Original Research

Volume 4, Issue 1, pp 21-29, June 2022

ACHIEVERS JOURNAL OF SCIENTIFIC RESEARCH

Opecn Access Publications of Achievers University, Owo

Available Online at www.achieversjournalofscience.org

Determinants of Adoption of Vetiver Grass Strips Technology (VGT) In Southeast Nigeria.

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Submitted: March 24, 2022 Revised: May 12, 2022 Accepted: May 30, 2022 Published: June 30, 2022

Abstract

Abia State faces a severe erosion problem that affects agricultural production which may lead to poverty of crop farmers. The use of vetiver grass strips technology (VGT) helps control soil erosion. However, there is a dearth of information on the determinants of adoption of VGT in Abia and therefore was investigated. Random sampling technique in 4 stages was adopted for this study. The ADP zones (Aba, Umuahia, and Ohafia) in the state were considered, 13 blocks were selected from the 38 blocks in the state. 30 cells out of 93 cells in the selected blocks were randomly selected. 250 farming households were randomly selected proportionate to size of the cells. Data on socio-economic characteristics of the farmers, awareness and adoption of VGT, quantity of inputs and outputs of crops, expenditure on food and non-food items were collected using a structured questionnaire. Data were analyzed using descriptive statistics, adoption index and probit regression at $\alpha_{0.05}$. Respondents mean age was 48 years and 51.2% were male farmers. The household size and farm-size were 6.0 members and 2.0 ha, respectively. About 36% of them had tertiary education, while 59.2% were aware of VGT but 49.6% adopted it. 53.2% of the female were adopters with farm size of 1.57 ha and 42.7% had tertiary education. A unit increase in age, level of education and being a female increased the probability of adoption of VGT by 0.3169, 0.3078 and 0.2097 respectively, while a unit increase in farm-size reduced the probability of adoption by 0.0824 unit.

Keywords: Vetiver Grass Strip; Probit Model; Sustainable Agricultural Production

1.0 Introduction

Vetiver is an effective hedge when grown on the contour as it simultaneously reduces the flow of sediment from eroding sites and reduces run off. It also has the advantage of low cost when compared to other traditional engineered practices (Grimshaw, 2012). Vetiver grass has unique characteristics such as growing over a wide range of site conditions; non-competitive with adjacent crops; it is not a weed; it is resistant to pests and diseases; it is used as fodder for livestock; it is used for stabilizing earth embankments, drainage lines, roads etc; it is fire resistant and known to repel rodents; and needs minimum maintenance. Vetiver grass provides a good, widely and easily applicable technology that is practical, proven, effective, and profitable at a time when a great deal of attention is being paid to simple low cost technology for sustainable agriculture (Grimshaw, 2012).

The Vetiver grass technology involves the establishment of a hedge grass barrier across the slope of the land (Oshunsanya *et al.,* 2014). A well-established Vetiver grass hedge will slow down rainfall run off, spreading it out evenly, and will trap runoff sediments to create natural terraces. It is a farmer's technology as it avoids the use of complex hydrological data and design, and without the aid of high cost consultants and surveyors. Vetiver (*Vetiveria Zizanioides*) is a fast growing perennial grass that grows up to a metre or more and on a wide range of areas from high lands to low lands in various soil conditions (Oshunsanya *et al.,* 2014). It appears in a dense clump and grows fast through tilling. The clump diameter is about 30 cm and the height is 50-150 cm. The leaves are erect and rather stiff with 75 cm of length and 8 mm of width. Vetiver is a true miracle grass by its character of special massive long roots that anchor and penetrates straight into the ground. It has the following advantages as it was used for making thatch, handy crafts, perfumery, and employed in religious activities in the past and presently it is being used at larger scale for soil and water conservation and other agricultural practices. In addition, presently the miracle grass as it is commonly called is broadly modified for use for environmental protection and other non-agricultural applications and also on an industrial scale. Vetiver can also be used for other miscellaneous purposes like construction materials, livestock forage, landscaping and ornamentals, mulch, compost, veneer, fibre board, ash for concrete work, and insecticide. The grass also can also get rid of heavy metals from industry sewage, leachate form garbage, and take part in various industrial, commercial products. The benefits of Vetiver are considerable and it is expected in future to serve as a socio-economic tool for many countries for making clean environment. Vetiver is now being used in over one hundred and twenty countries including the South east of Nigeria (Nzeribe and Nwachukwu, 2008).

