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VALUATION OF RICE FARMERS' PREFERENCES AND WILLINGNESS TO PAY FOR CLIMATE-SMART AGRICULTURAL TECHNOLOGIES IN SOUTHEAST, NIGERIA

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ABSTRACT

This paper sought to investigate the valuation of rice farmers' preferences and willingness to pay for climate-smart agricultural technologies in Southeast Nigeria. Two objectives and one hypothesis guided the conduct of the study. The examination of rice farmers' willingness-To-Pay (WTP) for improved CSA technology services revealed greater proportion of the respondents to be strongly not willing to pay for over 77.8% of the CSA technologies while barely 7.4% were mildly willing to pay. Rice farmers were strongly not willing to pay for the following CSA technologies: rainwater harvesting, cover crops method, directed seeded rice, systems of rice intensification, use of solar pumps, etc, while the CSA technologies they were mildly willing to pay for are drip irrigation and drainage management. The major reason for respondent's unwillingness to pay were: poverty (2.0%) and CSA technologies as the responsibility of the Government to farmers within the state (5.0%). For the estimated willingness to pay value, the mean monthly minimum WTP in South-East was estimated at ₦5176.7123 while the mean monthly maximum WTP for rice farmers was estimated as ₦10,926.95. Water-smart technologies (76.8%) was mostly preferred CSA technology. Based on the ordered probit regression analysis of factors influencing willingness to pay for CSA technology, primary occupation (X5), access to credit (X8) and distance to market (X12) were found to be significant. The study recommended that rice farmers should adapt to climate change, natural resource pressure and contribute to mitigating climate change.

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Contribution/ Originality: This study contributes to knowledge by investigating the farmers' preferred CSA technologies, willingness to pay for such preferences and factors influencing farmers' preference for improved CSA technologies in Southeast Nigeria using a more direct and change-oriented approach through field research.

1. INTRODUCTION

Agriculture is one of the most important sectors of Nigerian economy that contributes significantly to the well-being of the rural poor, sustaining 90 percent of the rural labour force, accounts for about 25 percent of Gross Domestic Product, two third of the Nigerian workforce and about 5 percent of total exports (Damola, 2010). Agriculture as an area of human activity at risk from climate change and a driver of climate and environmental change, features prominently in the global climate change agenda. Recent studies estimate that global rice production needs to increase between 7-13 percent in the coming decade in order to meet the projected demand at current market prices (Okpiaifo et al., 2020). The future challenge for the local rice industry is to satisfy the country's projected growing demand and climate change is a threat to achieving this.

Climate change is no longer a trivial issue. It is one of the biggest challenges facing agricultural productivity today (Anarah, Ezeano, & Osuafor, 2019). Climate change refers to any change in climate over time whether due to natural variability or as a result of human activities (Intergovernmental Panel on Climate Change IPCC, 2001). It can also be defined as the average weather condition (temperature, relative humidity, solar radiation and rainfall) of an area monitored over a long period of time (Unanaonwi, 2010).

Africa for instance accounts for less than 4 percent of global emissions, yet its 850million inhabitants are the most vulnerable to climate change impacts (Ozor, Madukwe, Enete, & Amaechina, 2012) they also noted that Africa is one of the most vulnerable continents to climate change and climate variability with least technological capacity to address the climate change effects. Climate change affects all economic sectors of Africa and therefore present unprecedented challenges for the continent (Elijah, Osuafor, & Edeh, 2020). The IPCC 4th Assessment Report predicts that climate change could cause yields to decrease by as much as 50% in some highly vulnerable areas, including Africa (Intergovernmental Panel on Climate Change IPCC, 2001). As the most populous country in Africa, Nigeria is the most vulnerable to climate change, with about 70% of her people dependent on agriculture for their livelihood. Agwu and Okhimamhe (2009) reported that the evidence of the unpleasant impact of climate change abound in the southeast of Nigeria. "Therefore, increasing droughts, floods, erosion, land degradation and other threats to agriculture, and its acceleration in the coming decades will impact heavily on food security.

Agricultural production activities are generally more vulnerable to climate change than other sectors (Ojemade, Osuafor, & Bankole, 2018). Agriculture places heavy burden on the environment in the process of providing humanity with food and fiber while climate is the primary determinant of agricultural productivity (Apata, Samuel, & Adeola, 2009). The good news is that agriculture can be integrated into the solution to reduce the pace of climate change by sequestering carbon in the soil instead of emitting it into the atmosphere. It is possible to achieve what the Fanen and Olalekan (2014) terms "climate-smart agriculture" or "triple wins": attaining higher yields, placing more carbon in the soil, and achieving greater resilience to heat and drought. Climate-smart agriculture (CSA) is a bundle of interventions that help in realizing the triple wins.

