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Assessment of Prioritized Climate Smart Agricultural Practices and Technologies of Household Farmers in Southeast, Nigeria

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Abstract The study assessed prioritized climate smart agricultural (CSA) practices and technologies of household farmers in Southeast, Nigeria. A multi-stage sampling technique was used to isolate 326 household farmers who participated on the study. Data collection was done using research instrument (questionnaire). Both descriptive and inferential statistics were employed for data analysis. Results indicated that majority of the respondents were females, had secondary education, and had household size of 9 persons with a mean age of 48 years and 19 years of farming experience. Temperature variation (3.85), increase in number of sunny days (3.50), increase in amount of rainfall (3.10), variation in rainfall pattern (3.56), decrease in total rainfall (3.21), increase in frequency of heavy rains (2.85), etc were seriously perceived as climate change effects in the area. Again, various prioritized CSA practices and technologies such as growing a single crop, using a mixture of appropriately chosen genotypes of a given species (46.6%), use of quality seeds and planting materials of well-adapted crops and varieties (77.9%), crop rotation and diversity (41.1%) integrated pest management (47.5%), improved water use and management (26.4%), etc. were adopted by the farmers in mitigating climate change effects. Climate threats identified in the area include, decrease in overall productivity due to increased extreme weather events (0.97), decrease in crop production due to changes in average rainfall (0.94), decrease crop production due to increase in temperatures and rainfall variability (0.79), rapid migration of some pests and diseases (0.72), etc. Lack of access to up to-date information (2.88), access to micro-finance and insurance (2.57), access to agricultural input and output markets (2.14), etc. constrained the adoption of CSA practices. Age, education, occupation, years in farming experience further influenced the adoption of CSA practices and technologies. Policy motions in propagating climate change awareness through the mass media were recommended.

Keywords Assessment, Prioritized, Climate Change, Smart Agriculture, Practices, Technologies

1. Introduction

The extreme effect of climate change is becoming clearer with the consistent disruption in the pattern of some climate variables such as rainfall, temperature, etc. It is emphatically true that hot weather extremes have become more frequent and more intense across most land regions since the 1950s [1]. Noticeably, various natural factors and anthropogenic activities are responsible for the process of climate change scientifically evidenced from 20th century. Climate change has considerably impacted on human existence and different natural systems; and its future projections are more severe and serious, endangering the food security and existence of different eco-systems. Over the years human activities had widely exacerbated climate change in diverse ways causing innumerable disruptions of agricultural activities.

Moreover, agriculture has been widely recognized as part of the causes of climate change, for instance, deforestation, slash and burn practices, tillage operations, uncontrolled use of fertilization, livestock production (especially enteric fermentation of ruminants), and methane from rice farms are some of the major causes of climate change in Southeastern region [2]. Southeast Nigeria, which is in the rainforest region, is important to Nigeria's agriculture as the region predominantly produces important crops like cassava, oil palm, plantain, yam, maize, etc. but unfortunately, this region is being threatened by climate change occasioned with erosion and flooding as major visible impacts. This is as a result of variations in rainfall patterns, temperature, relative humidity, wind, frost, etc. ravaging the entire region. Again, incidence of pest and diseases, decreasing crop productivity, low yields, resource-use inefficiency, loss of crops, low income, poverty, decreasing resilience of production systems, etc. are some of the notable drivers of climate change impacts on agriculture in Southern Nigeria. Uncertainty about the scale, dimension and nature of the impacts, which affects farmers' planning and investment decisions could be the reason of climate change persistence in the southeast zone. Furthermore, adverse impacts of climate change experienced in the area include disruption of economies, source of livelihoods and the ecosystems on which all living things depend [3].

Therefore, the need to really respond to climate change in the region cannot be overemphasized thus, adaptation practices and mitigations. Adaptations to these adverse impacts of climate changes are very important if the food, nutrition and livelihood security objectives of farmers must be met. Adaptation is any activity that can reduce the damages caused by climate change [4]. Farmers adapt to the challenges of climate change differently based on their perception and private benefit-cost calculations. Many adaptation practices reflecting best practices, such as crop and livestock improvement, sustainable resource management, and many others are being undertaken by farmers across the Southeast zone of Nigeria, yet productivity and resilience gains had remained small. This calls for an urgent need for large-scale adoption of climate-friendly and climate-proof practices such as climate smart agricultural practices and technologies in the zone.

