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Factors Influencing The Adoption Of Moringa Plant Cultivation Among Farming Households In Southwestern Nigeria: A Tobit Approach

AJAYI, Francis Oluwadamilare & ADEYEMI, Ayotunde Adewale
Department of Agricultural Education
School of Vocational and Technical Education
Osun State College of Education
Ila-Orangun, Osun State, Nigeria
Email: francisolu1@gmail.com

ABSTRACT
This paper investigates the factors determining the intensity of Moringa plant cultivation among farmers in South west Nigeria. A multi-stage sampling procedure was employed to collect data from 312 farmers using a pre-tested questionnaire. Data were analyzed by the use of Tobit regression technique. Results showed that intensity of Moringa plant cultivation was influenced positively and significantly by level of education (7.5625), access to extension contact (5.1371), cooperative society membership (7.8418), and availability of Moringa plant (10.1750). The differential impacts of adoption on the probability and intensity of Moringa plant cultivation have important implications as they suggest that agricultural production efforts aimed at enhancing new technologies by policy makers, institutions, organizations and agricultural planners should generally focus on farm households that are not currently cultivating Moringa plants while efforts should be concentrated more on the key variables identified in this study in order to forecast more accurately on future Moringa plant cultivation.

Keywords: determinants of Adoption, Moringa plant, Farmers and Tobit approach**.**

INTRODUCTION

Moringa oleifera belongs to the monogeneric family Moringaceae (Verdcourt 1985; Olson 2002). The family Moringaceae includes species exhibiting a wide range of forms, from bottle trees to slender trees, sarcorhizal trees, or tuberous shrubs (Olson and Carlquist 2001). All these species are native to the Indian subcontinent, the Red Sea area, and parts of Africa, including Madagascar. Although Moringa is native to India and Pakistan (Morton 1991; Duke 2001), it is widely cultivated, especially in dry tropical areas of the Middle East and Africa (Palada *et al*. 2007; Nouman *et al*. 2013) and more recently in many countries located within the tropics, like Nicaragua, because its pods, seeds, leaves, and roots are useful as fodder, vegetable, and plant growth enhancers (Sanchez *et al.*, 2006; Nouman *et al*., 2013). Besides being consumed by humans, (Gidamis *et al*., 2003), it is also used as animal fodder (Nouman *et al*., 2013),t of turbid water (Suarez *et al*., 2003), and a source of phytomedical compounds (Anwar *et al.*, 2006).

Moringa oleifera is the most widely cultivated species of a Monogeneric family, the Moringaceae (order Capparales) that is native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan (Stevens *et al.,* 2013). This rapidly growing tree also known as the horse radish tree, drum stick tree, benzolive tree, kelor, marango, mlonge, moonga, mulangay, nebedary, saijhan or ben oil tree) (Fahey *et al*., 2005), was utilized by the ancient Romans, Greeks and Egyptians, it is now widely cultivated and has become naturalized in many locations in the tropics. It is a perennial softwood tree with timber of low quality, but which for centuries has been advocated for traditional medicinal and industrial uses. It is already an important crop in India, Ethiopia, the Philippines and the Sudan and is being grown in West, East and South Africa, Tropical Asia, Latin America, the Caribbean, Florida and the Pacific Islands. *Moringa oleifera* was among the most promising species, in a survey of 120 Asian indigenous vegetables for nutrient content, antioxidant activity and traditional knowledge on their medicinal uses, (Ray *et al.*, 2006). In West Africa, one of the best known uses for Moringa is the use of powdered seeds to flocculate contaminants and purify drinking water but the seeds are also eaten green, powdered and steeped or tea or used in curies. This tree has in recent times been advocated as an outstanding indigenous source of highly digestible protein, calcium, iron, vitamin c and carotenoids suitable for utilization in many of the so called 'developing' regions of the world where undernourishment is a major concern. *Moringa oleifera* is the best known of the thirteen species in the genus Moringa. These are *Moringa oleifera*, *M. arborea, M. borziana, M. concanensis, M. drouhardii,, M. hildebrandtil, M. longituba, M. ovalifolia, M. peregrine, M. pygmaea, M. ruspoliana, M. stenopetala* (Mishra *et al.*, 2011). It is considered as one of the world's most useful trees, as almost every part of the tree has an impressive effect of food, medication and industrial purposes (Adebayo *et al.*, 2011; Moyo *et al.*, 2011). Different parts of this plant contain a profile of important minerals, proteins, vitamins, β carotene, amino acids and various phenolics and provide a rich and rare combination of zeatin with several flavonoid pigments (Anwar *et al.*, 2007), so it is a good source of natural antioxidants. It is generally known in the developing world as a vegetable, a medicinal plant and a source of vegetable oil, (Bennett *et al.*, 2003, Paliwal *et al.*, 2011).

