American-Eurasian J. Agric. & Environ. Sci., 4 (4): 468-472, 2008
ISSN 1818-6769

Application of Logit Model in Adoption Decision: A Study of Hybrid Clarias in Lagos State, Nigeria

[1]O.A. Adeogun, [1]A.M. Ajana, [1]O.A. Ayinla, [1]M.T. Yarhere and [2]M.O. Adeogun

[1]Nigerian Institute for Oceanography and Marine Research, Victoria Island, Lagos, Nigeria
[2]Federal College of Fisheries and Marine Technology, Victoria Island, Lagos, Nigeria

Abstract: The study is aimed at estimating and explaining the parameters of the adoption process of Hybrid Clarias "Heteroclarias" by fish farmers in Lagos State, Nigeria. The main purpose for the development of the hybrid is to produce viable and fast growing stock for distribution to fish farmers in order to alleviate the problem of short supply of fish fingerlings and increase fish production. Like any new innovation, hybrid catfish technology must endure a phase of dissemination. Innovators and policy makers who manage fisheries resources need knowledge of the expected rate of adoption. In this study, a conceptual framework was developed for the decision to adopt or not to adopt and econometric analyses of the diffusion process are presented using Logistic regression model. While appropriate low-input, cost production system and technology package should be emphasized, the knowledge, accuracy and technical responsibilities become more significant to the success of the technology as well as aquaculture industry.

Key words: Aquaculture % Heteroclarias % Adoption % Logit model

INTRODUCTION

Following the evolution of fish farming in Nigeria in 1945, aquaculture production has make an insignificant contribution to national and global fish production. This is evidenced in the annual fluctuation in production obtained from the sector coupled with amount of foreign exchange spent to import fish into the country. Nigeria is currently the leading country in Sub-Saharan African in fish production in terms of value and weight but contribution to Gross Domestic Product (GDP) and protein consumption is still relatively insignificant. Hecht [1] reported that production as at 2003 stood at 30, 677 tonnes, a percentage increase of about 41 percent when compared with 15,000 tonnes obtained in 1994. Nigeria has consistently maintained a leading position in the region since 2003. In term of economic and trade, aquaculture makes a minor contribution to overall fish and protein supply and GDP. This can be attributed to the emerging nature of the sector when compared with agriculture and fisheries which are important primary sector. Agriculture contribution to GDP between 1999 and 2002 was 34 percent while aquaculture contribution alone to GDP within the same period was 0.154 percent. In relation to meat production, capture fisheries and aquaculture contributed 475,162 and 30,677 tonnes respectively to meat production. Fish as a total of animal protein excluding import and export was 32.7 percent and culture fisheries contribution to fish supply was 6.06 percent. Per capita fish consumption for the country between 2003 and 2004 was 7.3 percent per kilogramme per year as compared to the recommended rate of 12.0 percent per kilograme per year.

One of the major problems facing the development of the sector is fish seed which has several dimensions such as quality and quantity of fish seed produced, cost and availability. All these undermine the development and sustainability of fish farming in the country. In the aggregate, these factors created "scarcity syndrome" and have led to situation where farmers have been forced to wait for a long periods before receiving fish seeds, sometimes abandoning ponds in the interim.

Realising these constraints to the development of aquaculture, the Nigerian Institute for Oceanography and Marine Research (NIOMR) pioneered the development of genetic improvement of catfishes through hybridization of *Clarias gariepinus* and *Heterobranchus bidorsalis*. Grow-out trials of these two species showed that

Corresponding Author: Dr. Oludare A. Adeogun, Nigerian Institute for Oceanography and Marine Research, P.M.B. 80108, Victoria Island Lagos, Nigeria

H. bidorsalis has a better growth performance but a longer maturing period to *C. gariepinus*. This finding led to the hybridization of the two species which resulted into “Heteroclarias”. The hybrid was found to have a growth performance comparable to that of *H. bidorsalis* and *C. gariepinus*.

Since the development of the hybrid catfish, most studies have been restricted to feeding habits, growth rate and morphological studies neglecting the socioeconomic factors, which may play a significant role in determining the pattern of the adoption of the innovation. Study of adoption behaviour of the technology is expected to supply crucial information on the patterns of adoption and identify who is by-passed by the innovation. Understanding who non-adopters are and reason for non-adoption can assist in repacking the technology to meet the need of the producers as well as put in place other key services that would enable them to adopt. This paper therefore seeks to investigate and explain the parameters of the adoption process of Hybrid Clarias “Heteroclarias” by fish farmers in Lagos State, Nigeria using logit regression model.

