Universal Journal of Agricultural Research 10(6): 610-619, 2022 http://www.hrpub.org
DOI: 10.13189/ujar.2022.100602

CROP Rotation and Diversity Practices among Rural Farmers in Ebonyi State, Nigeria

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Received April 5, 2022; Revised June 2, 2022; Accepted June 21, 2022

Cite This Paper in the following Citation Styles

(a): *[1] Christiana Ogonna Igberi, Sikiru Ibrahim-Olesin, Chinyere Philis Nnorom, Anthony Oko-Isu, Micheal Olatunji Olaolu, Patricia Ngozi Egwu, Chidiebere Prince Osuji Emeka, Emeka Emmanuel Osuji, "CROP Rotation and Diversity Practices among Rural Farmers in Ebonyi State, Nigeria," Universal Journal of Agricultural Research, Vol. 10, No. 6, pp. 610 - 619, 2022. DOI: 10.13189/ujar.2022.100602.*

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Abstract Crop rotation has been identified as a practice that enhances soil fertility and healthy foods, but its awareness and adoption among rural farmers of Ebonyi State, who need the knowledge of best agronomic practices owing to the high cost of fertilizer, remain unknown. To bridge this gap, 180 rural farmers were selected for this study using a multi-stage sampling procedure. Data for the study was obtained using a structured interview schedule, and was analyzed with the use of descriptive statistics, chi-square, and probit regression. The results showed that the mean age of the farmers was 55, and the majority of them (72.22%) were males. However, the majority (87.78%) of the rural farmers were not aware of crop rotation and diversity practices, and a significant difference existed in the average mean annual income of the same land size for adopters (N886, 848.68) and non-adopters (N455, 055.60). The probit regression result showed that marital status, educational level, farm size, cropping system practiced, and access to extension services by the respondents increased the likelihood of farmers' adoption of crop rotation and diversity practices. Intercropping was used more by farmers, and it was found that more extension support and access to education, among other things, would make it more likely that rural farmers would use the method.

Keywords Cropping System, Income, Climate Change, Farming Practices, Rural Community

1. Introduction

The need to identify sustainable agricultural practices that can be easily adopted by rural farmers has become a subject of intellectual contemplation owing to lots of problems posed by conventional agricultural practices [1], including the unavailability and high cost of some inputs like fertilizers and other agrochemicals [2]. These problems are known to drastically affect farming activities and have reduced the overall agricultural output while also contributing to land degradation and the emission of green house gases in recent times [3]. Agricultural production has witnessed a drastic change in terms of new production technologies, mechanization, and government policies, but these developments have also brought some problems, which include a high cost of production stemming majorly from the cost of fertilizers and other farm inputs [4]. The

intensity of the use of chemicals and tillage in conventional agricultural production systems has negative effects on soil health and the environment [5]. To ensure a positive economic and environmental advantage to soil ecosystems, good and effective management practices such as crop rotation, low tillage, and the planting of cover crops are very necessary [6].

Crop rotation has been defined as the successive cultivation of different varieties of crops in a specified order on the same fields over a given period of time, in contrast to the cultivation of only one crop [5]. Park and Allaby [7] define it as the practice of planting different crops on the same area of land from year to year with the aim of improving the soil condition by controlling soil pests [8], controlling weeds [9], increasing the soil organic content [10], preventing erosion [11], increasing productivity and profitability [12], improving water and soil quality, decreasing nutrient loss [13], and improving soil health [14], among others. Crop rotation is, however, a very good practice that can ensure sustainable food production and can also fulfill an important function in lowering the carbon footprints of agronomic practices among farmers, particularly in developing countries and the world at large [15]. In addition, crop rotation has been identified as a good practice that can aid in carbon sequestration in this era of climate change. Le et al. [16] observed that carbon sequestration has more sensitivity to the cropping system than climate change, and this implies that with the effective practice of crop rotation, climate change may not significantly affect crop production. Farina et al. [17] in another study on the adaptation of agricultural systems to climate change, with particular reference to the effect of Durum wheat-based rotation on soil organic carbon (SOC) and nitrogen, showed that losses were greatly reduced even though crop rotation has no significant negative effect on the SOC. It added that nitrous oxide emissions were reduced and the best rotation with great results was the durum wheat-chicken pea. Crop rotation, on the other hand, has a big effect on reducing carbon dioxide emissions and other things that affect the environment and climate change [18].