Moringa oleifera is a type of tree that has recently attracted the particular interest of dieticians, healthcare professional, health seekers and green organization for its potential to be of tremendous health and ecological benefit to the entirety of mankind. Concerning its medicinal value, it acts as cardiac and circulatory stimulants, possess anti- tumor, antipyretic, antiepileptic, anti-inflammatory, antiulcer, antispasmodic, diuretic, antihypertensive, cholesterol lowering, antioxidant, antidiabetic, hepatoprotective, anti- bacterial and antifungal activities and are being employed for the treatment of different ailments in the indigenous system of medicine particularly in South Asia. Besides medicinal values of this plant , there has been earlier reports by, Fuglie (2000) that the leaf extract of *M. oleifera* accelerated growth of young plants, strengthened plants, improved resistance to pests and diseases, increased leaf duration, increased number of roots, produced more and larger fruits and generally increased yield by 20 and 35%.

Moringa is a drought tolerant plant that can be grown in diverse soils, except those that are waterlogged. Slightly alkaline clay and sandy loam soils are considered the best media for this species due to their good drainage (Abdul 2007). Thus, Moringa can be grown in versatile conditions including hot, humid, dry tropical and subtropical regions, except for waterlogged conditions. It can perform better under marginal conditions with ample nutritional quality. Almost every part of the tree is of value for food.

Moringa news (2008) reported that the leaf is a power house of nutritional value. The seed is said to be eaten like a peanut in Malaya. Thickened root is used as substitute for horseradish. The Foliage is eaten as greens, in salads, while in India's ancient tradition of Ayurveda believes that the leaves of *Moringa oleifera* prevent about 300 diseases; and Hartwell (1971) had reported that the flowers, leaves and roots are used in remedies for tumors and dropsy in Nicaragua. *Moringa oleifera*, because of its socio-economic and cultural importance, is raising a growing international interest among NGOs, scientists, public and private sectors which is leading to its adoption through diffusion of innovation theory.

Moringa oleifera adoption process start with innovators (traditional healers), who communicate and influence early adopters, (international organizations), who then broadcast over time new information on *M. oleifera* adoption, in the wake of which adoption rate steadily increases. To date, over 1,100 people are studying, growing, using, or implementing *M. oleifera* programs (MoringaNews, 2008). According to Rogers (2003), the rate of adoption and possibilities of over adoption can be predicted using five characteristics of a new innovation which are; relative advantage, compatibility, complexity, observability, and *trialability which makes M. oleifera* to be generally adopted and for its widespread use to be promoted.

Moringa plants possesses many valuable characteristics which make it a great asset to farmers, processors, scientist and other stakeholders in the value chain of Research Extension Farmers Input

Linkage System. The potentials that are naturally embedded in Moringa plants includes high protein contents of its parts (i.e. leaves, twigs, and stems), the high protein and Ben oil content of the seeds, the enormous number of polypeptides in seeds, the content of growth factors in the leaves and the high content of sugar and starch of the plant. It is therefore an important source of nutritious food in many countries like India and other parts of the world where it is being cultivated in commercial scale.

The numerous benefits of Moringa plant have attracted many researchers to conduct studies on all aspects of the tree with a view to knowing the usefulness of each of the components and their findings have greatly enhanced adoption of the plant globally. Naturally, adoption process starts with the innovator and in the case of *Moringa oleifera,* the innovators are the traditional healers, who communicate and influence early adopters (international organizations), who then broadcast over time new information on *Moringa oleifera,* in the wake of which adoption rate steadily increases (Rogers, 1969).

Moringa oleifera is a popular plant especially in the northern parts of the country where for ages, the leaves, roots, and back have been exploited for food and medicine. It is probably this long standing use of the plant by the locals and the positive results alluded to, that have engendered the current wave of researches by many stakeholders. The plants has its natural habitat, grows and thrives in those part of the world identified as poor, underdeveloped and developing countries like Asia, Africa, Caribbean etc. However in Nigeria where the plants thrives very well and growing in the wild through some natural dispersion methods, its potentials are yet to be fully harnessed. It is against this background that this study is therefore set out to unveil the factors influencing the adoption of moringa plant cultivation among farming households in south west, Nigeria.