Model for adoption behaviour: Quite a large number of studies have investigated the influence of various soci-economic, cultural and political factors on the willingness of farmers to use new technologies [2-4]. In many of the adoption behaviour, the dependent variable is constrained to lie between 0 and 1 and the models used were exponential functions while univariate and multivariate logit and probit models including their modified forms have been used extensively to study the adoption behaviour of farmers and consumers. Shekya and Flinn [5] have recommended probit model for functional forms with limited dependent variables that are continuous between 0 and 1 and logit models for discrete dependent variables. In this study, the responses recorded are discrete (mutually exclusive and exhaustive) and therefore, a univariate logit model was developed to analysed the adoption behaviour of farmers to hybrid catfish. The logit model, which is based on cumulative logistic probability functions, is computational easier to use than other types of model and it also has the advantage to predict the probability of farmers adopting the any technology.

Logit model: The logit model assumes that the underlying stimulux (Ii) is a random variable which predicts the probability of hybrid catfish “Heteroclarias” adoption:

$$P_i = \frac{e^{Ii}}{1+e^{Ii}} \qquad (1)$$

Conceptually, the behavioural model used to examine factors influencing ‘Heteroclarias” adoption is given by:

$$Y_i = g\,(I_i) \qquad (2)$$

$$I_i = b_o + Gb_j X_{ji} \qquad (3)$$

Where, Y_i is the observed response for the i^{th} observation (i.e. the binary variable, $Y_i = 1$ for an adopter, $Y_i = 0$ for non-adopter). Ii is an underlying stimulus index for the i^{th} observation (Generally, there is a critical threshold $\{I_i^*\}$ for each farmer, if $I_i < I_i^*$, the farmer is observed to be non-adopter and if $I_i \$ I_i^*$, the farmer is observed to be adopter); g is the functional relationship between the field observation (Y_i) and the stimulus index (I_i) which determines the probability of the hybrid fish adoption).

I = 1, 2, ….., m are observation on variables for the adoption model; m is the sample size; X_{ji} is the j^{th} explanatory variables for the i^{th} observation and j = 1, 2,3, ….., n; bj is an unknown parameter, j = 0,1, 2, ….., n, where n is the total number of the explanatory variables.

The logit model assumes that the underlying stimulus index (Ii) is a random variable which predicts the probability of “Heteroclarias” adoption:

$$P_i = \frac{e^{Ii}}{1+e^{Ii}}$$

Therefore, for the i^{th} observation (an individual farmer):

$$I_i = \text{In}\,\frac{P_i}{1-P_i} = b_o + \sum b_j X_{ji} \qquad (4)$$

which is a logit model [6].

The relative effect of each explanatory variable (X_{ji}) on the probability of hybrid catfish adoption is measured by differentiating wit respect to X_{ji}, i.e.

$\frac{dP_i}{dX_{ji}}$, using the quotient rule

$$\frac{dP_i}{dX_{ji}} = \left(\frac{e^{Ii}}{1+e^{Ii}}\right)\left(\frac{Ii}{X_{ji}}\right) \qquad (5)$$

The formula can be used in predicting changes in the probability of adopting hybrid catfish which can be employed to estimate the changes in the number of farmer adopting the technology. Given a policy change, comparison of the estimated number of adopter before and after policy change provides a measure of its impact.

The adoption index measured by the intensity of adoption where intensity of adoption is defined as the proportion of area devoted to hybrid catfish culture is:

$$\text{Rate of adoption} = \frac{\text{No. of pond(s) devoted for hybrid culture}}{\text{Total number of functioning pond(s)}}$$

Empirical model specification: The data in which the empirical model is based were drawn from a sample size of ninety-five fish farmers in Lagos State, using a stratified random sampling technique. Structured and unstructured questionnaire was used to solicit information from the respondents. The rate of adoption of the technology was based on the proportion of pond area devoted for the culture of hybrid catfish. The dependent variable is measured by dichotomous variable: farmers who had used the technology or still using the technology were categorized as adopter while those not using were non-adopter. The definitions and measurement of variables as well as sample characteristics are presented in Table 1.

The probability of hybrid catfish (C_A) is specified as a function of economic and social factors. It is represented as follows:

$$C_A = f(X_1, X_2, \ldots, X_9) + gi \qquad (6)$$

The attributes in equation 6 was specified in the empirical model to include the following variables: age, educational level, pond size, farming experience, access to seed, access to credit, farm distance, market distance, frequency of extension contact with farmers, average income and gi, the random disturbance.

The perceived superior yield performance of the technology is expected to relate to adoption and area of pond use. On-farm trial revealed that the technology significantly out-performed the parent line. Therefore, it is hypothesized that then hybrid catfish is positively related to adoption decision. Studies have shown that the age of the farmers is related to adoption decision. Younger farmers have been found to be knowledgeable about new practices and at the same willing to take risk [3,7,8].