In Africa, Kanampiu et al. [19] identified a high maize yield in rotation with soybeans in Kenya, while in the Benin Republic of West Africa, Maliki et al. [20] stressed that the rotation of yam and maize is a usual practice. In Ghana, Naab et al. [21] observed that crop rotation increases crop yield, enhances economic return, and increases soil fertility. In Nigeria, crop rotation has been an indigenous practice [22]. Hamza and Ezekiel [23] recorded a greater sorghum yield in soybean-sorghum rotation as compared to maize-sorghum rotation, while Oluwole et al. [24] stressed that the soil quality improved in practices such as crop rotation, forest and alley farming system. Uzor et al. [25] have stressed increased maize yields in grain legumes-maize rotation consequent to the improvement of soil nitrogen, an increase in phosphorous and effective cation exchange capacity. Ebonyi state is renowned for its massive agricultural activities, and the farmers in the state have benefited from FAO training on different agricultural practices [26]. Obinna [27] identified crop rotation as an indigenous practice in the state, but there is little or no proof to show the level of adoption of crop rotation among farmers in Ebonyi state. This study, therefore, assessed the crop rotation and diversity practices among rural farmers of Ebonyi State, Nigeria. Specifically, it: described the socioeconomic characteristics of the crop farmers in Ebonyi State; classified farmers according to the adoption of crop rotation and diversity practices; classified farmers based on the cropping system practiced; classified the farmers according to their annual income from their farming activities; determined the effect of selected socioeconomic characteristics of farmers on their adoption of crop rotation and diversity practices; and compared the income variability of the adopters and non-adopters of crop rotation and diversity practices.

2. Materials and Methods

2.1. Study Area

Ebonyi State is located at latitude 6° 15' 18" N and longitude 8° 05' 55" E in the southeastern part of Nigeria. The State occupies a land area of approximately 5,935 km2 with a population of over 2 million people [28]. The state has thirteen (13) Local Government Areas and it is bounded to the east by Cross River State, to the north by Benue State, to the west by Enugu State and to the south by Abia State. The dominant vegetation of the state is characterized by tree shrubs that comprise abundant palm trees, particularly in its south and central zones. The two main seasons are the rainy and the dry seasons. The rainy season begins around late April and ends in early October, and the dry season lasts from late November to early April [29]. The state is basically an agricultural state, and it is a leading producer of rice. Other crops produced are maize, yam, potatoes, cassava, and beans, while solid minerals identified in the state are lead, crude oil and natural gas, among others [30].

2.2. Sampling Technique

The researchers employed a multi-stage sampling procedure in order to select the respondents contacted for this study. In the first stage, local government areas (LGAs) were selected from each of the three zones of the state, which were: Ikwo and Ezza South LGAs from the central zone; Izzi and Abakaliki LGAs from the northern zone; and Ohaozara and Afikpo North LGAs from the southern zone. The thirteen (13) Local Government Areas of Ebonyi State are all known for their great farming activities, but the researchers focused on the selected LGAs for easy representation. In the second stage, a random selection of two communities from each of the

selected LGAs was done, while the last stage involved the random selection of fifteen (15) farmers from each of the selected communities, bringing the sample size of the study to 180 farmers. This was also accompanied by interviewing some groups of farmers.

2.3. Method of Data Analysis

Descriptive statistics were used to determine respondents' socioeconomic characteristics, and they were also used for their classification based on the cropping system practiced. It was employed to know their adoption of crop rotation and diversity practices and was also used to classify the farmers according to their annual income, while the socioeconomic determinants of their adoption of crop rotation and diversity practices followed Kolady et al. [31] and Oyetunde-Usman, et al. [32] with the use of Probit regression. The Probit regression is modified as:

$$P(Y=1|X1,\ X2,\ X3,\ X4) = \Phi\ (\beta0+\ \beta1X1\ +\ \beta2X2\ +\ \beta3X3+\ \beta4X4) \quad (1)$$

The above is a population Probit model with predicator variables, X1, X2, X3, X4 and Φ $(\cdot)$ is the cumulative standard normal distribution function.

The predicted probability that Y = 1 or 0, given the independent variables, X1, X2, X3, X4 can be estimated as:

$$z=\beta0\ +\ \beta1X1\ +\ \beta2X2\ +\ \beta3X3\ +\ \beta4X4 \quad (2)$$

βj is the effect on 'z' of a unit change in the independent variable 'Xj', given that other variables are held constant (k−1).