METHODOLOGY

Study Area: The study was carried out in South West Nigeria which comprises of six states which are: Oyo, Ogun, Lagos, Osun, Ekiti and Ondo States out of which Osun, Ondo and Ekiti were purposively selected for the study based on the predominance of tree crop farming. The three states have about 64 Local Government Areas with one area office. The region falls within the tropical humid climate that is characterized by wet and dry seasons. The state's economy is basically agrarian, with large scale production of cocoa, palm produce and rubber. Other crops like maize, cassava, cocoyam, fruits and vegetables are also produced in large quantities. The dry season is short, lasting generally from December to February. The average annual rainfall is about 1,220mm; the monthly minimum temperature is about 22.49^0 while the monthly maximum temperature is about 26.6^0C. Furthermore, the yearly relative humidity is about 76.05%.

Sampling Technique and Sample Size

The study was carried out in South West, Nigeria out of which three states: Ondo, Ekiti and Osun states were purposively selected owing to their contribution to tree crops production in Nigeria. Multi-stage sampling technique was used to select the respondents for the study. At the first stage, two Local Government Areas were purposively selected from each of the states based on intensity of Moringa cultivation, making a total of six Local Government Areas in all the states. At the second stage, four villages were randomly selected from each Local Government Area from the list of the villages collected from the Agricultural Development Project officers in each state headquarters, thus a total of 24 villages were chosen from the three states. At the last stage, simple random techniques using snow ball was used to elicit information from 13 Moringa farmers in each of the villages chosen. In all, primary data were collected from 312 farmers through the use of interview schedule consisting of validated and reliable open and close ended questions on socio-economic characteristics of the farmers, farmer's awareness, knowledge and adoption of Moringa cultivation practices and their perception of the plant.

Analytical techniques

Data collected were analyzed by using descriptive and Tobit regression model. Descriptive statistics involving the use of tables, mean, frequency counts and percentages were used to describe the basic features of the study data while Tobit was used to determine the effect of various explanatory factors on adoption of Moringa cultivation in the study area.

Description and measurement of variables

Ten variables were proposed and reasons for their inclusion offered. The expected signs of their coefficients were predicted *a priori* based on past studies, economic theory, and/or logical reasons.

(i) The dependent variable (Y_i): This is a continuous and discrete variable for the *i*th farmer. A farmer is scored one if he adopts the technology, and zero if otherwise. It is hypothesized that this decision is influenced by the independent variables.

(ii) The independent variables: These include all those variables that are associated with the adoption of Moringa cultivation. They include farmers' characteristics, technology characteristics and institutional characteristics.

RESULTS AND DISCUSSION

Expected signs of independent variables

Farmers' characteristics

Farmers' age (X_1):

This is the age of the ith farmer measured in years. Age has been included in the model as Evidence from previous studies shows that the age of an individual affects his mental attitude to new ideas and may influence adoption in one of several ways. For instance, as the farmer ages, it is expected that his willing to embrace new ideas would diminish. Younger farmers have been found to be more knowledgeable to new practices (Adesina *et al.,* 1992; Ogundari and Ojo, 2007; Ayanwale and Amusan, 2012); more receptive and adaptable to new technological innovations and may be more willing to bear risk and adopt a technology. The older the farmer, the less likely he adopts new ideas as he tends to be more conservative by gaining more confidence in his old ways methods as newly introduced technology usually comes with additional cost (Ajibefun *et al.*, 2010; Hossain, 2012)

Educational level (X_2)

Educational level is defined as the total amount of formal schooling received by the farmer. The adoption of improved technology is a managerial concern that requires some managerial skills. Such skills are often gained through education (Ayanwale and Amusan, 2012). Also, education reduces the level of ignorance of an individual by improving his ability to decode, understand and process information and therefore is a measure of the ability to assess new technology. Thus, following earlier empirical findings, the maintained *a priori* expectation is that level of literacy is positively related to adoption behaviour. It was measured as number of years of schooling.

Technology characteristics;

Household size (X_3);

This is defined as the total number of people living with the farmer family unit. That is, it comprises all the people living under the same roof and who eat from the same pot with the *i*th farmer. This variable is brought into the model because it plays an important role in determining what occurs on the farm. Some previous studies show this variable is positively related to adoption behaviour as it provides a larger supply of family labour while other studies view that this variable has a negative relationship with adoption since increased household size increases consumption pressure. Thus, it is difficult to predict this variable 'a priori'. Hence, household size and adoption will depend on the balance of the opposing forces of family demand (Nsoanya *et al*., 2011). The variable was measured by the number of persons in the household.

Net farm income (X_4);

This is the net farm income per hectare of the farm. Since this variable can be viewed as a proxy for wealth, the options to acquire and use technologies may be expanded by it (Rajan, 2012). It is included to determine whether the potential adopters' social status and purchasing power have an effect on technology use. This is because wealthy farmers have sufficient resources to absorb the cost and risk of failure of the innovation. The variable is expected to have a positive relationship with adoption as the farmer tends to experiment with new ideas that tend to increase net farm income. This variable was measured in naira.

