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ANALYSIS OF THE FACTORS INFLUENCING THE ADOPTION OF AGROFORESTRY IN THE SOUTHERN ZONE OF BENUE STATE, NIGERIA

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ABSTRACT

Farmers in developing countries rarely deliberately plant trees on their farms and this deprived them of several advantages of scattered farm trees.. This study was carried out to analyze the factors that influenced the adoption of agro-forestry in the southern zone of Benue State. Out of the nine LGAs that make up the study area, two LGAs of Okpokwu and Ogbadigbo were randomly selected for the study. Both open and closed ended questionnaire were administered to the farmers in the study area. Data were collected from three districts of each of the LGAs. One hundred and twenty (120) questionnaires were distributed in each of the LGAs. Descriptive statistics and Logit regression models were used to analyze the data. The variables that had significant co-efficients are the visits by extension agents (ß = 0.5087, $p<0.01$), perceived benefits of agroforestry (ß = 0.0814, $p<0.05$), educational level of the household heads (ß = 0.4544, $p<0.05$), membership of cooperative society (ß = 0.0505, $p<0.05$) and size of household (ß = 0.3778, $p<0.05$). Variables that were negatively significant are age of household heads and farm size. It should be noted that a positive sign on a parameter indicated that higher values of the variables tend to increase the likelihood of adopting agroforestry. In conclusion, the study found that seven out of the eleven factors considered influence the adoption of agroforestry in the study area. There is therefore need to embark on mass sensitization on the benefits of agroforestry especially on livelihoods, environment, food security and health.

Keywords: Factors Influencing, Adoption, Agroforestry, Southern zone, Benue

Introduction

Recent fluctuations in the elements of weather such as late arrival of rain and high temperature have been attributed to human activities such as deforestation (Igwebuike *et al*; 2001). One of the ways of mitigating the effect of weather variability is the adoption of agroforestry. Zomer *et al*. (2014) refer to agroforestry as the inclusion of trees within the same farming system. Still, a definition put forward by Food and Agriculture Organization of the United Nations (FAO, 2005) posits that agroforestry is a system that embraces both traditional and modern land use systems where trees are cultivated together with crops and/or animal production systems in agricultural settings. Subsequently, agroforestry is classified into agrisilviculture, silvopastoral and agrosilvopastoral. Also, Briggs (2012) and Nerlich *et al*. (2012) aver that the system of planting trees, crops, and livestock in the same farm has been practiced in many countries.

Agroforestry is a land management practice with consideration for the natural process of soil nutrient renewal. Charley and West (1977) claimed that the litter fall is the major pathway for the return of nitrogen, phosphorus, calcium and magnesium to the soils. This implies that cultivation of perennial shrubs and trees would allow leaf-fall onto the soil, subsequently

decomposition of which would enrich the soil. Agroforestry also contributes towards maintenance of the ecological balance which is the basis for environmental sustainability. Furthermore, climatic changes, global warming or the greenhouse effect caused by environmental degradation can be checked with agroforestry practices. Anderson (1990) emphasized that Agroforestry plays a major role in reclamation of degraded or abandoned lands and is a workable approach to mimic natural succession and increased biodiversity.

The threatening impact of climate change on livelihood, food production, health status, and other aspects of rural livelihood has been confirmed by various researches. For instance, Deschênes and Greenstone (2007) avow that the effect of climate change is perceived on food security, natural resources, economic activities, physical infrastructures, and environmental degradation. Likewise, different researchers, but from related field submit that the threat is caused by natural phenomenon and human activities which have consequently given rise to greenhouse gases. Ironically, just as agricultural production contributes to climate change, yet it is also affected by it.

Agroforestry technology has received a lot of enthusiasm and hope from some rural communities in Nigeria. For instance, Stigter (2011) described the ICRAF project financed by (IFAD) in some parts of Edo State in Nigeria, Cameroon and Democratic Republic of Congo as a regenerative measure that is reversing the economic status of the poor in the communities. Glenn (2005) also noted that in Embu district of eastern Kenya more than 300 farmers were planting tree legumes in fodder banks for use as an inexpensive protein supplements for the dairy cows while in south east Asia similar success was been observed as hundreds of farmers in Southern Philippines were adopting contour hedgerow systems based on natural vegetative strips.