3. Results and Discussion

Table 1 shows that the farmers' average age was 55.45 years, and the majority of the farmers fell within the range of 51–60. This is not far from the finding of Ifeanyi-Obi et al. [33] in which the average age of cocoyam farmers in Southeast Nigeria was found to be 51 years. It is also not far from the findings of Diagi and Nwagbara [34], which asserted that the majority of the swamp rice farmers in Ebonyi State fall around the age of 40. The implication of this is that able-bodied youths are not many in the study area, and the aged available farmers were known for the traditional methods of their forefathers. This is a great threat to improving practices in the study area.

The study showed that the majority (72.22%) of the farmers were males. This is in line with some studies like Diagi and Nwagbara [34], which asserted that agriculture is dominated by males (73.7%). This, however, goes against another work by Igboeji et al. [35], who identified that females are the majority (58.3%) of small-scale rice farmers in Ebonyi. Despite males' dominance, females too are active small-scale farmers in Ebonyi. Improvement training should, however, not exclude women as they are important contributors to rice production in the state.

The study indicates that the majority of the farmers (50%) did not have formal education. This goes against the findings of Igboeji et al. [35], and Nwaobiala [36], which asserted that the majority (41.2% and 34%) of small-scale rice farmers in Ebonyi State have primary education. The lack of formal education by the farmers makes it difficult to practice improved practices, but the presence of some others with primary education can still make it easy for them to be trained.

The majority of the farmers (94.44%) were married, and this is similar to the finding of Igboeji et al. [35], which showed that the majority of small-scale rice farmers (62.5%) are married. It is also in line with the percentage recorded by Ifeanyi-Obi et al. [33] among farmers in Southeast Nigeria. With the belief that marriage increases responsibility and improves hard work, married farmers will show more commitment and be always ready for improvement.

The highest household size (44.45%) was between 11 and 15, and this went in line with the finding of Igboeji et al. [35], which put the average household size of small-scale rice farmers in Ebonyi State to be between the ranges of 11 and 15 as well. The average household size was 9, and the majority of farmers (61.11%) operated small-sized farms of between 1.9 and 1.9 hectares of land, and they had an average farm size of 1.78 hectares. These are the characteristics of small farm holders, and as such, the challenge should be how to encourage them to increase their farm size.

Table 1. Socioeconomic characteristics of the respondents

Variable	Percentage	Frequency	Average
Age(Years)			
Lessthan40	18	10	
41-50	22	12.23	
51-60	110	61.11	55.45
Above61	30	16.66	
Total	100	100	
Sex			
Female	50	27.78	
Male	130	72.22	
Total	180	100	
Educational level			
No formal Education	90	50	
Primary Education	48	26.66	
Secondary Education	17	9.45	
Tertiary Education	25	13.89	
Total	180	100	
Marital Status			
Married	172	95.56	
Single	2	1.11	
Widowed	6	3.33	
Total	180	100	
Household Size			
1-5	35	19.44	
6-10	65	36.11	9.25
11-15	80	44.45	
Total	180	100	
Farm Size (Ha)			
1.1-1.9	110	61.11	
1.91-2.9	43	23.89	1.78
2.91-5	27	15	
Total	180		

Source: Field Survey (2020)