Off-farm income (X_5);

Off-farm income is measured as the total amount of income earned from external off-farm sources during the season. Income from these sources is relevant since they enable the farmer to undertake new agricultural practices. Off-farm-income can also help to overcome a working capital constraint or may actually support the purchase of some fixed-investment type of innovation. It is therefore postulated that the coefficient of this variable would be positively correlated with the farmer's adoption behaviour

Institutional access:

Membership in association/Cooperative society (X_6):

Cooperatives enhance the interaction and cross-fertilization of ideas among farmers. The influence of credit for instance, on Moringa plant' use is measured in terms of membership in cooperatives as its use is promoted by cooperatives. If a farmer is a member of a cooperative, credit and new technological innovations such as Moringa plant are provided to him as a package. Thus, membership in a cooperative is very important in the adoption of a technology since it indicates higher socio-economic status. Having access to other sources of credit may not have much effect on the purchase of Moringa plant because a farmer may not know where to buy them. A positive sign is hypothesized for this variable. It was measured as a dichotomous variable with respondents' membership attracting one and non-membership, zero.

Labour force (X_7)

This is defined as the number of 'man-equivalents' of people working on the farm. New technologies may increase the seasonal demand for labour, in which case adoption may be less attractive for those operating in areas with less access to labour markets (Launio *et al*., 2013). This variable is therefore expected to have a positive influence on adoption behaviour.

Extension contact (X_8):

This variable incorporates the information which farmers obtain during the year on the importance and application of new technological innovations through counseling and demonstrations by extension agents on a regular basis. The impact of this information on adoption decisions vary, however according to its channel, sources, content, motivation and frequency (Lee, 2008). Thus, based on the innovation-diffusion literature, the expected sign for the coefficient of this variable is positive. It is measured as a dichotomous variable with respondents contact during the period recorded as one, and zero otherwise.

Availability of Moringa plant (X_9):

The adoption of a technology is promoted by its availability since it is obvious that the technology will not be used unless made available in the right quantity form and time (Adekoya and Babaleye, 2007;). This variable will determine whether adoption behaviour of the potential adopter is supply-constrained. It was measured as a dichotomous variable with adequate technology supply attracting one and inadequate supply, zero. The variable is hypothesized to have a positive sign.

Distance of Moringa plant' source from farm (X_{10}):

Most farmers that adopt new innovations do so because of the proximity of the innovation distribution source. Thus, the response of potential adopters will depend upon the costs associated with acquiring the technology. These costs include transportation and risk costs which increases as the distance travelled by the farmer to purchase the new technological innovation increases. The greater the distance between the input buying station and the respondents' farm, the higher the acquisition cost (Launio *et al*., 2013). The variable is therefore expected to have a negative influence on farmers' adoption behaviour. It was measured in kilometres (km).

Tobit analysis

Tobins procedure (sometimes called Tobit analysis) is a logical extension of probit analysis model based on the cumulative normal distribution (Deegan *et al*., 1976). The cumulative normal distribution is viewed as a desirable transformation in this case since it relates a variable (number of standard deviations from the mean) which has a range from minus infinity to plus infinity to another variable (a probability) which has a range from zero to one.

For example, while the discrete (Probit) model determines potential adopters' decision about whether or not to adopt a technology, with the dependent variables taking a value of 1 or 0 respectively, the continuous (linear regression) model only explains variations in the quantity of the innovation used after the decision to adopt has been made. Heckman (1980) offered an alternative procedure to deal with censored samples which would allow for different factors influencing adoption and effort. The two equations procedure involved estimation of a probit model of the adoption decision, calculation of the sample selection bias and incorporation of that bias into a model of effort estimated with OLS. While Heckman's procedure allows for different model specification for adoption and effort, it does not allow for the decomposition of elasticities afforded by the Tobit procedures.

The Tobit model is therefore viewed as a hybrid of the discrete and continuous model which will simultaneously analyzed the potential adopters' decision about whether or not to adopt the innovation and the intensity of use after adoption. Additionally, while the Tobit beta coefficients do not directly measure the correct regression coefficients for observations above the limit, they provide more information than is commonly realized. The technique can be used to determine both changes in the probability of being above the limit and changes in the value of the dependent variable if it is already above the limit. This can be quantified for useful and insightful deductions (McDonald and Moffit, 1980).