The North Central Zone of Nigeria has the largest land mass for the growth of both forest and cereal crops. The vegetation cover is otherwise called the guinea savanna zone which forms a mix-up of forest and grass belt known as the middle belt of Nigeria. Wild fire often occurs in the dry season which may expose large expanse of land to both wind and water erosion or degraded fields and destruction of homes. The increase of heat wave frequency as a result of little or no grass cover during the dry season and over exploitation of the few trees may also result in climatic changes. The consequences of such changes may include low rainfall, excessive heat among others. Adoption of agroforestry systems by farmers in the study area may reduce the aforementioned hazards.

Hence, the paper seeks to examine the adoption of agroforestry practices. Consequently, it is believed that the outcome of this research will help the farmers, government and other key stakeholders to develop policies and programmes on agroforestry system (climate change mitigation) which can enable further reduction of greenhouse gasses to sustain biodiversity, increase food production and thus, enhance farmers' livelihoods.

Methodology

Study Area

The study was conducted in two Local Government Areas (LGAs) of Okpokwu and Ogbadigbo both situated in the Southern zone of Benue State, Nigeria. Benue State is situated within the guinea savannah vegetation zone of Nigeria and it is topographically located on an altitude of about 1000m above sea level and lies within longitude 13^0E and latitude 11^0N (Benue, 2007). It has an area of 34,059km^2 and a

population projection of 7,881,642 as at 2020. It is surrounded by five states, namely Nassarawa to the north, Taraba to the northeast, Cross River to the south, Anambra to the southwest and Kogi to the west. There is also a short international boundary between the state and the Republic of Cameroun along Nigeria's southeast border.

Sampling Procedure and Sample Size

A random sampling procedure was used in choosing the respondents for the study. The respondents were mainly full time farmers. The sample size obtained from the agriculture department of the Local Governments showed that the number of registered full time farmers in Opokwu was given as 1,298 and 1,340 Ogbadigbo. Out of this 10% was chosen as the sample size to give 135 farmers in each of the LGAs. Consequently 135 questionnaires were administered in Opokwu, 120 were retrieved. Similarly in Ogbadigbo, out of the 135 administered, 120 were correctly filled and returned. In other words, a total of two hundred and forty (240) open and closed ended questionnaires were filled and returned by the farmers who were randomly selected in three districts from each of the two LGAs. The primary data provided information on the socio-economic characteristics of farmers and factors influencing farmer's adoption of agro-forestry practices.

Data Analysis

Descriptive statistics such as frequencies and percentages were used to describe the socio-economic characteristics of the respondent while Logit regression was used to analyse the factors influencing farmer's adoption of agro-forestry practices.

Logit regression model

Logit regression analysis is a uni/multivariate technique which allows for estimating the probability that an event occurs or not, by predicting a binary dependent outcome from a set of independent variables. The linear probability model is depicted as:

$$P_i = \in (\gamma = 1/X_i) = \beta_1 + \beta_2 X_i \quad (1)$$

Where X refers to the variables that influenced the decision to adopt and Y means that the household heads adopt or not. Let us consider the following representation of determinants of adoption

$$P_1 = \in (\gamma = 1/X_i) = \frac{1}{1+exp[-(\beta_1+\beta_2 X_i)]} = \frac{1}{1+exp(-Z_i)} \quad (2)$$

Where,

$$Z_i = \beta_1 + \beta_2 X_i \quad (3)$$

This equation (3) is known as the (cumulative) logistic distribution function. Here Z_i ranges from $-\infty$ to $+\infty$; P_i ranges between 0 and 1; P_i is non-linearly related to Z_i (i.e X_i) thus satisfying the two conditions required for a probability model. In satisfying these requirements, an estimation problem has been created because P_i is non-linear not only in X but also in the ß's. This means that one cannot use OLS procedure to estimate the parameters.