Climate smart agricultural (CSA) strategies usually integrate innovative indigenous practices, technologies and services that are relevant for a specific location. This implies that CSA is context specific [5]. However, uptake of CSA practices, technologies and services can increase crop production and productivity, enhance resource-use efficiency, increase profitability and net income, enhance resilience, ensure food security, and reduce or sequester below and above ground carbon. Uptake of CSA practices and technologies, inter alia, depends on the policy and institutional frameworks of the country. Therefore, responding fully to climate change needs systematic adaptation, mitigation and food security strategies [6]. The fifth and sixth assessment reports of IPCC provides a framework to support good decisions and better integrate adaptation, mitigation, development and equity and to provide solutions and response options, through assessments of climate information relevant for decision-making, risk assessment, adaptation, mitigation, climate-resilient development pathways, and sustainable development respectively. However, prioritizing CSA practices and technologies in a zone, like Southeast Nigeria, requires an effective and efficient participation of relevant stakeholders in the agricultural sector [7]. Southeast Nigeria has a great potential to boost large-scale agricultural production through greater investment in agriculture and increased use of proven and verified adaptation practices and technologies. Prioritization of climate smart agricultural production practices and technologies tends to improve farm yields, increase agricultural productivity, enhance farmers' resilience, ensure food security, mitigate adverse impacts of climate change, raise farm income and reduce carbon emission. Again, prioritization of climate smart agricultural production practices and technologies raises household farmers' potentials, diversification opportunities, technical know-how and overall agricultural transformation while promoting national food security, environmental protection, ecosystem resilience, and greenhouse gas mitigations [8].

However, the assessment of prioritized climate smart agricultural practices and technologies in Southeast Nigeria has not been profiled or literally reported before now, thus making this study a novel investigation. Again, the choice of Southeast Nigeria for this study is inspired by its great potential to boost agricultural production in Nigeria. The possibility of climate smart agriculture contributing towards the discourse on achieving emission reduction in Nigeria's Nationally Determined Contribution, which is a commitment to the United Nations Framework

Convention on Climate Change and pursuing sustainable growth and agricultural resilience as contained in the Agriculture Promotion Policy popularly known as the “Green Alternative”, the National Agricultural Resilience Framework and the Economic Recovery and Growth Plan [9] and how best to promote climate smart models of agricultural transformation further motivated the need for this study. These issues are especially relevant in Nigeria particularly the Southeast zone, where floods and erosions adversely affect agricultural production and put greater pressure on the remaining fertile farmlands.

Taking into consideration the above mentioned data, the main objective of this research was to assess the prioritized CSA practices and technologies of the farmers in southeast, Nigeria. The specific objectives included 1. Identify the socio-demographic characteristics of the respondents in the study area; 2. Assess the perceptions of climate change across the southeastern zone; 3. Ascertain the adopted climate smart agricultural practices and technologies; 4. Identify climatic threats of the farmers in the area; 5. Identify the constraints to the adoption of climate smart agricultural production practices; 6. Analyze hierarchy model regression on adoption of climate smart agricultural practices and technologies; 7. Analyze demographic disposition of farmers to adoption of climate smart agricultural practices and technologies.

2. Materials and Methods

2.1. Description of the Study Area

The study area was South East Geopolitical zone of Nigeria. Southeast zone is made up of five States namely Abia, Anambra, Ebonyi, Enugu, and Imo. It is bounded on the east by Cross River State, on the north by Kogi and Benue States, on the south by Akwa Ibom and Rivers States and on the west by Delta and Edo States. Estimate of the population of the area is 21, 955,414 persons [10]. The vegetation of the area is predominantly rainforest, which supports the cultivation of food crops such as rice, maize, yam, cassava, oil palm, cowpea, sweet potato, cocoyam, plantain, banana, melon, bambara nut, breadfruit, groundnut, and various vegetables and fruit trees. The people of the zone engage mostly in rain fed farming, agricultural labour providers and trading activities, as well as other occupations such as civil service, corporate businesses, etc. The Zone is largely affected by food insecurity due to over dependence on rain-fed agricultural practices which contribute to restricted agricultural income sources. Again, climate change had also influenced food security of the zone causing serious food shortages, hence the need for stakeholders to prioritize their adaptation strategies and scale up mechanization.