In Nigeria, climate change is seriously threatening agricultural productive activities in rural communities which are mainly rain-fed. Agwu and Okhimamhe (2009) report that the evidence of the unpleasant impact of climate change abounds in southeast Nigeria. These include increased cases of flooding and numerous gully erosion sites which have resulted to loss of arable farmlands, farm stead, economic tree, biodiversity and others. The case of lowland rice production is particularly deserving of attention as it is a significant anthropogenic source of CH_4 and N_2O (Kehinde, Shittu, & Osunsina, 2019). Anambra state is a riverine area which is always prone to excessive rainfall and flood (Albert, Harry, & Ishikaku, 2015). Minimizing the impacts of climate change requires adaptation. Adaptation to climate change is action that minimizes the consequences of actual and expected changes in the climate (Elijah et al., 2020). It refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Thus, agriculture production systems require adaptation to these changes in order to ensure the food and livelihood security of farming communities. Adaptation options that sustainably increase productivity, enhance resilience to climatic stresses, and reduce greenhouse gas emissions are known as climate-smart agricultural (CSA) technologies, practices and services (Fanen & Olalekan, 2014).

Climate smart agricultural practices focus on developing resilient food production systems that lead to food and income security under progressive climate change and variability (Lipper et al., 2014). In general, the CSA options integrate traditional and innovative practices, technologies and services that are relevant for a particular location to adopt climate change and variability (CIAT, 2014). Despite the various benefits of CSA technologies, the current rate of adoption by farmers is fairly low (Palanisami et al., 2015) due to factors such as socio-economic characteristics of farmers, bio-physical environment of a particular location, and the attributes of new technologies (Below et al., 2012; Deressa, Hassan, & Ringler, 2011). Furthermore, Arun, Aggarwal, Joshi, and Vyas (2017) recognize the fact that since climate risk on agricultural production are location specific, the identification, prioritization, promotion and demand for available CSA technologies by farmers are major challenges for scaling out CSA in diverse agro-ecological zones such as that of South-East, Nigeria.

Considering the adverse effects of climate change in South-East, Nigeria, the application of CSA technologies by Rice farmers in their production activities may be the solution envisaged for food production deficits arising from climate change. Kehinde et al. (2019) maintained that farmers can reduce the impacts of climate change globally by shifting to agricultural practices that reduce GH emissions. Although, some traditional practices carried out by Rice farmers could be termed 'climate smart', but then, there are some other innovative technologies/practices that Rice farmers may not be aware of which promotes the three pillars of CSA. Based on this premise and considering the fact that CSA may be a new concept to Rice farmers in South-East, Nigeria, this study will address the following research questions: Which of these technologies do rice farmers prefer and what are the reasons for their preferences? What factors determine their choice of preference for the technologies? Are they willing to pay for their preferred choice of these technologies?

1.1. Objectives of the Study

The broad objective of this study was to investigate rice farmers' preferences and willingness to pay for climate-smart agricultural technologies in South-East, Nigeria. Specifically, the study:

i. Ascertained the respondents' preferred CSA technologies and willingness to pay for such preferences.
ii. Determined factors influencing farmers' preference for improved CSA technologies.

1.2. Hypothesis

Based on the stated objectives, one null hypothesis was tested:

Ho: Socio-economic characteristics of rice farmers do not significantly influence their preference for climate smart agricultural technologies in the study area.

2. MATERIALS & METHOD

The survey was conducted in southeast agricultural zone of Nigeria comprising of Abia, Ebonyi, Enugu, Anambra and Imo states (Figure 1). Southeast is located between latitudes 04°17' N and 07°06' N and longitudes 05°23' E and 09°28' E (Ojiako, Tarawali, Okechukwu, & Chianu, 2017).

Table-1. Sampling Procedure

Southeast states of Nigeria	Number of registered Rice farmers	90% Proportionate selection	Approx. value	Data error/Missing information	Actual Sample size
Abia state	91	81.9	80	13	67
Ebonyi state	141	126.9	80	12	68
Enugu state	98	88.2	80	13	67
Anambra state	127	114.3	80	8	72
Imo state	102	91.8	80	5	75
Total	559	503.1	400	51	349

The climate of southeast Nigeria is generally tropical with two clear identifiable seasons: the wet and dry seasons with average highest annual rainfall at 1952 mm and temperature pattern-mean daily and annual temperature at 28 and 27°C, respectively (Igbokwe et al., 2008). The sample for the study initially consist of 400

Rice farmers (80 from each state of the region i.e. 90% of the population size from registered rice farmers in the various states for a proportionate selection) and as a result of data noises, missing information and response errors, 51 questionnaires were rejected, the research continued with information from 349 Rice farmers which became the sample size for the study.

