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Analysis of the use of credit facilities by small-scale fish farmers in Kenya

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Abstract The government of Kenya encourages aquaculture development by offering credit facilities through the government agricultural finance institution, Agriculture Finance Corporation. Nevertheless, the level of credit use in fish farming is very low. Access to credit is among several factors that affect farmers' decision of whether to use particular technology or services. The study examined factors that affected the decision of fish farmers in Kenya to utilize credit facilities in fish production using a probit model. The analysis suggests that farmers in the Western province will have a 19% more probability of using credit facilities for their fish farming operations than farmers from the other provinces such as the Rift Valley, Central, and the Eastern province. The effect of tilapia sales on the probability of credit use by fish farmers is more than three times that of catfish sales. Total pond acreage owned by fish farmers had a positive effect on credit use but the effect was very small and negligible. The level of fish farmers' use of credit facilities is very low, and there is probably the need to educate farmers on credit use and for the government agricultural lending agency and other commercial agricultural lenders to invest in this enterprise. Kenyan lending institutions have financed traditional agricultural enterprises, and with the growing production of farmed fish, more research is needed to document the aquaculture business model to assist in assessing the profitability potential in aquaculture.

Keywords Aquaculture · Credit · Probit analysis

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Abbreviations

CRSP	Collaborative Research Support Program
FAO	Food and Agricultural Organization
GoK	Government of Kenya
Ksh	Kenya Shillings
LR	Likelihood ratio
USAID	United States Agency for International Development

Introduction

Aquaculture makes important contributions to livelihoods, national economic development, and regional food security in Africa. In Kenya, aquaculture practices follow a pattern similar to many countries in Africa, characterized by low levels of pond production that have stagnated over the past decade (Hecht 2006). Fish farming in Kenya began in the post-independence era from 1963, when the number of fish farmers increased considerably and peaked at about 20,000 in 1985 with a production level of about 1,080 metric tons, then plummeted thereafter (Aloo and Ngugi 2005). Notably, the period between the early 1970s and the early 1990s is generally regarded as the golden age of donor support for aquaculture development in Kenya, a period when partnerships between the government and nongovernmental agencies in aquaculture development were facilitated by increased technical and financial assistance from multilateral and bilateral agreements. Donor support for aquaculture and the natural resources sector as a whole declined significantly from the early 1990s for various reasons. It has been suggested that donor emphasis shifted towards other priorities such as good governance, health, human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS), education, and democratization (Hecht 2006).

The Department of Fisheries in Kenya has been at the forefront of aquaculture policy development aimed at diversifying fisheries resource production. The emphasis of most of the government aquaculture policy initiatives has been on social objectives, such as improved nutrition in rural areas, generation of supplementary income, diversification of activities to reduce risk of crop failures, and creation of employment in rural communities. During the preparation of the Poverty Reduction Strategy Paper in 2000, the GoK identified aquaculture development as a core activity for funding through the current Medium-Term Expenditure Framework budgeting system. The GoK embarked on a reorganization of various sectoral ministries, resulting in the creation of a Ministry of Fisheries to develop and promote aquaculture and the sustainable utilization of fisheries resources in collaboration with other sector agencies and structures. The GoK's intervention policies are resulting in increased awareness and practice of aquaculture in the rural agricultural community. While some farmers operate fish farms as an independent enterprise, others incorporate fish farming as part of the portfolio of agriculture enterprises they operate such as crop and livestock production. Large-scale intensive aquaculture appear to be beyond the means of most African farmers but economic studies have shown that commercial small- and medium-scale fish farming is a profitable enterprise for African producers (Molnar et al. 1991; Engle et al. 1993; Lightfoot et al. 1996; Wijkstrom and MacPherson 1990).