2.2. Sample Selection

A multistage sampling method was deployed to select participants for this study. From the five (5) states of the zone, three (3) were randomly selected through balloting in order to narrow the scope of the study. This study includes: Anambra, Abia and Ebonyi. The list of Local Government Areas (LGAs) with visible evidence of climate change-related impacts was obtained from the Ministries of Agriculture, Natural Resources and Environment and the Nigeria Erosion and Watershed Management Programme (NEWMAP) offices. From this list, eight LGAs were purposively selected: four LGAs were selected from Ebonyi, three were selected from Abia state, and one from Anambra state. In each of the selected eight LGAs, four communities were selected by considering high dependency on rain-fed agriculture, high incidence of flood and/or high number of farmland erosion sites present in the areas. Finally, 12 farmers were purposively selected in each community bringing the total to 384 participants. However, out of the 384 copies of questionnaire administered, only 326 copies were usable representing 84.90% response rate. However, the outbreak of Covid-19 affected the sampling method and data collection.

2.3. Data Collection and Procedure

This study adopted the cross sectional survey design for data collection. Prior to data collection, the researchers employed fifteen (15) enumerators to assist in data collection after creating rapport with the farmers. The enumerators were trained and the researchers and enumerators interacted with the selected farmers to ascertain their socioeconomic characteristics, assess their perception of climate change, past climatic threats and their impacts on agriculture, what climate smart agricultural practices and technologies are available to them, costs and benefits associated with the use of such practices and technologies, preferences and prioritization of the practices and technologies, and constraints to the adoption of climate smart agricultural production practices and technologies. To adequately collect data for this study, data instruments were developed by the researchers and subjected to face and content validity.

2.4. Method of Data Analysis

Data collected were carefully coded in IBM SPSS Statistical software version 20 and analyzed using descriptive statistics, coefficient of variation, hierarchical regression, ANOVA Means and multi-linear regression. Farmers’ understanding about climate change was analyzed with descriptive statistics and compared using inter-rater method. The composite score was utilized in virtually all statistical analysis and is more reliable in analysis than the single item [11].

Table 1. Socio-demographic characteristics of the respondents

Variables	N	Mean/%	Sd
Age in years			
Min. age = 25/Max. Age = 80	326	48.11	9.65
Years in farming			
Min. = 1/Max. = 60	326	19.38	9.95
Household size			
Min. = 2 persons /Max. = 40	326	9.01	5.43
Gender		%	
Male	139	42.6	
Female	158	48.5	
No Response	29	8.9	
Educational Status			
No formal education	44	13.5	
Primary education	94	28.8	
Secondary education	117	35.9	
Tertiary education	71	21.8	
Occupation			
Crop farming	202	62.0	
Animal farming	34	10.4	
Off-farmer	10	3.1	
Crop & Animal	67	20.6	
Others	13	4.0	
Local Government Area			
* Under-Ebonyi			
Ikwo	118	36.2	
Izzi	42	12.9	
Ezza North	30	9.2	
Ohaukwu	25	7.7	
*Under-Abia			
Bende	20	6.1	
IsialaNgwa South	20	6.1	
Ikwuano	15	4.6	
*Under Anambra			
Awka South	56	17.2	
State			
Abia	78	23.9	
Anambra	33	10.1	
Ebonyi	215	66.0	
Total	326	100	

Source: Field data, (2020)