Figure-1. Map of Southeast, Nigeria.

Source: Maps.nigeria.com (2020).

Figure 1 shows (from left to right), the map of Southeast Nigeria, where it is located in the map of Nigeria and where located in the map of Africa. Interview schedule was used to collect data from the respondents which addressed issues such as farmers' level of awareness of CSA technologies, preferred CSA technologies and willingness to pay for such preferences, and factor influencing farmers' preference for improved CSA technologies. The instrument was validated by two experts, one from the Department of Agricultural Economics, University of Nigeria, Nsukka and one from Department of Agricultural Economics and Extension, Nnamdi Azikiwe University, Awka. Descriptive statistics and ordered probit regression model at 5% probability level were used to achieve the objectives. The statistical package for service solution (SPSS) version 22 was used for data analysis.

2.1. Model Specification

Ordered probit regression model was specified as follows:

$$Y(\leq j) = In = \left(\frac{p(Y \leq j\ X)}{p(Y > j\ X)}\right) \qquad (1)$$

$$Y(\leq j) = \ln\left(\frac{p(Y \leq j|X)}{p(Y \leq j|X)}\right) \qquad (2)$$

$$Pr(Y \leq j) = \ln\left(\frac{\Sigma pr(Y \leq j|X)}{1 - \Sigma pr(Y \leq j|X)}\right) = \alpha_j + \beta_1 X_1 + \dots + \beta_{15} X_{15} \qquad (3)$$

Hence:
j = 1, 2, 3
Where;

Y = Preference level for CSA technologies (which is categorized into three: high preference = 3, medium preference = 2 and low preference = 1).

α = Threshold.

β1-β15 = Estimated parameters

X1 = Age (Years).

X2 = Sex (Dummy variable; male = 1; female = 0).

X3 = Marital status (single = 1; Married = 2; widowed = 3; divorce = 4; separated = 5).

X4 = Educational level (Number of years spent in school).

X5 = Primary occupation (Dummy variable; farming = 1; otherwise = 0).

X6 = Annual farm income (Naira).

X7 = Access to credit (Dummy variable; yes = 1; otherwise = 0).

X8 = Extension contact/visit (Dummy variable; yes = 1; otherwise = 0).

X9 = Farm size (hectares).

X10 = Membership of association/farmers organization (Dummy variable; yes = 1; otherwise = 0).

X11 = Formal training on CSA technologies (Dummy variable; yes = 1; otherwise = 0).

X12 = Distance to market (Kilometres).

X13 = Exposure to mass media (Dummy variable; Yes = 1; otherwise = 0).

X14 = Years of farming experience (Years).

X15 = Household size (number of heads in a particular house).

3. RESULTS AND DISCUSSION

3.1. Preferences scale and Contingent valuation (Willingness-To-Pay) for CSA Technologies

In examining rice farmers' willingness-To-Pay (WTP) for improved CSA technology services, the result in Table 2 showed greater proportion of the respondents are strongly not willing to pay for over 77.8% of the CSA technologies while barely 7.4% were mildly willing to pay.

The CSA technology options rice farmers were strongly not willing to pay for were: rainwater harvesting, cover crops method, directed seeded rice, systems of rice intensification, use of solar pumps, zero tillage / minimum tillage, mulching, application of green manure, integrated nutrient management, Leaf color chart, Intercropping rice with legumes, crop insurance, Weather based crop agro-advisories, climate information (seasonal and in season), improved rice variety that is flood tolerant, mixed farming, adjusting planting dates, crop diversification, agro-forestry (100.0%), integrated pest management, bio-gas while the CSA technology options Rice farmers were mildly willing to pay for include: drip irrigation and drainage management, majority (93.5% and 95.7%) of Rice farmers who were willing to pay preferred a yearly payment and payment on its own (as payment vehicle) respectively.

The major reason for respondent's unwillingness to pay were: poverty (2.0%) and CSA technologies is the responsibility of the Government to farmers within the state (5.0%). For the estimated willingness to pay value, through the use of the continuous open-bounded question, the mean monthly minimum WTP in South-East, Nigeria is estimated at ₦5176.7123 while the mean monthly maximum WTP for Rice farmers is estimated as ₦10,926.95.

Comparing to the present charge fees of ₦20,000, this WTP is 2 times lower. From the choice experiment outcome, water-smart technologies (76.8%) was mostly preferred possibly due to the nature of crop produced which is requires large volume of water in all aspects of production, irrigation becomes quite essential to maximize output.