The increase in awareness among farmers in Kenya about the viability of farming fish as an alternative agricultural enterprise has led to an ongoing increase in fish farming activities in the Western, Central, Eastern, and Rift Valley provinces of Kenya. This increase has also been the result of some nongovernmental initiatives on technology transfer programs toward improving fish farming. For example, the USAID-funded Aquaculture CRSP in Kenya since the 1990s played a significant role in promoting new fish production technology. Consequently, the last 6 years have been marked by aggressive research, training, and private-sector involvement in aquaculture. Total aquaculture production recorded a growth from 962 metric tons in 2002 to 1,100 metric tons in 2006 (GoK 2007). Production per unit area has risen from 1,500 kg/ha/year in 1999 to 2,500 kg/ha/year in 2005 while the number of farmers increased from 9,800 to 11,500 during the same period, a 17.3% increase over a 6-year period. With continued investments in aquaculture and increased productivity, production is projected to reach 4,500 metric tons by the year 2010. Production in real terms is predicted to grow by over 300% per annum in the next 3 years (GoK 2007). Predicted trends in diversification and expansion in aquaculture are based on expectations of increased private investments, as many private farms are in the initial stages of production. The focus of most of the private large-scale commercial fish farmers is to produce for both the local and export markets.

There is an emerging commercial-scale aquaculture industry in Kenya comprising both large- and small- to medium-scale production. A number of fish farmers who were farming at small-scale subsistence level have turned into small-scale commercial level earning as much as Ksh 450,000 (US $6,000) per hectare of water surface (Ngugi and Manyala 2004). The main aquaculture activity practised by households in inland areas is Nile tilapia (*Oreochromis niloticus*) farming, though African catfish (*Clarias gariepinus*) is also produced to some extent. The domestic market for Nile tilapia is quite promising. Prices are as high as Ksh 140 (US $1.87) per kg in major cities such as Eldoret and other parts of the country. The major towns surrounding the aquaculture production centers constitute assured markets. The market for Nile tilapia and African catfish is mainly confined to whole fish. The distribution chain is mostly short, characterized by farm-gate sales, although lately there are increasing numbers of intermediaries, especially in the fast-growing baitfish market for catfish fingerlings. Prices in the baitfish market vary widely from Ksh 3 (US $0.04) to Ksh 10 (US $0.13). Kaliba et al. (2007) studied the economic profitability of small-scale production of Nile tilapia in Kenya, and concluded that an all-male culture of Nile tilapia provides significant economic returns to justify capital investment using borrowed capital.

In spite of the political support from government for aquaculture development, one of the constraining factors to aquaculture development in Kenya is the lack of credit and/or use of credit by farmers. Resource-poor farmers are often reluctant to invest in any new agricultural enterprise due mainly to their limited cash resources and/or access to credit. Capital is among several factors needed to operate an efficient, viable, and profitable aquaculture enterprise. The government now encourages fish farmers to make use of credit facilities offered through the government agricultural finance institution, Agriculture Finance Corporation (AFC), which traditionally services the maize and livestock sectors. Nevertheless, the level of credit use in fish farming is very low. Some financial institutions offer credit services to fish farmers, though the majority of commercial lenders do not, because they believe fish farming is a high-risk or unprofitable activity (FAO 1999). Lack of knowledge concerning aquaculture, and the perception that fish farming is a marginal and risky investment, have contributed to the absence of investments in that sector (Ngugi and Manyala 2004).

There is a wide body of literature on the factors that affect farmers' decision of whether to use particular technology or services. Much of the literature focuses on the determinants of adoption of technology in agriculture, which can generally be categorized into three paradigms: technology innovation diffusion, adopters' perception, and economic constraints (Feder et al. 1985; Feder and Umali 1993). The main determinants of adoption of technological innovations reported in most studies were the costs of the technology, farm size, farmer's human capital, education, labor availability, access to extension services, and access to credit (Feder et al. 1985; Feder and Umali 1993). Huffman (2001) stressed the importance of education in farmers' decision-making process, indicating that those with better education possessed a greater ability to acquire and process information and were more able to critically evaluate the productive characteristics and costs of adopting innovative technologies than those who were less educated. Access to credit has also been reported to have a significant influence on the adoption of improved agricultural technologies by smallholder farmers in developing countries (Adesina and Zinnah 1993; Lowenberg-DeBoer et al. 1994; Doss and Morris 2001).

This paper aims to identify and examine factors that affect the decision of fish farmers in Kenya to utilize credit facilities in fish production using a probit model. The study focuses on how farm characteristics affect the farmer's decision-making process. The paper is organized as follows: The "Introduction" provides some background information on the aquaculture industry in Kenya and how they have been funded. The "Materials and methods" section presents the source of data and an outline of the theoretical framework for the binary-response choice model used. The "Results" section presents the results obtained by applying data and information collected from the producer survey into the probit model and some discussion of the results. The "Summary and concluding remarks" summarize the important points of this study and draws some conclusions.