3. Results and Discussion

3.1. Socio-Demographic Characteristics of the Respondents

The socio-demographic characteristics of the respondents are shown in Table 1. The mean age of the respondent was 48.11; this implies that the participants were relatively young enough to practice CSA amongst other mitigation and adaptation measures. The years of experience in farming revealed that the average year invested by the respondents was 19.38 years implying that the respondents had relatively acquired enough farming experience to handle both internal and external farm challenges as the arise. The household size of participants indicated a mean value of 9 persons per household, implying adequate provision and availability of man-power resources needed to combat adverse consequences of climate change and conveniently practice CSA [12]. The presented data clearly indicates that majority of the respondents were females (N=158, 48.5%), males were 139 (42.5%) while 29 (8.9%) did not indicate their gender. From the result, women dominated the study area which signified more of women involvement in agriculture in the zone. In assessing the educational status of participants, results show that 44 (13.5%) had no formal education; 94 (28.8%) had only primary education, 117 (35.9%) had secondary education, and 71 (21.8%) had tertiary education. This implies that on the average, the respondents completed their secondary education and could read and write and thus, understood climate change, its impacts and mitigation strategies [13]. The occupation of respondents showed that majority of them were into crop farming 202 (62.0%), followed by those in crop and animal farming 67 (20.6%), and those in animal farming 34 (10.4%), and those who are off-farmers 10 (3.1%); participants who ticked ‘other’ category outside the options given in the scale of measurement were 13 (4.0%). The above result implies that the respondents were much occupied into agriculture (crop and animal husbandry) which is their primary source of income and livelihood. Consequently, eight (8) local government areas were selected. Four (4) from Ebonyi State, three (3) were from Abia state and one (1) was from Anambra State. In Ebonyi State, Ikwo LGA had 118 (36.2%), Izzi 42 (12.9%), Ezza North 30 (9.2%), and Ohaukwu 25 (7.7%). The LGA’s under Abia State in numerical terms were Bende 20 (6.1%), Isiala-Ngwa South 20 (6.1%) and Ikwuano 15 (4.6%). For Anambra State, only one (1) LGA was sampled: Awka South 56 (17.2%). Furthermore, results showed the number of participants sampled across the three (3) Southeastern States. Ebonyi had 215 (66.0%), Anambra 33 (10.1%) and Abia 78 (23.9%). This implies that a total number of 326 respondents participated in this survey and provided requisite information needed for data analysis and interpretations.

3.2. Perceptions of Climate Change across the Southeastern Zone

Table 2 shows the perceptions of climate change across the Southeastern zone. A four- point Likert measurement was used to assess the perceptions of climate change across the three selected states of the Southeastern zone. This gave a mean statistical value of 2.5 which served as a threshold in disaggregating the perceptions of climate change across the zone. Any value of the individual respondents higher than 2.5, obviously indicated a higher perception of climate change and otherwise lowers perception. From the result, all the perception items ranging from temperature variations to increased duration of dryness during rainy season showed mean values higher than the threshold score of 2.5. This indicates a high perception of climate change across the three selected states of the Southeastern zone. This further implies the ugly trends of climate change across the Southeastern zone which agrees with meteorological data and/ or information. Indeed, there are temperature variations, increase in number of sunny days, increase in amount of rainfall, variation in rainfall patterns, decrease in total rainfall, increase in frequency of heavy rains, increase in flooding and duration of flood, also decrease in ground water table, increase in the intensity of heat, decrease in number of sunshine days during rainy season, and increased duration of dryness during rainy season ravaging agricultural productivity of the farmers in the entire Southeastern zone. For instance, increasing temperature will increase atmospheric water demand, which could lead to additional water stress from increased water pressure deficits, subsequently reducing soil moisture and decreasing yield [14]. An accelerated phenology from increased temperatures leads to a shorter growing period and less days of crop water use within a cropping season. Other indirect temperature impacts include frequent heat waves, increase in farms weeds, pests, and diseases The potential impacts of heavy precipitation include crop damage, soil erosion, and an increase in flood risk due to heavy rains which in turn can lead to injuries, drowning and other flooding-related effects on health [15]. Excessive rainfall can affect crop productivity in various ways, including direct physical damage; delayed planting and harvesting, restricted root growth, oxygen deficiency and nutrient loss. Too much rainfall hurts young plants and trees root systems. Excessive rain deprives roots of the oxygen needed for survival, and a lack of oxygen in the soil doesn't allow water or soil nutrients the opportunity to be absorbed [16]. The warmer the soil and the longer it is saturated, the bigger the loss of nitrogen by denitrification. Frequent and excessive rainfall can force some farmers to delay side-dressing of nitrogen (most likely from urea). Flooding and wet weather are so costly to agricultural land because they cause untold damages to field crops in relation to reduction of crop harvest. Flooding can damage farm property, delay and/or reduce harvests, interrupt supplies and utilities, and cost the lives of livestock and even people. Immediate impacts of flooding include loss of human life, damage to property, destruction of crops, loss of livestock, and deterioration of health conditions owing to waterborne diseases. Again, during the dry season, humidity is very low, causing increase in the intensity of heat and a decrease in ground water table and leading to death of plants and poor income of the farmers [17].