Here, P_i is the probability of adoption and is given by:

$$\frac{1}{1+exp(-Z_i)} \quad (4)$$

Then (1-Pi), the probability of not adopting is:

$$(1 - P_i) = \frac{1}{1-exp(Z_i)} \quad (5)$$

Therefore, one can write

$$\frac{P_i}{(1-P_i)} = \frac{1+exp(Z_i)}{1+exp(-Z_i)} \quad (6)$$

$P_i/(1-P_i)$ is the odds ratio in favour of adopting agroforestry by household heads i.e the ratio of the probability that a farmer will adopt to the probability that he will not adopt. Taking natural log of (Z), we obtain

$$L_i = ln[P_i/(1-P_i)] = Z_i = \beta_0 + \beta_1 X_1 + \cdots + \beta_6 X_6 + \beta_7 X_7 + e \quad (7)$$

That is, the log of the odds ratio is not only linear in X, but also linear in the parameters. L is called the logit. The parameters to be estimated include the following:

P = Adoption of Agroforestry (I = Yes, 0 = Otherwise)
X_1 = Extension visits (1= visited, 0= otherwise)
X_2 = Perceived benefits of agroforestry (1= Aware, 0 = otherwise)
X_3 = Credit Received (Naira)
X_4 = Ownership of farm (1 = Owned farm, 0 = otherwise)
X_5 = Years spent schooling (Years)
X_6 = Proneness to pest and disease (1 = area highly prone, 0 = otherwise)
X_7 = Age of respondents (Years)
X_8 = Occupation of respondents (1 = Full time farmers, 0 = otherwise)
X_9 = Farm size (Hectares)
X_{10} = Membership of cooperative (Years)
X_{11} = Size of households (Number)

Results and Discussion

Factors Influencing the Adoption of Agro- Forestry Practices.

The regression parameters and diagnostic statistics were estimated using the maximum likelihood estimation (MLE) technique (Table 1). From the maximum likelihood estimates of the logit regression (equation 6), it is possible to draw conclusions about the magnitude and direction of each variable on the probability of adopting agroforestry. The log likelihood ratio statistic was significant (P<0.01) suggesting that the independent variables taken together influence the adoption of agroforestry by the farmers. The result showed that seven out of the eleven listed regressors had significant influence on the adoption of agroforestry by the farming household's head. The variables that had significant coefficient are the visits by extension agents (x_1), perceived benefits of agroforestry (x_2), educational level of the household heads (x_5), membership of cooperative society (x_{10}) and size of household (x_{11}). Variables that were negatively significant are age of household heads (x_7) and farm size (x_9). The variable that were not significant are credit received, ownership of farmland, pest and diseases and occupation of household heads. It should be noted that a positive sign on a parameter indicated that higher values of the variables tend to increase the likelihood of adopting agroforestry. Similarly, a negative value of a co-efficient implied that higher values of the variables would reduce the probability of adopting agroforestry.

The marginal effects of the independent variables revealed that on the average a percent increase extension visit will lead to a 0.17 percent increase in the probability of adopting agroforestry in the study area holding all else constant. Access to extension services has also been found to be a key aspect in technology adoption. Farmers are usually informed about the existence as well as the effective use and benefit of new technology through extension agents. Extension agent acts as a link between the innovators (Researchers) of the technology and users of that technology. This helps to reduce transaction cost incurred when passing the information on the new technology to a large heterogeneous population of farmers (Genius *et al*., 2010). Extension agents usually target specific farmers who are recognized as peers (farmers with whom a particular farmer interacts) exerting a direct or indirect influence on the whole population of farmers in their respective areas (Genius *et al*., 2010).

Many authors have reported a positive relationship between extension services and

technology adoption. A good example include; Adoption of Imazapyr-Resistant Maize Technologies (IRM) by Mignouna *et al*. (2011); Factors determining technology adoption among Nepalese Karki and Siegfried (2004); Uaiene *et al*., 2009; Adoption of improved maize and land management in Uganda by Sserunkuuma (2005); adoption of modern agricultural technologies in Ghana by Akudugu *et al.* (2012) just to mention a few. This is because exposing farmers to information based upon innovation-diffusion theory is expected to stimulate adoption (Uaiene *et al*., 2009). In fact, the influence of extension agents can counter balance the negative effect of lack of years of formal education in the overall decision to adopt some technologies (Yaron, Dinar and Voet, (1992); Bonabana- Wabbi 2002).