Materials and methods

Data

The data used in this study is part of a 2005 project that involved a survey of fish farmers in the Western, Central, and Eastern provinces as well as the Rift Valley of Kenya. The survey instrument had three sections: a section that collected information on general household characteristics and other demographic information; a section on general farming activities, including crop and livestock production and types of farm machinery and equipment used; and a section that solicited specific information relating to fish farming activities. The data collected from the survey have detailed information on individual demographic factors and farm characteristics, and it shows diverse variation among farms and farmers. The survey was conducted face to face by Moi University researchers and government fisheries extension officers. Sampling of farmers was done by a combination of randomness and convenience, dictated mainly by accessibility to the farms. A total of 138 individuals responded to the survey. There were no refusals, providing a response rate of 100%. Data from the section on fish farming activities are analyzed in this study. Out of the 138 total responses, 131 were deemed useful for the analysis.

A descriptive analysis of the fish farming data collected and used for the study is presented in Table 1. Of the 131 respondents, 24% utilized credit facilities for their fish farming operations, 69% were located in the Western province, 74% had at least a secondary education, and 60% sold their fish directly to consumers. The survey suggested that 87% of farmers (28 out of 32 farmers) who used credit facilities for fish farming activities were located in the Western province. Analysis of the summary statistics also shows a wide range of pond acreage and fish sales among these farmers (Table 1). The age of fish farmers ranged from 22 to 76 years. The average age of the respondents is about 50 years. Most of the

Table 1 Summary statistics of variables

Variables	Mean	Standard deviation	Minimum value	Maximum value
Dependent variable				
Credit use ($y = 1$; 0 otherwise)	0.24	0.43	0	1
Explanatory variables				
Western region (= 1; 0 otherwise)	0.69	0.46	0	1
Age	50	12.86	22	76
At least secondary education (= 1; 0 otherwise)	0.74	0.49	0	1
Pond acreage	615.60	980.97	40	7,200
Tilapia sales	9,883.21	17,751.90	570	164,060
Catfish sales	1,514.58	4,690.10	251	40,000
Direct sales to customers (= 1; 0 otherwise)	0.60	0.49	0	1
Labor cost per day	340.24	1,222.99	58	9,600

farmers utilized hired labor for their aquaculture operations. The average hired labor cost per day was Ksh 340 (US $4.53). One farmer paid as much as Ksh 9,600 (US $128) per day in labor cost. The largest total acreage reported was 7,200 m^2 and the minimum was 40 m^2, with an average of 616 m^2 among all respondents. Tilapia is the most produced and sold fish species; the maximum sales value was reported to be Ksh 164,060 (US $2,187.47), the minimum sale value was Ksh 570 (US $7.60), and the average among all respondents was Ksh 9,883 (US $131.77). Catfish sales value average Ksh 1,515 (US $20.20), with a maximum reported sales value of Ksh 40,000 (US $533.33).

Empirical analysis

An assessment of choice behavior in the decision-making process of an individual or segments of the population has been studied in the literature for various kinds of issues. The literature relates to choice behavior regarding technology, foods, and services, and choice models have been utilized to predict human decision-making behavior in these studies. Examples include decision-making relating to chemical-free foods (Baker 1999; Magnusson and Cranfield 2005), organic foods (Loureiro et al. 2001), environmental services (Bell et al. 1994), technology (Moon and Balasubramanian 2004; Adesina and Zinnah 1993), and farm diversification (Windle and Rolfe 2005).