Table 2. Perceptions of climate change across the southeastern zone

Items	SD	A	D	SA	Mean	Sd
Temperature variation	2(0.6%)	3(0.9%)	37(11.3%)	284(87.1%)	3.85	.43
Increase in number of sunny days	2(0.6%)	39(12.0%)	79(24.2%)	206(63.2%)	3.50	.73
Increase in amount of rainfall	11(3.4%)	83(25.5%)	96(29.4%)	136(41.7%)	3.10	.90
Variation in rainfall pattern	3(0.9%)	32(9.8%)	69(21.2%)	222(68.1%)	3.56	.71
Decrease in total rainfall	19(5.8%)	68(20.9%)	65(19.9%)	174(53.4%)	3.21	.97
Increase in frequency of heavy rains	17(5.2%)	123(37.7%)	79(24.2%)	107(32.8%)	2.85	.95
Increase in flooding and duration of flood	8(2.5%)	88(27.0%)	74(22.7%)	156(47.9%)	3.16	.91
Decrease in ground water table	13(4.0%)	94(28.8%)	79(24.2%)	140(42.9%)	3.06	.94
Increase in the intensity of heat	6(1.8%)	30(9.2%)	72(22.1%)	218(66.9%)	3.54	.74
Decrease in number of sunshine days during rainy season	22(6.7%)	157(48.2%)	52(16.0%)	95(29.1%)	2.67	.97
Increased duration of dryness during rainy season	18(5.5%)	69(21.2%)	65(19.9%)	174(53.4%)	3.21	.96

Source: Field data, (2020)

Note: SA = Strongly Agree; A = Agree; D = Disagree; SD = Strongly Disagree; Sd = Standard deviation.

Table 3. Adoption of prioritized climate smart agricultural practices and technologies

Items	No	Yes	Mean	SD
Growing a single crop, using a mixture of appropriately chosen genotypes of a given species	174(53.4%)	152(46.6%)	0.47	0.50
Use of quality seeds and planting materials of well-adapted crops and varieties	72(22.1%)	254(77.9%)	0.78	0.42
Crop rotation and diversity	192(58.9%)	134(41.1%)	0.41	0.49
Integrated Pest Management	171(52.5%)	155(47.5%)	0.48	0.50
Improved water use and management	240(73.6%)	86(26.4%)	0.26	0.44
Sustainable mechanization	278(85.3%)	48(14.7%)	0.15	0.36
Using quality seeds and planting materials	26(8.0%)	300(92.0%)	0.92	0.27
Choosing crop species and varieties adapted to the prevalent or expected impacts of climate change	134(41.1%)	192(58.9%)	0.59	0.49
Sustainable soil and land management for increased crop productivity	100(30.7%)	226(69.3%)	0.69	0.46
Selecting species capable of resisting specific extreme weather conditions	85(26.1%)	241(73.9%)	0.74	0.44
Mulch of different materials and colours, for controlling weeds and reducing evapotranspiration	204(62.6%)	122(37.4%)	0.37	0.49
Planting trees on beams	244(74.8%)	82(25.2%)	0.25	0.44
Adjusting time of planting	104(31.9%)	222(68.1%)	0.68	0.47

Source: Field data, (2020)