There are factors affecting adoption of agricultural technology in literature. They include the following: Personal characteristics of the technology, endowments, imperfect information, risk, uncertainty, institutional constraints, input availability, social networks, learning, and infrastructure (Feder *et al.,* 1985; Koppel, 1994; Foster and Rosenzweig, 1996; Kohli and Singh, 1997; Rogers, 2003; Uaiene, 2009; Loevinsohl *et al.,* 2013). Akudugu *et al.* (2012) and Lavison (2013) grouped the determinants of agricultural technology adoption into three categories namely; economic, social and institutional factors. McNamara, Wetzstein and Douce (1991) categorized the factors into farmer's characteristics, farm structure, institutional characteristics and managerial structure, Nowak (1987) grouped them into informational, economic and ecological, while Wu and Babcock (1998) classified them under human capital, production, policy and natural resource characteristics.

Although there are many categories for grouping determinants of technology adoption, there is no clear distinguishing feature between variables in each category as categorization is done based on the author's perspective to suit the current technology being investigated, the location, and the researcher's preference, or even to suit client needs (Bonabana-Wabbi, 2002). For instance, some researchers classify the level of education of a farmer as a human capital while others classify it as a household specific factor.

2.0 Methodology

Abia State is one of the highest ranking states in term of active gully sites. Abia State is located in south eastern region of Nigeria. Abia State lies within approximately $4^0 4^1$ and $6^0 14^1$ North and longitudes $7^0 10^1$ and 8^0 East. The State shares common boundaries to the North with Ebonyi state, to the South and Southwest with Rivers State, and to the East and South East with Cross

Rivers and Akwa Ibom states respectively. To the West is Imo State, and to the Northwest is Anambra State. The State has a human population of about 2,833,999 (NPC, 2006) and covers an area of about 5,243.7sq.km of the total land area of Nigeria. With its capital in Umuahia it has seventeen local government areas namely Aba North, Aba South, Arochukwu, Bende, Ikwuano, Isiala-Ngwa North, Isiala-Ngwa South, Ukwa East, Ukwa West, Umuahia North, Umuahia South, Umu-Nnochi, Isuikwato, Obingwa, Ohafia, Osisioma, Ugwanagbo. Agriculture is the major occupation of the people of Abia State. This is induced by the rich land which stretches from the northern to the southern parts of the State. About 70 percent of the population is engaged in subsistence farming with the main food crops grown as yam, cassava, rice, cocoyam and maize while the cash crops include oil palm, rubber, cocoa, banana and various types of fruits. The data for the study was obtained from both primary and secondary sources respectively. Information collected included socio-economic and institutional characteristics e.g. farming systems, level of inputs used and output of crops. Information on prices of crops produced were also collected. The primary data were collected through the means of well-structured questionnaires. The secondary data on soil erosion, soil conservation practices in the State were collected from Ministry of Agriculture, Agricultural Development Projects (ADPs), National Bureau of Statistics, and governmental agencies. The data included information on the causes of erosion in the area and assessment of the rate of erosion (NBS, 2012)

A four-stage random sampling technique was adopted for this study. The three Agricultural Development Project zones (ADPs): Aba, Umuahia and Ohafia in the state were considered. Thirteen blocks (representing 34.2%) were randomly selected from the thirty-eight blocks in the State. Thirty cells (representing 32.2%) of the ninety-three cells in the selected blocks were randomly selected. Two hundred and fifty farming households were randomly selected proportionate to the size of the cells. Data on socio-economic characteristics of the farmers (gender, age, education, household size, farm-size), awareness and adoption of vetiver grass strip technology, quantity of inputs and outputs of crops, expenditure food and non-food items were collected using a structured questionnaire. The analytical tools include descriptive, adoption rate, probit model. The descriptive statistics was used to analyse the socio-economic characteristics of vetiver grass adopter's households. These include tables, means, standard deviation, frequencies, percentages. The adoption rate was estimated by computing an index with this formula (Feder *et al.*, 1985; Dontsop, 2010)

$$Adoption\ rate = Area\ applied\ with\ vetive\ grass \div Total\ Farm\ Size \ldots\ldots 1$$

The Probit model was used to analyze the determinants of the adoption of vetiver grass technology. The assumption is that the individual small holder farmer is considered either to adopt a particular soil conservation practice or not. The independent or explanatory variables include farmer's socio-economic characteristics, farm characteristics, farm and non-farm income. Others are the use of infrastructural facilities like access to credit, farmer's attitude toward risk and perception of the technology.