The functional form of F (which is the adoption component of the model) can be specified as a linear combination of observable explanatory variables as:

$$Y^*_i = \beta X_i + \mu_i.$$

This can be represented algebraically for the ith farmer as:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta 2\, X_{2i} + \ldots + \beta_N X_N \ldots ; \qquad i = 1, 2, \ldots N$$

Such that

$$Y_i = \begin{cases} 0 \text{ if } Y^*_i \leq T \\ Y_i \text{ if } 0 < 1; & (i = 1,2,\ldots, n) \\ 1 \text{ if } Y_i > T \end{cases}$$

Where,

Y_i = observed dependent variable: the share of total rice area of *i*th farmer under Moringa plant.

Y^*_i = non-observable latent variable representing the continuous dependent variable When positive decision occurs for the use of the technology (e.g. moringa cultivation).

T = non-observable threshold (cut-off) point.

N = number of observations.

The Tobit application: determinants of Moringa plant adoption

Tobit regression analysis was performed on primary data collected from the study area, using the shazam software package. In the Tobit model, data on the dependent variable can be classified into two groups. One portion of the data, the non-adopters equal to a limit (usually zero) and the other portion the adopters, is above the limit (to be estimated).

According to Tobin (1958), an index, which is a linear function of the explanatory variables, is created as:

$$I_t = X'_t\alpha = X'_t(\beta/\sigma)$$

Where

I_t = the utility index for the ith farmer, the larger the value of I_i the greater the utility individual i receives from choosing the option to adopt the technology (y = 1).

α = vector of normalized coefficient

β = regression coefficient

σ = standard error of estimate

X_t = explanatory variables, t = 1, 2, 3,…,10

The coefficient vector, α, (equation) is transformed into the regression coefficient vector β by multiplying all elements of α by the calculated error of the estimate, σ. For example, estimates of locational factors (X_{10}) in model, Table 1 shows that α = 0.0456, σ = 7.4321 and β = 0.3385.

Table 1:Tobit parameter estimates of fertilizer adoption

Variable	Normalized coefficient (a)	Standard error	Asymptotic t-ratio	Regression coefficient(β)	Elasticity of index
X_1	-0.0070	0.0070	0.9980	-0.0520	0.3206
X_2	0.1364	0.2425	7.5625	2.0137	0.1360
X_3	0.0361	0.0354	1.0197	0.2685	0.1165
X_4	0.0110	0.0249	0.4423	0.0818	0.0607
X_5	1.0232	0.2639	3.8777*	7.6045	0.5480
X_6	0.0003	0.0004	7.8418*	0.0002	0.6765
X_7	0.0645	0.0658	0.9809	0.4794	0.1309
X_8	0.0131	0.1625	5.1371*	0.0974	00149
X_9	1.2265	0.1205	10.1750*	9.1154	1.6449
X_{10}	0.0050	0.0211	0.2361	1.0371	0.0205

Source: Field survey, 2015

Predicted probability of Y > Limit given average X(1) = 0.7582
Observed frequency of Y > Limit is = 0.7100
At mean values of All X(I), E(Y) = 6.2672
Standard error estimate (σ) = 7.4321
Log –likelihood function = -771.5651
Mean square error = 34.0976
Mean absolute error = 0.4025
Squared correlation between observed and expected values = 0.6887
Number of observations = 312
Limit observations = 87
Non-limit observations = 213
*significant at 5%

A likelihood ratio of 771.57 leads to the rejection of the null hypothesis that there is no relationship between the dependent variable and the set of explanatory variables. This, together with R^2 value, supports the adequacy of the model.

In order to determine the type of relationship exiting between specific factors and farmers' adoption behaviour, Tobit regression analysis was carried out. Table 1 above examined the effects of the ten variables namely: Tobit regression estimates from the ten variables (Table 1) showed level of education (X_2), net farm income (X_4) extension advice (X_8), cooperative society membership (X_6), availability of Moringa plant (X_9), were highly significant (positive) in explaining Moringa plant cultivation adoption decisions in the study area. This shows that the signs most of the estimated coefficients or the independent variables were of the predicted signs.

CONCLUSION

The paper concludes that an assessment of factors which create opportunities or act as obstacles for the adoption of these technologies therefore becomes very crucial for policy consideration. However, care is taken in drawing general policy inference as the results of this study can only be applicable to areas with similar basic system of farming. In the light of the above, the following policy recommendations are made:

RECOMMENDATIONS

Policy makers, agricultural planners, institutions and organisations involved in Moringa production and distribution need to consider the key variable (level of education, extension advice, cooperative society membership and availability of Moringa plant) identified in this study in order to forecast more accurately, future Moringa plant adoption.

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