Table-2. Preferences and willingness to pay for CSA Technologies by rice farmers in Southeast, Nigeria.

WTP parameters	Preferences and preference scale (1 to 10)	Mean Min. WTP Amount	Mean Max. WTP Amount
Water-smart technologies	76.8%		
Rainwater harvesting	7	0.00	0.00
Drip irrigation	5	14,062.50	33,697.92
Cover crops method	1	0.00	0.00
Furrow-irrigated raised bed planting	1	0.00	0.00
Drainage management	9	12,083.33	23,229.17
Directed seeded rice	7	0.00	0.00
Systems of rice intensification	6	1,197.92	9010.42
Sprinkler irrigation	9	11,406.25	24,947.92
Energy-smart technologies	13.6%		
Use of solar pumps	8	52.08	104.17
Zero tillage / minimum tillage	4	0.00	0.00
Nutrient-smart technologies	24.8%		
Mulching	3	0.00	0.00
Application of green manure	4	1447.92	52.08
Integrated nutrient management	2	52.08	104.17
Leaf color chart	4	0.00	0.00
Intercropping rice with legumes	7	0.00	0.00
Application of organic manure	4	0.00	0.00
Weather-smart technologies	15.6%		
Crop insurance	4	19,375.00	36,354.17
Weather based crop agro-advisories	7	83.33	156.25
Climate information (seasonal and in season)	8	2125.00	4458.33
Knowledge-smart technologies	37.6%		
Improved rice variety that is flood tolerant	10	4875.00	8916.67
Mixed farming	2	0.00	0.00
Adjusting planting dates	5	0.00	0.00
Crop diversification	1	0.00	0.00
Contingent crop planting	3	0.00	0.00
Carbon-smart technologies	16.9%		
Agro-forestry	1	0.00	0.00
Integrated pest management	2	442.11	831.58
Bio-gas	3	94.74	187.50
		67,297.26	142,050.35
		5,176.7123	10,926.95
Payments Frequency	*Frequency**	*Percentage*	
Mid yearly	2	4.3	
Yearly	87	93.5	
Payment vehicle			
On its own	4	4.3	
With water bill	89	95.7	
Reasons for unwillingness to pay			
We are poor and we cannot pay	2	2.0	
Complete Government responsibility not farmers	5	5.0	

Note: *Multiple responses recorded.

3.2. Ordered Probit Regression Estimate of Factors Influencing Farmers' Preference for Improved CSA Technologies

Table 4 presents the result of the ordered probit model and its marginal effect used to investigate the factors influencing the level of preference rice farmers have for CSA technologies in Southeast, Nigeria. The four categories or preference levels: High, medium, low and no level, formed the dependent variables as ordered 3, 2, 1 and 0 respectively. Fifteen (15) explanatory variables were considered in the *a priori* expectation model specification;

however, only 14 were allowed in the statistical model from which only 3 were statistically significant, 2 at 1% confidence level and 1 at 5% confidence level.

Table-3. Ordered probit regression estimate of factors influencing farmers' preference for improved csa technologies in South-East, Nigeria.

Variables	Estimated Coefficients	Standard Error	Z	P>/z/
Age (X1)	-0.0182977	0.0144588	-1.27	0.206
Sex (X2)	-0.4109561	0.2661928	-1.54	0.123
Marital status (X3)	-0.0795494	0.1932991	-0.41	0.681
Educational level (X4)	0.0757764	0.1532184	0.49	0.621
Primary occupation(X5)	0.4023521***	0.1434632	2.80	0.005
Annual farm income (X6)	1.56e-07	2.36e-07	0.66	0.508
Extension visit (X7)	0.0091934.	0.3302992	0.03	0.978
Access to credit (X8)	-0.6603216***	0.2579741	-2.56	0.010
Farm size (X9)	-0.0155371	0.0441311	-0.35	0.725
Membership of association/farmers organisation (X10)	0.243111	0.2687898	0.90	0.366
Formal training on CSA technologies (X11)	-0.3713203	0.2414614	-1.54	0.124
Distance to market (X12)	-0.4347176**	0.2113661	-2.06	0.040
Years of farming experience (X13)	0.0274781	0.0228625	1.20	0.229
Household size (X14)	0.0009175	0.0822043	0.01	0.991
Cut 1	-1.676792	1.003064		
Cut 2	-0.7906666	0.9948554		
Cut 3	0.9663096	1.006532		
Number of observation	96			
LR Chi2(14)	23.55			
Prob > chi2	0.0518			
Log-likelihood value	-106.35121			
Pseudo R-squared	0.0997			

Note: ***represents significant at 1%; **represents significant at 5%. Dependent variable: ordered preferences (e.g. high, medium, low and no preference).