3.3. Adoption of Prioritized Climate Smart Agricultural Practices and Technologies

Table 3 shows the prioritized climate smart agricultural practices and technologies adopted in the area. The result indicated that different prioritized CSA practices and technologies were adopted by the farmers based on certain criteria which include; their perception levels, exposures, farm sizes, labour availability, understanding, knowledge, contacts with extension agents, technical know-how, finance, etc. For instance, 46.6% of the farmers adopted growing a single crop using a mixture of appropriately chosen genotypes of a given species as against 53.4% who adopted otherwise. Use of quality seeds and planting materials of well-adapted crops and varieties were adopted by 77.9% and crop rotation and diversity by 41.1%. Again, integrated pest management, 47.5%, improved water use and management, 26.4%, sustainable mechanization, 14.7%, using quality seeds and planting materials, 92.0%, choosing crop species and varieties, 58.9%, sustainable soil and land management for increased crop productivity, 69.3% and selecting species capable of resisting specific extreme weather conditions, 73.9%. Furthermore, mulch of different materials and colours, for controlling weeds and reducing evapotranspiration, planting trees on beams and adjusting time of planting were adopted by over 130% of the farmers. The general implication is that these climate smart adaptation techniques help farmers to cushion the negative impacts and/ or adverse climate change consequences influencing farm production of the farmers in the area [18,19,20].

3.4. Identified Climatic Threats of the Farmers

Table 4 indicates identified climatic threats of the farmers in the area. The Table data shows that the farmers identified the various climate threats peculiar to them. Over 93% of the farmers identified decrease in overall productivity due to increased extreme weather events and decrease in crop production due to changes in average rainfall as against 8.6%. This implies that these farmers experienced a decrease in farm productivity due to adverse climate change effects. Again, over 80% of the farmers indicated increased exposure of livestock and crops to heat-related stress and disease, and shift in planting date due to delay in onset of rain and harsh weather as against 35%, while decrease crop production due to increase in temperatures and rainfall variability, reduced stream flows and quality of water supply and rapid migration of some pests and diseases were identified by over 70% of the farmers. This implies that farmers in the southeast region suffered adverse consequences of climate change which significantly influenced crop production in the entire area leading to food shortage and insecurity witnessed in the region [21,22,23.24]. The result is further validated by the mean values estimated across the responses.

3.5. Constraints to the Adoption of Climate Smart Agricultural Production Practices

The constraints to the adoption of climate smart agricultural production practices in the area are shown in Table 5. A threshold mean value of 2.5 was estimated and was used to judge and/ or classify the constraints influencing the adoption of CSA production practices of the farmers. From the Table, lack of access to up-to-date information 2.88, access to micro-finance and insurance 2.57, and investments and financing 2.52 were classified as being extremely serious while access to agricultural input and output markets 2.14 and lack of national level planning and implementation 2.30 were considered as not really a serious concern. The result implication is consequent upon the fact that these constraints limited and seriously influenced the adoption of CSA production practices of the farmers [25]. For instance, lack of access to up-to-date information whereby farmers do not have first-hand data or information regarding climate change mitigation and adaptation measures poses a serious barrier [26,27,28]. Access to micro-finance and insurance comes whereby the farmer are unable to access micro-credit facilities from the commercial banks, etc and thus are financially incapacitated to pay for insurance coverage. Again, whereby farmers cannot finance their investments due to poor funding is a potent adoption hindrance [29,30]. The planning and implementation of climate change strategies such CSA production practices at the core stakeholders level is not only important but necessary that the farmers whose production are mostly affected should be at the center of any mitigation, adaptation or solution policy for effective uptake as noted by the IPCC fifth and sixth assessment reports.

Table 4. Identified climatic threats of the farmers in the area

Items	No	Yes	Mean	SD
Decrease in overall productivity due to increased extreme weather events	10(3.1%)	316(96.9%)	0.97	0.17
Decrease in crop production due to changes in average rainfall	18(5.5%)	308(94.5%)	0.94	0.23
Decrease crop production due to increase in temperatures and rainfall variability	69(21.2%)	257(78.8%)	0.79	0.41
Reduced stream flows and quality of water supply	83(25.5%)	243(74.5%)	0.75	0.44
Increased exposure of livestock and crops to heat-related stress and disease	59(18.1%)	267(81.9%)	0.82	0.39
Rapid migration of some pests and diseases	92(28.2%)	234(71.8%)	0.72	0.45
Shift in planting date due to delay in onset of rain and harsh weather	54(16.6%)	272(83.4%)	0.83	0.37