Table 1: Definition of variables in the empirical model

Dependent variable	
Y_i	Farmer adoption decision which takes the value of 1 if he is adopting and 0, otherwise
Independent variable	
Age (X_1)	Age of the farmer, measured in year
Education (X_2)	Farmer's education level: 1 if he is able to read and 0, otherwise
Farm size (X_3)	Farm size represented by pond area, measured in hectare
Experience (X_4)	Year farming experience, measured in year
Extension (X_5)	Contact with extension agent, measured by the frequency of contact or participation at cooperative meeting
Farm distance (X_6)	Distance between homestead to farm measured in kilometer
Access to fish seed (X_7)	Access to seed is measured in kilometer
Market distance (X_8)	Place of sale measured in kilometer
Average income (X_9)	Measured in Naira (N)

Following the earlier empirical findings, the maintained hypothesis is that age is negatively related to adoption. Years of experience (i.e. when the farmer became fish farmer) are distinguished from farming experience. The latter is not relevant for empirical model since most farmers judged their total experience as starting from the first day that they were going out with their parent to farm. What is important is the experience since the farmer became decision maker on his own field [9]. Farm size represented by pond area has been shown to be positively related adoption decision [10,11], therefore, it is hypothesized that the sign is positive. Contact with extension agents is expected to be positively related based on the innovation-diffusion theory. Such contact, that is, exposing farmers to information can stimulate adoption [3,12-14]. Years of experience in fish culture are related to the ability of the farmer to obtain process and use information relevant to fish farming. A positive relationship is hypothesized between this variable and the probability of hybrid catfish adoption.

Empirical result: A summary of the socio-economic characteristics of the sampled respondents in the study area reveals that actual mean estimates obtained for variables did not show much variation (Table 2). Most of the farmers were still within the productive age. Majority (66.9 percent) in the area are young and energetic male farmers with high literacy levels. Monoculture of *Clarias species* and hybrid is prevalent accounting for 58 percent.

Table 2: Descriptive statistics of some variables used in the empirical model

Variable	Mean value	Standard deviation
Proportion		
Age	40.02	15.70
Education	0.96	0.21
Farm size	0.80	1.55
Extension	1.85	2.00
Farming experience	1.85	3.59
Farm distance	4.75	0.47
Access to seed	0.67	0.36
Market distance	0.85	0.22
Average income	n.a	n.a

Source: Data analysis, 2005: n.a = information cannot be determine.

Table 3: Estimated results for farmer adoption model

Variable	Parameter estimate	Asymptotic Standard error	t-ratio
Intercept	-4.831	1.542	
Age	-0.152	0.063	0.286
Education	0.635	8.800	2. 854*
Farm size	-0.301	0.264	0.459
Extension	2.779	0.822	3.382*
Farming experience	-0.645	0.312	0.658
Farm distance	3.395	2.840	1.675
Access to seed	-1.096	0.527	2.082*
Market distance	-2.970	1.294	2.295*
Average income	n.a	n.a	n.a

*Parameter estimate significant at 5%; Source: Field survey, 2007

Total number of cases:= 95 -2 log likelihood= 35.770

Cases correctly predicted= 100% Chi square statistics= 65.089

The study further revealed that farm operators usually look on the extension agents to provide information and farm inputs. About 66 percent established that extension agents within their locality were the primary source of information on the hybrid but since there was scarcity of the hybrid fish, adoption sometimes become difficult. This may have affected adoption rate in the study area.

Rate of adoption: The rate of adoption is the relative speed with which members of a social system adopt an innovation. It is measured as the number of individual who adopt a new technology within a specified period. In measuring the rate of adoption of Heteroclarias, the proportion of pond (proxy) devoted to the hybrid relative to the proportion of functioning ponds was used as criteria. The rate of adoption for the state was found to be 33.3 percent.

Logit regression analysis using Shazam software package shows that most of the coefficients are not consistent with hypothesized relationships and their tests of significance help to indicate their importance in explaining adoption decisions of the farmers. The parameter estimates for the model was evaluated at 5% level of significance. Logit estimates for the survey location (Table 3) revealed that apart from age, year of farming experience and farm size which were found not statistically significant in explaining hybrid catfish adoption; education, contact with extension agents, access to seed and access to market were statistically significant at 5% level. The positive sign and significance of the extension contact variable implies that extension is an important factor that will promote farmers adoption of the hybrid fish in the study area.

The study revealed that the main source of technology is through extension personnel. The non-availability could be attributed to non-domestic supply and non-accessibility in terms of quantity and time. Farm size though not statistically significant has a negative correlation with adoption. This sign is contrary to *a priori* expectation and implies that an inverse relationship exist between the farm size and adoption. The result further confirmed that increase in farm size might not afterall lead adoption of the technology.