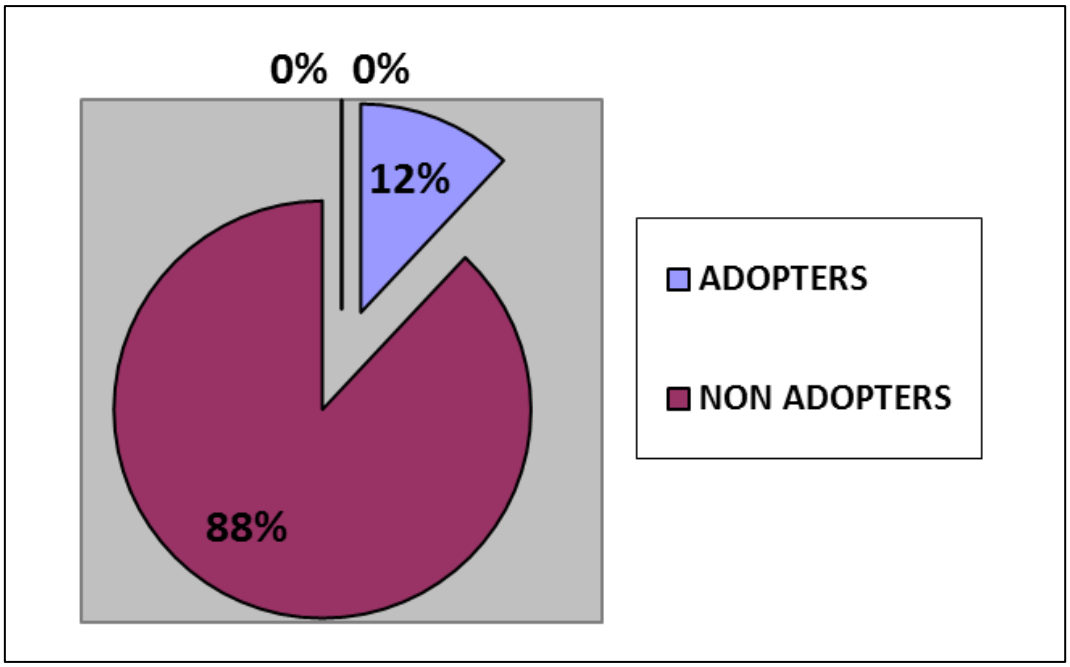

Figure 1. Distribution of farmers according to adoption and non-adoption of crop rotation and diversity (n=180).

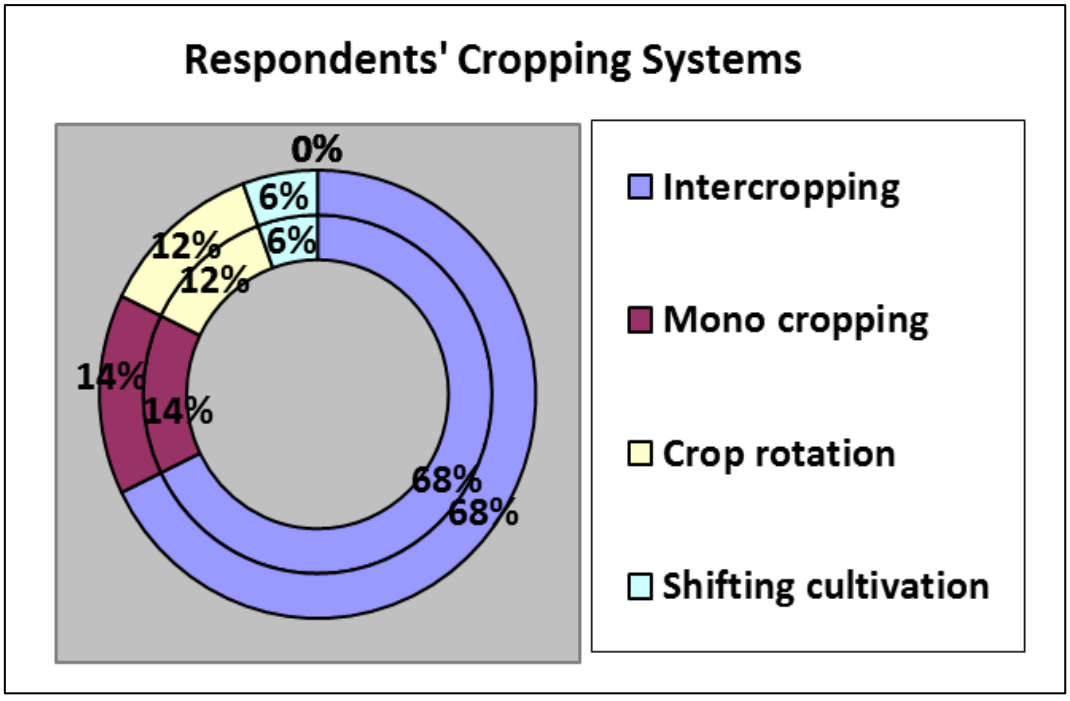

Figure 2. Distribution of farmers according to cropping system adopted (n=180)

The adoption rate of crop rotation and diversity in Ebonyi state was low, as shown in figure 1. Only 12% of the total population of farmers under study adopted a crop rotation system of production. This could not have a significant impact on the changing pattern of cropping. The majority of farmers still hold on to the traditional mixed cropping system without being mindful of any alternative cropping system that could help increase their productivity. This shows the challenge, and particularly, the need for effective program and extension activities that would enhance sizeable adoption.