The relationship between the probability of adoption variable P_i, and its determinants, X_i is given as

$$Pi = \beta 0 + \beta Xi + \varepsilon i \ldots\ldots (2)$$

X_i is a vector of explanatory variables, β_0 = intercept and βi is the vector of parameters. The probit model computes the maximum likelihood estimator of βi given the non-linear probability distribution of the random error εi. The dependent variable Pi is a dichotomous variable, which is one when a farmer adopts vetiver grass technology and zero if otherwise. Given the regressors xi, the goal is to describe P(yi) =1| xi)

The explanatory variables Xi are:

X_1 = Gender of farmer (male = 1 and female = 0)

X_2 = Household size.

X_3 = Age of farmer in years.

X_4 = Years of formal education.

X_5 = Farm size (ha).

X_6 = Proximity to input market (km).

X_7 = Primary occupation (farming = 1, others = 0)

X_8 = Total income in ₦

X_9 = Cooperative membership (member = 1, non – member = 0)

X_{10} = Risk (risk averse = 1, non-risk averse = 0)

X_{11} = Perception of technology (simple =1, complex = 0)

X_{12} = Access to credit (access =1, no access = 0)

X_{13} = Land Ownership Status (land owner =1, others = 0)

X_{14} = Access to leisure (access = 1, none = 0)

X_{15}= Cost of Vetiver in ₦

X_{16} = Cost of Adoption is estimated as the Variable cost in ₦

X_{17} = Cost of labour in ₦

E_i= Random error.

Variables such as Risk (X_{10}), Perception of technology (X_{11}), and Leisure (X_{14}) were determined using Likert Scale.

3.0 Results and Discussions

3.1 Socio-economic Characteristics of the Respondents by Adoption

Table 1 shows some of the socio-economic variables by adoption. The table shows that there were more female adopters (53.2%) than male adopters (46.8%). This may be due to the fact that female headed households are responsible for much of the agricultural work in the area and are more concerned about food security of the household than the males. This is supported by Nhemachena and Hassan (2007) which showed that females adopt technology than males. Furthermore, majority of the crop farmers were educated (87.6%) with about 91% in the adoption category while 84% are in the non-adoption group. This confirms the fact that education enhances adoption of Vetiver grass strips (Ajewole, 2010). The educational level of a farmer increases his ability to obtain, process and use information relevant to adoption of a new technology (Mignouna *et al.*, 2011). Also, the crop farmers are more advanced in age in the adopter's category than the non-adopter's category. Older farmers are assumed to have gained knowledge, experience over time and are able to evaluate technology information more than younger farmers (Mignouna *et al.*, 2011). Finally, more of the adopters (97.6%) cultivate a small farm-size of between 0-1 than the non-adopters of 92.1% which implies the technology is land-saving. Small farm size provides an incentive to adopt a technology especially in the case of an input saving technologies like Vetiver grass. This is supported by Yaron *et al.* (1992); Harper and Rister (1990).

Table 1: Distribution of Crop Farmers by their Socio-economic Characteristics and Adoption Status.

Variables	Adopters(N=124)		Non-adopters (N=126)		Total (N=250)	
	Frequency	(%)	Frequency	%	Frequency	%
Gender						
Male	58	46.8	70	55.6	128	51.2
Female	66	53.2	56	44.4	122	48.8
Education						
None	11	8.9	20	15.9	31	12.4
Primary	25	20.2	21	16.6	46	18.4
Secondary	35	28.2	49	38.9	84	33.6
Tertiary	53	42.7	36	28.6	89	35.6
Age						
20-39	25	20.2	20	15.8	45	18.0
40-59	79	63.7	86	68.3	165	66.0
60-79	20	16.1	20	15.9	40	16.0
Farm-size						
≤1.0	49	39.5	40	31.7	89	35.6
1.1-2.0	52	41.9	35	27.8	87	34.8
2.1-3.0	04	3.3	18	14.3	22	8.8
3.1-4.0	07	5.6	10	7.9	17	6.8
>4.0	12	9.7	23	18.3	35	14.0

Mean age of adopters = 48.84; Mean farm-size of adopters = 1.58

Mean age of non-adopters = 48.06 Mean farm-size for non-adopter = 2.51

Source: Field Survey.