The marginal effect for perceived benefits of agroforestry revealed that on the average a 1 percent increase in the information on the benefits of agroforestry will lead to a 0.027 percent increase in the adoption of agroforestry. Acquisition of information about a new technology is another factor that determines adoption of technology. It enables farmers to learn the existence as well as the effective use of technology and this facilitates its adoption. Farmers will only adopt the technology they are aware of or have heard about it. Access to information reduces the uncertainty about a technology's performance hence may change individual's assessment from purely subjective to objective over time (Caswell et al., 2001; Bonabana- Wabbi 2002). However access to information about a technology does not necessarily mean it will be adopted by all farmers. This simply implies that farmers may perceive the technology and subjectively evaluate it differently than scientists (Uaiene *et al*., 2009). Access to information may also result to dis-adoption of the technology. For instance, where experience within the general population about a specific technology is limited, more information induces negative attitudes towards its adoption, probably because more information exposes an even bigger information vacuum hence increasing the risk associated with it (Bonabana- Wabbi 2002). It is therefore important to ensure the information is reliable, consistent and accurate. Farmers need to know the existence of technology, its beneficial, and its usage for them to adopt it.

The marginal effect of years spent in school acquiring education showed that on the average, a 1 percent increase in education will lead to a 0.154 percent increase in the adoption of agroforestry. Education of the farmer has been assumed to have a positive influence on farmers' decision to adopt new technology. Education level of a farmer increases his ability to obtain; process and use information relevant to adoption of a new technology (*Mignouna et al*., 2011; Lavison 2013; Namara *et al*., 2013). For instance a study by Okunlola *et al.* (2011) on adoption of new technologies by fish farmers found that the level of education had a positive and significant influence on adoption of the technology. This is because higher education influences respondents' attitudes and thoughts making them more open, rational and able to analyze the benefits of the new technology (Waller *et al*., 1998).

The marginal effect of membership of cooperative society or other social groups showed that on the average, a 1 percent increase in duration of membership of such societies will lead to a 0.017 percent increase in the adoption of agroforestry. Farmers within a social group learn from each other the benefits and usage of a new technology. Uaiene *et al*. (2009) suggests that social network effects are important for individual decisions, and that, in the particular context of agricultural

innovations, farmers share information and learn from each other. Studying the effect of community based organization in adoption of corm-paired banana technology in Uganda, Katungi and Akankwasa (2010) found that farmers who participated more in community-based organizations were likely to engage in social learning about the technology hence raising their likelihood to adopt the technologies.

The marginal effect of size of household revealed that on the average a 1 percent increase in the size of the household will lead to a 0.128 percent increase in the adoption of agroforestry. Household size is simply used as a measure of labor availability. It determines adoption process in that, a larger household have the capacity to relax the labor constraints required during introduction of new technology (Mignouna *et al*, 2011; Bonabana- Wabbi 2002)

The marginal effect of age showed that on the average, a 1 percent increase in the age of the household head will lead to a 0.030 percent decrease in the probability of adopting agroforestry. Age is generally assumed to be a determinant of adoption of new technology. Older farmers are assumed to have gained knowledge and experience over time and are better able to evaluate technology information than younger farmers (Mignouna *et al*, 2011; Kariyasa and Dewi 2011). On contrary age has been found to have a negative relationship with adoption of technology. This relationship is explained by Mauceri *et al*. (2005) and Adesina and Zinnah (1993) that as farmers grow older, there is an increase in risk aversion and a decreased interest in long term investment in the farm. On the other hand younger farmers are typically less risk-averse and are more willing to try new technologies. For instance, Alexander and Van Mellor (2005) found that adoption of genetically modified maize increased with age for younger farmers as they gain experience and increase their stock of human capital but declines with age for those farmers closer to retirement.

