers lack the knowledge of the danger pose by the practice to the environment.

Level of awareness and adoption of Water Management practices was very low. This finding is contrary to expectation in view of the short rainfall duration of the Sudan and Sahel savannah which constitute more than half of the total land area of the North Western zone of Nigeria. The low adoption was traced to low level of technical knowledge and limited capital to procure water management inputs. Adoption rate of IPM was very low (29%) despite a fairly high awareness of the practice. Although several training and lecture on IPM have been delivered by experts, the dissemination of the practice to the end user especially biological and cultural methods by extension workers was rarely demonstrated. This finding is in line with Saguaye 2017 who reported 20.50% for crop management such as biological weed and pest management. Agricultural GHG emissions can be reduced to a significant extend by carbon sequestration in forest biomass and through change of land use from pastures to secondary forests (FAO, 2010). In the study area, adoption of agro forestry practice is very low. The low adoption was due to inadequate training on agro-forestry practices in the study area. The few adopters in the study area prefer planting tree crops that generate economic benefit in the short run. Trees like mango, oranges, neem, shea and locust bean are commonly preserved by farmers in the study area for economic reason. The generally low adoption rates of CSA found in this study corroborates with recent studies. Saguye, 2017 reported adoption rate of 33.76% for agroforestry, 25.62% for soil and water management and 20.50% for crop management (such as crop rotation, intercropping with legumes, biological weed and pest management) in Ethiopia. A study in Costa Rica indicated low CSA Erosion prevention in drainage ditches, integrated irrigation and drainage systems, efficient use of agrochemicals, use of waste water for irrigation, composting organic waste, reduced water use and water recycling, organic fertilizer (WorldBank, CIAT, CATIE, 2014).

Willingness to Accept Financial Incentives

The findings from choice experiments revealed that larger proportion (72% to 80%) of the respondents preferred to accept appropriate incentives to shift to the selected Climate Smart Agriculture. However about one-quarter of the respondents still prefer to continue with the existing farming systems at the prevalent maximum financial incentives offered by the market. The estimated mean Willingness to Accept (WTA) Incentives – a measure of the minimum financial incentives the average farmer is willing to receive to shift his/her production system to the specified CSA option, are: N36,522 , N85,715, N56,255 per hectare for adoption of Agro forestry, CSA with manure and CSA without manure respectively. Agro forestry has the least minimum acceptable price bargain because of the realization of the potential of the practice to create opportunity for farmers to make use of abundant marginal lands to generate extra income. However least percentage of respondents embraces the practice because of fear of land grapping as well as long time involved before any benefits could be tapped from the practice. Highest percentage of respondents prefers to adopt CSA with manure but with highest minimum acceptable price. This is because of farmers' awareness of the yield-enhancing benefit of manure. Highest minimum acceptable price for adoption of CSA with manure was traced to low availability which makes it difficult to obtain adequate quantity of manure at the right time. The percentage of respondents that preferred CSA without manure was also high but relatively lower than those using CSA with manure. The minimum acceptable price for CSA without manure was lower than that of CSA with manure because of farmers' awareness of high cost associated with adoption manure due to scarcity.

Table 5: Farmers preferences for CSA options and financial requirement

	*Percentage	**Average Minimum Incentive (N/Ha/Yr)**
Status quo (Existing farming systems)	25	0
Agro forestry	72	36,000
CSA with manure	80	85,715
CSA without manure	78	56,255

Source: Survey data 2017 *Multiple responses

CONCLUSION

The study determined the extent of farmers' adoption of climate smart agricultural practices as baseline for introduction of incentives for adoption of climate adaptation and mitigation measures. The findings indicated that a large proportion of respondents were not aware of most of the practices and so, adoption of most of the practices was very low. Agronomic practices in term of cultivation of high yielding, drought tolerant, disease and pest resistant seed varieties was the most adopted practice due to long time of research and extension activities on seed varieties as well as favourable government policy and support prograrmme on seed production and utilization in the country. Adoption of Integrated Pest Management, water management, integrated soil fertility management and agro-forestry were very low. Effort should be made to encourage farmers in the study area to adopt climate smart agricultural practices as a whole by following the recommendations as listed below:

- Sensitization campaign on reality of climate change and the need to adopt climate smart practices towards reduction of adverse effect of climate change should be intensified.
- Policy and supportive programmes towards climate change mitigation and adaptation in the study area should focus on adoption of all Climate Smart Agricultural practices especially those ones that were not highly adopted by farmers.
- Efforts should be made by research institution to train extension staff properly about all the components of climate smart agricultural practices. ;
- Extension staff should in turn disseminate extensively accurate information on Climate-Smart Agricultural practices to cover a larger proportion of farmers in the study area.
- Government should provide incentives and enabling policy environment towards adoption of good CSA practices in general and specifically those ones that were not highly adopted.
- Credit facilities should be provided in order to enhance the capacity of farmers in procuring the necessary climate smart inputs.

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