3.2 Adoption Rate (index) of Crop Farmers

Table 2 shows the adoption rate of Vetiver grass adoption in the study area. The table shows that 22.0 % of the respondents had adoption rate of between 0.9-1.0, while 2% had adoption rate of between 0.5-0.6. The mean adoption rate was found to be 0.496. The implication is that about 49.6% of the crop farmers in Abia state adopted Vetiver grass technology which is still encouraging compared with other studies. The relevance of this table is that it shows the extent of use of vetiver grass which points to the extent of productivity of the crop farmers. Empirical studies argue that adoption of agricultural technologies like vetiver grass can reduce poverty both directly and indirectly (Moyo *et al.*, 2007). The direct effects include the productivity gains and low cost of production which can improve income of the adopters while the indirect benefits from the technology adoption may come in form of increased supply which may lower food prices. The increased productivity may also stimulate demand for labour which may translate into increased employment and earnings for the poor who usually supply labour to the farms.

Table 2: Adoption Rate of Crop Farmers

Interval	Frequency	Percentage (%)
0.001-0.1	10	8.0
0.101-0.2	12	10
0.201-0.3	06	5.2
0.301-0.4	11	8.8
0.401-0.5	22	17.6
0.501-0.6	03	2.0
0.601-0.7	18	14.4
0.701-0.8	08	6.4
0.801-0.9	07	6.0
0.901-1.00	27	22.0
Total	124	100

N= 250 Mean Adoption rate = 0.4960 Source: Field Survey

3.3 Determinants of Adoption

Table 3 shows the estimated parameters for the adoption of vetiver grass strips in Abia State of Nigeria. The chi square of the log likelihood function is statistically significant ($P < 0.01$). This shows that the estimated model fits the data very well. It further shows the result of the probit regression that identifies the factors that affect adoption. The goodness of fit of the model was verified by the chi square value which is significant at 1%. It shows the model has a good fit. The result shows that seven variables were statistically significant at various levels. Four variables were statistically significant at one percent level. These were Gender (X_1), Age (X_3), Farm size (X_5) and Cost of labour (X_{17}). The three variables that were statistically significant at five percent level were Educational level (X_4), Risk (X_{10}), Perception of technology (X_{11}). It can be deduced from Table 13 that age (X_3) was statistically significant ($p<0.01$) and positively related to vetiver grass adoption. This could be as a result of the fact that older people are more likely to be endowed with resources like land, household labour, experience etc. than younger ones which enable them to adopt innovations. This is supported by Panin (2000) who found out that decisions relating to adoption of innovations are influenced positively by age. Also, Kassie *et al.* (2012) states that age means more exposure to production technologies and environments, and greater accumulation of physical and social capital.

Table 3: Determinants of Adoption of Vetiver Grass.

Variables	Coefficients	Standard Error	P>/z/ t-value	Marginal Effect
Gender (X_1)	0.5320***	0.2179	0.015	0.2097
Household size (X_2)	0.0300	0.1713	0.861	0.0119
Age (X_3)	0.8359***	0.3419	0.014	0.3169
Educational level (X_4)	0.8109**	0.3803	0.033	0.3078
Farm size (X_5)	-0.2067***	0.0651	0.002	-0.0824
Proximity(X_6)	0.0183	0.0106	0.085	0.0073
Primary Occupation(X_7)	-0.2342	0.2297	0.308	-0.0932
Total Income (X_8)	$3.63e^{-07}$	$5.71e^{-07}$	0.525	$1.45e^{-07}$
Cooperative Membership (X_9)	0.0085	0.2394	0.972	0.0034
Risk (X_{10})	0.6778**	0.3197	0.034	0.2625
Perception of Technology (X_{11})	0.2335**	0.1009	0.034	0.0931
Access to credit (X_{12})	-0.3459	0.2197	0.115	-0.1372
Land Ownership (X_{13})	0.0342	0.2363	0.885	0.0137
Access to Leisure (X_{14})	-0.1803	0.1077	0.094	-0.0719
Cost of Vetiver seedlings(X_{15})	0.0001	0.0002	0.441	0.0000
Cost of Adoption(X_{16})	0.0001	0.0001	0.100	0.00004
Cost of Labour (X_{17})	$9.9e^{-06}$***	$3.27e^{-06}$	0.002	$3.96e^{-06}$
Constant	-0.7316	0.7311	0.317	