3.3. Marginal Effects of Ordered Probit Regression Estimate of Factors Influencing Farmers' Preference for Improved CSA Technologies

Table-4. Marginal effects of Ordered Probit Regression Estimate of Factors influencing farmers' preference for improved CSA technologies in South-East, Nigeria: Dependent variable: ordered preferences (e.g. high, medium, low and No preference).

Variables	High Preference	Medium Preference	Low preference	No preference
Age (X1)	-0.0098869	0.0087027	0.00898	-0.0048072
Sex (X2)	-0.0391774	-0.2151537*	0.0798332	0.1116056
Marital status (X3)	0.1132004	-0.0169717	0.113235	-0.0402808
Educational level (X4)	-0.0986312	0.0913099	-0.0267522	-0.0603761
Primary occupation(X5)	-0.0347409	-0.0818742	0.0139331	0.0419331
Annual farm income (X6)	-3.73e-07**	1.21e-07	-5.52e-08	-5.92e-08
Extension visit (X7)	-0.2280933	0.1802893	0.0839213	0.0135476
Access to credit (X8)	-0.1717546*	-0.1808213	0.0684748	-0.0574086
Farm size (X9)	0.0371019	-0.0197152	-0.0135904	0.0208787
Membership of association/farmers organisation (X10)	0.145363	-0.0501342	-0.1313881	0.0653802
Formal training on CSA technologies (X11)	.0231325	0.0097969	0.0091929	-0.0300279
Distance to market (X12)	0.01320207	0.029548	0.1022138	-0.0054779
Years of farming experience (X13)	0.0137355	-0.002541	-0.0188462*	0.0119933
Household size (X14)	-0.024301	-0.0318677	-0.0091647	0.0525322

Note: **represents significant at 5% and *represents significant at 10%. (*) dy/dx is for discrete change of dummy variable from 0 to 1.

3.4. Hypothesis Testing

H01: Socio-economic characteristics of Rice farmers do not significantly influence their preference for climate smart agricultural technologies in the study area.

The significant variables were primary occupation (X5), access to credit (X8) and distance to market (X12). The likelihood ratio Chi square of -106.35121 with a p-value of 0.0518 revealed that the model as a whole is statistically significant so the null hypothesis was rejected the alternate hypothesis accepted. And, the model estimated pseudo R-squared is 0.0997 suggesting that approximately 10% of the variation in WTP is explained by the explanatory variables. Primary occupation (0.4023521) significantly influence preference level of Rice farmers in South-East, Nigeria at ($p<0.01$); however, the marginal effect analysis revealed that a unit increase in terms of better improvements in Rice farmers' primary occupation will reduce the probability to high preference of CSA technologies by 0.0347409, medium preference level by 0.0818742, increase low preference level by 0.0139331 as well as no preference level by 0.0419331. This can be due to the fact that non-farming related primary occupations are likely to divert farmers' attention away from rice farming and when this happens, preferences for CSA technologies dwindles (Okunmadewa et al., 2010). Also, access to credit was also statistically significant at ($p<0.01$). This suggests that an increase in credit access will decrease the likelihood of high, medium and no preference of CSA technologies by 0.1717546, 0.1808213 and 0.0574086 and increase the likelihood of low preference by 0.0684748. The prevalence of credit access lack and their impact on production efficiency has led to low production on farming enterprises. So an increase in credit access was supposed to increase especially their high or medium preference for CSA technologies and reverse may be the case if there is high loan diversion and repayment defaults as implied by the result obtained, hence leading to increase in low preference for improved CSA technologies (Balogun et al., 2011). Then, distance to market (-0.4347176) was found to be significant at ($p<0.05$) and negatively affect preference levels for CSA technologies.

The marginal effect reveals that the more the distance to the market, the more the likelihood of having increase in high, medium and low preferences by 0.01320207, 0.029548 and 0.1022138 with a decrease in no preference level. This implies that market proximity attracts lesser preference levels; short distance enables rapid sales and disposal of marketable commodities, creates a single flow business pattern of grow and sell and less attention may be given to climate related issues, environmental sustainability and improved climate smart agricultural technologies (Adepoju, Yusuf, Omonona, & Okunmadewa, 2011).

4. RECOMMENDATIONS

Based on the findings, the following recommendations were made: Farmers need to adapt to climate change and natural resource pressure, and contribute to mitigating climate change not just being aware; and farmers need to improve on agriculture systems at every scale and become more efficient in resource use (use less land, water and inputs to produce food more sustainably together with reducing food loss and waste) to meet the future challenges.

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