The various cropping systems practiced by farmers were classified into four categories, as shown in Chart 2. It includes inter-cropping, mono-cropping, crop rotation and diversity, and shifting cultivation. These cropping systems are the major ones practiced in the South East, Nigeria and Ebonyi state in particular. There are several reasons for the farmers' adopting each of these cropping systems. The

knowledge of the cropping system is, however, important because it determines the sustainability of both the crop production yield and the nutrient content of the soil.

From the study, inter-cropping was practiced by the majority of the farmers (67.77%). This cropping system has been an age-long practice of farming in most parts of southeast Nigeria [37], while the mono-cropping system was only practiced by 14.44% of the farmers who could decide to plant only one crop on each of their plots of land for increased yield. The incorrect tradition that farmers used to get high yields from their traditional system was still in place in various parts of Nigeria. The fact that there were not many people on earth then was not being considered; rather, they believed that allowing only one crop on each plot would give the crops more space for expansion in growth instead of competing with different varieties planted on the same plot.

The study showed that 12% of the farmers practiced crop rotation and diversity with the view to increasing yield and replenishing the soil nutrients by sequentially selecting different varieties of crops for the purpose. This is not the case with the study of Onyeneke, et al. [38], which was conducted in Nassarawa State, Nigeria. It was found that crop rotation was also a common adaptation strategy by farmers in the area, and the probable reason for its adoption by about 70.63% of the farmers was that it enhances production, controls pests and diseases, conserves soil moisture, and is less expensive. In the same vein, crop diversification was adopted by the majority of the farmers (95.00%), while it was found that the dominant practice under crop diversification is intercropping of sorghum, maize with sweet potatoes and cowpea or melon [39]. Despite the enormous benefits of this cropping system, it was not being practiced by farmers in the southeast, including Ebonyi State.

The study also showed that some of the farmers (5.55%) still practicing shifting cultivation. This mostly happened in Izzi and Abakaliki where there is still a lot of undeveloped lands mass. The population surge and urbanization have not extended so much.

From Table 2, the highest income earners are the adopters of crop rotation and diversity practices. These are earners between 700-899 thousand Naira, who were 18 in number (81.8%), and earners of 900 thousand Naira and above, who were 4 in number (18.2%). Non-adopters are primarily earners earning between 300–499 thousand Naira (63.3%), followed by earners earning between 500–699 thousand Naira (30 in number (19.0%), and earners earning between 100–299 thousand Naira with a frequency of 28 and a percentage of 17.7%. Thevalue 0.000 shows a significant relationship, meaning that, income is a good determinant of their adoption of crop rotation and diversity practices.

Table 2. Variability between the annual incomes of the adopters and non-adopters of crop rotation and diversity practices

Annual Income (‘000 Naira)	**Adoption** Non Adopters	**Adoption** Adopters	**Total**	**Chi Square**	**P Value**
100-299	28 (17.7%)	0 (0%)	28 (15.6%)	120.00	0.00*
300-499	100 (63.3%)	0(0%)	100 (55.6%)		
500-699	30 (19.0%)	0 (0%)	30 (16.7%)		
700-899	0 (0%)	18 (81.8%)	18 (10.0%)		
900 and above	0 (0%)	4 (18.2%)	4 (2.2%)		
Total	158 (100%)	22 (100%)	180 (100%)		

Source: Field survey (2020)

Table 3. Variance Inflation Factor (VIF) result from Probit regression model

Variable	VIF	1/VIF
Ownership of land	4.25	0.235313
Age	4.24	0.235749
Willingness to accept new cropping system	4.15	0.240933
Household size	4.07	0.245904
Education level	3.39	0.295344
Estimated annual income	3.16	0.316495
Farm size	2.45	0.408699
Awareness of CRDP	1.98	0.504380
Cropping system	1.64	0.608147
Membership in cooperative societies	1.44	0.696260
Access to extension services	1.36	0.736857
Access to improved seeds	1.28	0.782098
Access to credits	1.15	0.865854
Marital status	1.15	0.870494
Sex	1.15	0.891302
Mean VIF	2.46	

Table 4. Effects of selected socioeconomic characteristics of respondents on their adoption of crop rotation and diversity practices using the probit regression

Independent variable	coefficient	Std. error	Z	P>|z|
Age	-0.045	0.052	-0.85	NS
Sex	-0.467	0.437	-1.07	NS
Marital status	-1.347	0.797	-1.69	*
Education level	0.352	0.291	1.21	**
Farm size	0.141	0.355	0.40	*
Household size	0.507	0.638	0.79	NS
Awareness of CRDP	0.230	0.203	1.16	NS
Annual income	0.357	0.381	0.94	NS
Cropping system	0.504	0.227	2.22	**
Extension services	0.970	0.453	2.14	**