This result is consistent with finding from India and Bangladesh [15,16]. Farmer's age and education (though significant) were found to be negatively and positively related to adoption behaviour respectively. These two parameters are consistent with our a priori expectation. The implication of these findings is that a younger farmer with better education has the tendency to take risk and adopt the technology. As anticipated, market distance was found to significant and positive. The farther the market from the farm field, the more it becomes difficult for the products to reach market. Lack of information about input and product as well as prices might contribute to low adoption. Market distance is therefore considered to be a significant predictor.

The empirical model can be used to draw economic implication for the hybrid catfish improvement strategies in the State. The estimated model was used to predict probability of Heteroclarias adoption:

$$I_i = -0.152-0.301+2.779-0.645-2.970-1.096+0.635-1.75$$

The probability that a farmer will adopt the technology is given by:

$$P_i = \left(\frac{e^{-1.75}}{1+e^{-1.75}}\right) = 0.85$$

or 85 percent. The result shows that there is 85 percent chances that a farmer would adopt hybrid catfish all other things being equal.

CONCLUSION

This paper showed that education, contact with extension agents, access to seed and market distance are significant variables that influence fish farmers' hybrid catfish adoption and use decisions. The results demonstrated further that for the technology to be successful, government and private organizations in charge of fish seed distribution must ensure fish seed availability in the right quantity and appropriate time. This provides a justification for government policies aimed at providing adequate infrastructure and institutional arrangements that will enhance the procurement and distribution of the hybrid fish. Technical guidance in the form of extension training will also enhance adoption of the technology.

REFERENCES

1. Hecht, T., 2006. regional Review of Aquaculture development in sub-Saharan Africa – 2005. FAO Fisheries Circular No. 1017/4
2. Strauss, J., M. Barbosa, S. Teixeira, D. Thomas and R. Gomes Junior, 1991. Role of education and extension in the adoption of technology: a study of upland rice and soyabean farmers in Central-West Brazil, Agricultural Economics, 5: 341-359.
3. Polson, R.A. and D.S.C. Spencer, 1992. the technology adoption process in subsistence agriculture: the case of cassava in South Western Nigeria. Agricultural System, 36: 65-77.
4. Adesina, A.A. and M.M. Zinnah, 1993. Technology characteristics, farmers' perceptions and adoption decisions: A Tobit model application in Sierra Leone. Agricultural Economics, 9: 297-311.
5. Shakya, P.B. and J.C. Flinn, 1985. Adoption of modern varieties and fertilizer use on rice in the Eastern Tarai of Nepal. Journal of Agricultural Economics, 36: 409-419.
6. Engleman, L., 1981. LR: Stepwise Logistic Regression BMDP Statistical software (Ed. Dixon, N.J.), Berlkeley. University of California Press, pp: 330-346.
7. Bultena, G.L. and E.O. Hoiberg, 1983. Factors affecting farmers adoption of conservation tillage. Journal of Soil Water Conservation, 38: 281-284.
8. Gould, B.W., W.E. Saupe and R.M. Klemme, 1989. Conservation tillage: the role of farm and operator characteristics and the perception of erosion. Land Economics, 65: 167-182.
9. Mueller, R.A.E. and H.G.P. Jansen, 1988. Farmers and farm concepts in measuring adoption lags. Journal of Agricultural Economics, 39(1): 121-124.
10. Akinola, A.A., 1987. An application of probit analysis to the adoption of tractor hiring service scheme in Nigeria. Oxford Agrarian Studies, 16: 70-82.
11. Norris, P.E. and S.S. Batie, 1987. Virgi farmers' soil conservation decisions: An application of Tobit analysis. Southern Journal of Agricultural Economics, 19: 79-89.
12. Voh, J.P., 1982. A study of the factors associated with the adoptionof recommended farm practices in a Nigerian village. Agricultural Administration, 9: 17-29.
13. Oshuntogun, A., R. Adeyemo and E. Anyanwu, 1986. The adoption of innovation by cooperative farmers in Nigeria. Tropical Agriculture (Trinidad), 63: 18-160.
14. Kedebe, Y., K. Gunjal and G. Coffin, 1990. Adoption of new technologies in Ethiopian agriculture: the case of Tgule-Bulga District, Shoa Province, Agricultural Economics, 4: 27-43.
15. Ahmed, I., 1981. technological change and agrarian structure: A study of Bangladesh. International Labour Office, Geneva.
16. Onyewaku, C.E. and A.C. Mbuba, 1991. The adoption of the seed-Yam Minisett multiplication Technique by farmers in Anambra State, Nigeria. The Nigeria Journal of Agricultural Extension, 6 (1and2).