Source: Field data, (2020)

Table 5. Constraints to the adoption of climate smart agricultural production practices

Constraints	ES	MS	S	NAAS	Mean	SD
Lack of access to up to-date information	8(2.5%)	14(4.3%)	20(6.1%)	284(87.1%)	2.88	0.64
Access to micro-finance and insurance	10(3.1%)	29(8.9%)	51(15.6%)	236(72.4%)	2.57	0.78
Access to agricultural input and output markets	24(7.4%)	55(16.9%)	99(30.4%)	148(45.4%)	2.14	0.95
Lack of national level planning and implementation	35(10.7%)	38(11.7%)	48(14.7%)	205(62.9%)	2.30	1.04
Investments and financing	13(4.0%)	38(11.7%)	43(13.2%)	232(71.2%)	2.52	8.51

Source: Field data, (2020)

Note: ES = Extremely Serious; MS = Moderately Serious; S = Serious; NAAS = Not At All Serious; SD = Standard deviation.

3.6. Hierarchy Model Regression Results on Adoption of Climate Smart Agricultural Practices and Technologies

The hierarchy model regression result is shown in Table 6. Model 1 refers to the first stage in the hierarchy when only 'perception of climate' was used as a predictor. Model 2 refers to the second stage in the hierarchy when 'perception of climate and climate threat' were used as predictors. For Model 3, being the third stage in the hierarchy 'perception of climate, climate threat and ecosystem' were used as predictors. Model 4 being the fourth stage in the hierarchy, saw 'perception of climate, climate threat, ecosystem and constraints' as predictors. The first step indicated that perception of climate change in the area was significant; implying that any increase in climate change perception will directly influence the adoption of CSA practices and technologies. In step two, perception of climate change and climate threat were significant at 1% probability level, implying that any increase in both variables will lead to a significant increase in the adoption of CSA practices and technologies. In step three, perception of climate change, climate threat and ecosystem were all significant at 1% level, implying that a percentage increase in perception of climate change, climate threat and ecosystem will also result in 0.72% of adoption of CSA practices and technologies in the area. Furthermore, step four showed that only perception of climate change and constraints were significant at 1% level. The results proved that the variables investigated (perception of climate change, climate threat, ecosystem and constraints to climate change adoption) significantly influenced the adoption of CSA practices and technologies in the area. However, an overview of the result showed that perception of climate change was significant at the four stages and/ or steps, while climate threats were significant at two stages/steps implying that perception of climate change and climate threats triggers farmers to willingly adopt CSA practices and technologies as alternative mitigation strategies. Thus, we can assume that there is a multi-linear relationship between perception of climate change and adoption of CSA practices and technologies. The result tallies with the findings of [31,32]. The hypothesis of this study which states that CSA practices are not significantly influenced by climate lagging indicators such as (perception of climate, climate threat, ecosystem and constraints) that were proved false.

Table 6. Hierarchy model regression results on adoption of climate smart agricultural practices and technologies

Models	B	SE	T	F	Sig.
Step 1					
Constant	10.18	1.10			<0.05
Perception of climate	.09	.03	9.25*	9.51	<0.01
Step 2					
Constant	7.05	1.19			<0.05
Perception of climate	.11	.03	3.66*	21.20	<0.01
Climate threat	.54	.09	6.00*		<0.01
Step 3					
Constant	7.05	1.18			<0.05
Perception of climate	.11	.03	3.66*		<0.01
Climate threat	.52	.10	5.20*	17.47	<0.01
Ecosystem	.09	.03	3.00*		<0.01
Step 4					
Constant	7.42	1.32			<0.05
Perception of climate	.11	.03	3.66*		<0.01
Climate threat	-.01	-0.11	-0.09		<0.05
Ecosystem	-.04	.06	0.66	13.17	<0.05
Constraints	.09	.03	3.00*		<0.01

Source: Field data, (2020)

Note: *Significant @ 1% level

Table 7. Demographic disposition of farmers to adoption of climate smart agricultural practices and technologies

Variables	B	SE	Beta	t-value	P	R	R^2	F	P
Constant	6.25	.96		6.52*	<0.01				
Age	-.04	.02	-.15	-2.41**	<0.05				
Education	.65	.18	.22	3.71*	<0.01	.337	0.89	9.98	<0.05<0.01
Occupation	.35	.12	.16	2.95*	<0.01				
Years in farming	.05	.02	.17	2.71*	<0.01				

Source: Field Data, 2020.