Number of obs = 180LRchi2(15) = 103.31

Prob > chi2 = 0.0000

Log likelihood = -26.144806. Pseudo R2= 0.6640

From Table 3, the model was subjected to diagnostic checks to ensure that it conforms to regression assumptions. The tests carried out included multicollinearity, heteroscedasticity, and goodness of fit of the model. The Variance Inflation Factor (VIF) scores were well below 10 (2.46–4.25), with all the tolerance statistics ranging above 0.2 (Table 3). This confirms the absence of multicollinearity in the model, thus, the assumption was met. The heteroscedasticity test as provided by the Breusch-Pagan result was not significant (P-value of 0.3408). This suggests that the variance of the residuals is homogenous in the model, and thus, the assumption of homoscedasticity was met. The goodness-of-fit test of the probit model fit was significant ($p<0.05$), suggesting the good fit of the model.

The probit regression result of the determinants of adoption of crop rotation and diversity practices shows positive coefficients for educational level (0.352), farm

size (0.141), awareness of CRDP (0.235), annual income (0.357), cropping systems practiced (0.504), access to extension services (0.970), access to credit (0.474), and land ownership (0.636). This suggests that these variables increase the likelihood of adopting crop rotation and diversity practices. However, the negative coefficients of age (-0.045), sex (-0.467), marital status (-1.347), access to improved seeds (-0.317), membership in a cooperative society (-0.183), and willingness to accept new cropping systems (-0.132) suggest that these variables decrease the likelihood of adoption of crop rotation and diversity practices.

More so, marital status, educational level, farm size, cropping system practiced, and access to extension services by the respondents are significant predictors of adoption of crop rotation ($P < 0.05$).

According to the findings, respondents' educational level had a direct (positive) relationship with crop rotation and diversity adoption; this corresponds with Ahmed's [40] findings in Ethiopia, and it implies that those with higher education tend to adopt crop rotation and diversity innovations as a key means of soil conservation among the farmers in the study area. Education is a major factor in the adoption of innovation generally, as opined by Salau et al. [41]. It is widely believed that education creates a favorable mental attitude for the acceptance of new ideas and practices. Farm size and access to extension services were significant determinants of their adoption of crop rotation and diversity practices. This conforms to the findings of Olawuyi [42] and implies that the bigger the farm, the more likely it will adopt crop rotation and diversity practices. At the same time, farmers who have better access to extension services are likely adopters of crop rotation and diversity practices because extension services are purely intended to provide farmers with information that would enhance the increased productivity of farm enterprises. The significance of education in both decision making and the implementation of technically oriented practices such as crop rotation and diversity cannot be overemphasized, as many farmers attest to the fact that it requires systematic arrangement, which is time-consuming in its layout. This explains why many of the farmers did not adopt this practice despite its high yield and soil-conserving nature.

4. Conclusions

Based on the findings of the project, the majority of the farmers have not adopted crop rotation and diversity, despite its widespread importance, but they are rather engaged in other farming practices, which are chiefly intercropping and mono-cropping. The majority of the farmers in the study area also fall between the ages of 51 and 60, with a mean age of 55. Many of them are males (72.22%), and the majority (50%) have no formal education. A sizeable number (96%) were married, and their mean household size was 9, while their average farm size was 1.78 ha. Marital status, educational level, farm size, cropping system practiced, and access to extension services by the respondents increase the likelihood of farmers' adoption of crop rotation and diversity practices. When considering training or programs aimed at encouraging farmers to adopt crop rotation and diversity practices, socioeconomic factors that increase the likelihood of farmers adopting the practices are factors to consider. Owing to the importance of crop rotation in agricultural production, and its low adoption in the study area, farmers in Ebonyi State need proactive extension activities to enable them to take advantage of crop rotation in order to enhance the fertility of their soil and increase their production at a lower cost instead of purchasing fertilizers at exorbitant prices, which may not be sustainable in the long run. Farmers' education should therefore be designed around the recognition of these factors to ensure compliance.

Acknowledgements

The authors are most grateful to the Zonal Directors of ADP under the Ministry of Agriculture, Ebonyi State for supporting the team with Extension Agents that made locating and meeting the farmers easy.

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