The marginal effect farm size revealed that on the average a 1 percent increase in the farm size will lead to a 0.0017 percent decrease in the probability of adopting agroforestry. Many studies have reported a positive relation between farm size and adoption of agricultural technology. Some studies have shown a negative influence of farm size on adoption of new agricultural technology. Small farm size may provide an incentive to adopt a technology especially in the case of an input-intensive innovation such as a labor-intensive or land-saving technology. Farmers with small land may adopt land-saving technologies such as greenhouse technology, zero grazing among others as an alternative to increased agricultural production (Yaron, Dinar and Voet, 1992; Harper *et al*, 1990).

Table 1: Maximum Likelihood Estimate of Factors Influencing the Adoption of Agro-Forestry Practices.

	Effects on agroforestry	Marginal effects on agroforestry
Variable	Estimated coefficients	Estimated coeffients
Extension visit (x_1)	0.5087*** (2.95)	0.1734
Benefits of agroforestry (x_2)	0.0814** (2.29)	0.0277
Credit received (x_3)	0.0145 (1.62)	0.0049
Ownership of farm (x_4)	0.0072 (0.65)	0.0024
Years spent schooling (x_5)	0.4544**(1.91)	0.1549
Pest and disease (x_6)	0.0099 (0.24)	0.0033

Age (x_7)	-00892**(-2.42)	-0.0304
Occupation (x_8)	-0.0099(-0.09)	-0.0067
Farm size (x_9)	-0.0019** (-2.12)	-0.0017
Membership of cooperative (x_{10})	0.0505** (2.12)	0.0172
Size of household (x_{11})	0.3778** (2.17)	0.1288
Constant	-0.0054 (-0.01)	NA

Number of obs = 224
LR chi2(14) = 61.12
Log likelihood = -376.59013
Pseudo R2 = 0.0751

Source: Regression results 2017
Notes: Numbers in parenthesis are Z values for each coefficient
*** indicates statistical significance at 1%; ** at 5% and * at 10%
NA: Not available

Constraints to the Adoption of Agroforestry

The result in Table 2 revealed that the major factor (28%) hindering the adoption of agroforestry among farmers in the study area is lack of awareness about the benefits of agroforestry. Another challenge reported (22%) is insufficient funds to purchase the desired seedlings and other inputs such as manure. The result also revealed that 18% of the farmers had limited knowledge of the types of trees and their general benefits. Some of the farmers reported that pest and diseases with particular emphasizes on termites as their challenge. A lack of silvicultural practices involved in raising seedlings was reported by 10% of the farmers. Finally, a few of the farmers reported that they don't know where to purchase the seedlings.

Table 2: Challenges to the adoption of agroforestry

Constraints	Frequency*	Percentage
Lack of awareness	149	27.8
Insufficient funds	118	22.01
Limited knowledge of type of trees	94	17.54
Pest and disease (termites)	73	13.62
Limited knowledge of how to raise seedlings	56	10.45
Don't know where to get seedlings	46	8.58

- Multiple responses were allowed

Conclusion and Recommendation

The role of Agroforestry in sustainable land use system cannot be over emphasized. In an attempt to unravel the factors that influence the adoption of this system by farmers, the result showed that visits by extension agents, perceived benefits of agroforestry, educational level of the household heads, membership of cooperative society and size of household had significant influence on the adoption of agroforestry by the farming households in southern Benue. Other variables that were negatively significant are age of household heads and farm size. Indeed, the advantages of agroforestry are quite enormous. Agroforestry, among other benefits strive to optimize the use of land for agricultural production on a sustainable basis and at the

same time meeting other needs from forestry. Major challenges to the adoption of agroforestry identified in study such as lack of awareness, limited funds and a lack of knowledge of trees should be mitigated.

To further enhance the adoption of agroforestry in the area it is recommended that the farmers need to be educated on the benefits of agroforestry especially on livelihoods, environment, food security and health. This is a wakeup call to both the government and non-governmental organizations. The farmers should also be encouraged to form cooperative societies to enable them build capital and also access same.

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