Note: *P<0.05 *P<0.01

3.7. Demographic Disposition of Farmers to Adoption of Climate Smart Agricultural Practices and Technologies

The result presented in Table 7 was obtained from the double-log functional form of the regression model, where demographic factors such as age, educational status, occupation and years in farming yielded a coefficient of multiple correlation square (R^2) of 0.89. This shows that 89% of the variance in adoption of CSA practices and technologies was accounted for by the combined effects of age, educational status, occupation and years in farming. The result indicated that the independent contribution of the predictor variables was significant across board. Age was a predictor of adoption of CSA practices and technologies and was negatively significant at 5% level; this implies that as farmers advance in age the likelihood to adopt CSA practices and technologies diminishes. Education had a positive coefficient and was significant at 1% level, implying that increase in education of the farmers will result in increase in adoption CSA practices and technologies. The more educated farmers are, the more they subscribe to CSA practices and technologies [33]. Occupation established a positive correlation and was also significant at 1%, implying that respondents who took farming as their major occupation have the likelihood of adopting CSA practices and technologies more effectively compared with those that practiced farming as a secondary occupation [34,35] Lastly, the more years of experience in farming that a farmer acquires, the more likely to adopt CSA practices and technologies. Therefore, hypothesis two which states that demographic factors do not predict the adoption of CSA practices and technologies were equally rejected and the alternative hypothesis accepted.

4. Conclusions

The study provides an insight on the assessment of CSA practices and technologies and the need to prioritize for increased agricultural production in Southeastern States of Nigeria (i.e., Anambra, Abia and Ebonyi). The study revealed that perception of climate, climate threat; ecosystem and climate change constraints were important contributors to the adoption of climate smart agricultural production practices in the area. More inferential results showed that demographic variables independently and jointly predicted CSA practices and technologies among participants. Majority of participants agreed to decrease in overall productivity due to increase in extreme weather, decrease in crop production due to changes in average rainfall, increased exposure of livestock and crops to heat-related stress and rapid migration of some pests and diseases. Constraint factors to the adoption of CSA production practices were lack of access to current and relevant information, access to micro finance and insurance, lack of national level planning and implementation; and not having access to agricultural input/output markets. Use of quality seeds and planting materials; well-adapted crops and varieties; selecting species capable of resisting specific extreme weather conditions; sustainable soil and land management for increased crop productivity; adjusting time of planting; growing multiple crops, and using mixtures of appropriately chosen genotypes of a given species were some of the adaptation strategies adopted in the area.

The main implications of this study include (a) putting forth the empirical data that adoption of CSA practices across the Southeast zone would positively revamp the zone agriculture, thereby improving the socio-economic base of citizens, and reducing poverty index of the household farmers in the zone and (b) the diversification of CSA technologies in a way that will be indigenous to local population; suggesting that all the stakeholders, including policymakers, should be ready to embrace these innovative technologies.

However, for Nigeria to reap the benefits of CSA, concerted efforts and actions must be taken among other things, promote the implementation of context-specific CSA practices by farmers, avail necessary funds to farmers and develop indigenous policy frameworks that are amenable to CSA. The major limitation of this study was the use of only questionnaire in gathering data due the outbreak of Covid-19. Further studies should incorporate interviews and focus group discussions on the subject matter.

Based on the findings the following recommendations can be made: There is an urgent need for the government and non-governmental organizations to integrate CSA into national, regional and local policy frameworks to boost agricultural production of the farmers at all levels. Interest free loans and provision of other agricultural intervention incentives should be encouraged. This will also help to boost food production. Again, policy motions in propagating climate change issues through the mass media and through public-private partnership should be enacted and pursued rigorously to achieve the desired goals and objectives.

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