LR chi^2 (31) = 85.94	** Significant at 5%,	***Significant at 1%
Prob > chi2 = 0.0000	Log likelihood = -130.3074	Pseudo R^2 = 0.2480
N= 250 Y = 0.48497	Source: Field Survey.	

The marginal effect estimates explain that the probability of adoption of vetiver grass increases by 0.32 units when there is a unit increase in age. In addition, the table shows that the year of education (X_4) was also significant ($p<0.05$). This shows that the years of education is positively related to vetiver grass adoption. As education increases the probability of adoption of vetiver grass increases. This could be as a result of the fact that educated farmers are more aware of the benefits of modern technologies and may have a greater ability to understand new information, search for appropriate technologies to alleviate their production constraints thereby increasing their allocative and technical efficiency (Panin and Brummer, 2000). The marginal effect estimates explain that the probability of adoption of Vetiver grass increases by 0.31unit when there is a unit increase in education.

The ability to take risk (X_{10}) is significant ($p<0.05$) and positively related to probability of adoption of vetiver grass. This implies the more a farmer is willing to take risk, the more the probability of adopting Vetiver grass. The marginal effect estimates explain that the probability of adoption of Vetiver grass increases by 0.26 unit as the risk of the farmer increases by a unit.

The farm size (X_5) was found to be significant ($p<0.01$) and negatively related with probability of adoption which implies that as farm size increases the lower the probability of adoption of Vetiver grass since they are small holders, they may be cash constrained and may not be willing to expend on improved technology. This is shown by the mean farm size per household which is about 1.576 hectares. They are thus mainly small-scale producers. The marginal effect estimates explain that the probability of adoption of Vetiver grass reduces by 0.1 unit when farm size increases by a unit.

The cost of labour (X_{17}) was also significant ($p<0.01$). This means the decision to adopt vetiver grass is influenced positively by cost of labour. This may be as a result of the fact that Vetiver grass technology is labour intensive and requires labour. Gender (X_1) was found to be significant ($p< 0.01$) and positively related with the probability of adoption. This implies that despite the labour-intensive nature of Vetiver adoption more females adopt it than males. The marginal effect estimate explains that the probability of adoption of vetiver grass strips increases by 0.21 when the gender is a female. Perception of the technology (X_{11}) is significant ($p<0.05$) and positively related to adoption. This implies that as the farmers perceive Vetiver grass technology as a simple technology, the probability of adopting Vetiver grass increases. The marginal effect estimate explains that the probability of adoption increases by 0.1 unit as the perception of the farmer towards technology increases by a unit.

4.0 Conclusions and Recommendation

The study examined the determinants of adoption of vetiver grass strip technology in Abia state of Nigeria. Several socio-economic/demographic characteristics were found to be important determinants of vetiver grass adoption. Among these factors are age, farm size, gender, cost of labour, educational level, risk and perception of technology.

This study has found out that the adoption rate of vetiver grass strip in was 49.6%. Education leading to awareness of vetiver grass can be improved through extension services which will enhance more adoption. Education, gender, and age were the major factors affecting the adoption and income of vetiver grass farmers. Effective education services should be put in place to give some level of training to farmers especially women by organizing programmes such as farmer's day in rural areas. countries. Thus, it is recommended that government should invest more in education and women empowerment. The agricultural extension services rendered by Abia State Agricultural Development Programme which is moribund should be resuscitated and well facilitated in terms of human, natural and financial capital by the government. Furthermore, from the study it was discovered that vetiver grass technology was both a simple technology and pro-poor since it saves land. Government should invest more resources in this technology since it is profitable to invest in and it also ensures sustainability by helping to save land on the long run.

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