The theory of utility maximization provides the basis for modeling choice behavior. An individual has a utility function U, measuring the desirability of an alternative choice i among a set of choices J. The desirability of a choice is based on a vector of observable attributes x, and an unobserved vector of the attributes of all the alternatives and characteristics of individuals ε, i.e., $U(x, \varepsilon)$. Consequently ε is random. It is assumed that an individual will choose alternative option i if this is the alternative which maximizes his utility, i.e., the individual will choose i if

$$U_i(x,\varepsilon) > U_j(x,\varepsilon) \qquad \text{for}\, j \neq i, \quad \text{and}\, j = 1,\ldots,J. \tag{1}$$

The utility values are considered stochastic and as such the condition in Eq. 1 will occur with some probability. Decomposing the utility U into observed V and unobserved parts ε, the probability of choosing option i over the other alternatives can be denoted by

$$\pi(i) = \Pr[V_i + \varepsilon_i > V_j + \varepsilon_j \quad \text{for}\, j \neq i, \quad \text{and}\, j = 1, \ldots, J]. \tag{2}$$

The simplest case of Eq. 2 assumes that an individual has a choice between two alternatives ($J = 2$). The probability that alternative 1 is chosen from a choice set containing two alternatives (binary choice) is then defined as the probability that the utility of alternative 1 exceeds the utility of alternative 2. Substituting the attributes (x) associated with each alternative into the observed portion of the utility (V), the probability that alternative 1 is chosen is also the probability that the difference between the error terms does not exceed the difference of the observable parts of the utility, i.e.,

$$\begin{aligned} \Pr(y_i = 1) &= \Pr(\varepsilon_i > x'\beta) \\ &= 1 - \Phi(-x'\beta), \end{aligned} \tag{3}$$

where y_i is the observed choice by the individual and $\Phi(\cdot)$ is a notation for the distribution function of the error component. The logit (Train 1986; Ben-Akiva and Lerman 1985; Maddala 1983; Hensher and Johnson 1981) and probit (Train 1986; Maddala 1983; Hensher and Johnson 1981) models are examples of binary cases.

Choice modeling is said to be flexible, capable of dealing with a wide variety of attributes, and has good predictive ability of future choices (Louviere 1988). However, the modeling approach has some limitations. For example, the logit formulation cannot represent random taste variation, it exhibits restrictive substitution patterns, and it cannot be used with panel data when unobserved factors are correlated over time for each decision-maker (Train 2003). The probit model can handle these limitations but the assumption of a normal distribution may not provide an adequate representation of the random component, especially where price variables are involved. A misrepresentation of random components can lead to inaccurate model forecasts (Train 2003). This study utilized the probit model to estimate the effects of producer and farm characteristics on Kenyan fish farmers' use of credit for fish farming activities, where the two choices are that they either utilize credit or not in their fish farming activities. The probit model assumes that $\Phi(\cdot)$ in Eq. 3 is a standard normal distribution function, and the observed realization of the binomial process is empirically specified as

$$\Pr(y_i = 1|x) = \int_{-\infty}^{x'\beta} \varphi(t)\mathrm{d}t = \Phi(x'\beta). \tag{4}$$

In this study, y is a binary variable which indicates whether the farmer used credit or not, x represents a vector of independent variables, which includes regional location of the farmer, age, educational level, total pond acreage, catfish sales, tilapia sales, whether they sold direct to consumers, and the cost of hired labor on the farm, and β is a vector of unknown parameters to be estimated. The sign of the parameter estimates gives the direction of a change in each of the explanatory variables on the probability of a farmer using credit ($y_i = 1$).

The parameter estimates from choice models by themselves do not have any economic meaning. A meaningful assessment of the effects of explanatory variables is obtained when they are interpreted to affect the probability that a farmer would use credit ($y_i = 1$). This interpretation can be obtained by computing the marginal probability or marginal effect, which is defined as a product of the estimated parameter and the standard density function evaluated at the sample means. Marginal effects also measure the impact of a unit change in each of the independent variables on the probability of credit use. When the independent variable is continuous the marginal effect is evaluated at the sample means, but when the variable is a dummy or binary the marginal effect is computed as the change in the probability of credit use resulting from a change in x_j from zero to one, holding all other variables at some fixed values. The model was estimated using maximum-likelihood procedure of estimation in LIMDEP 8.0 (Greene 2007).

Results

Table 2 presents the estimation results from the probit model. In addition, several goodness-of-fit measures are reported. One measure is the chi-squared statistic. A second is the pseudo-R squared and a third measure is an examination of how well the model classified respondents correctly based on estimated probabilities. Using the LR statistic test, the calculated chi-square statistic was found to be 29.77, which rejects the null hypothesis that all slope coefficients are 0 at the 0.01 level of significance. The results suggest that the overall ability of the model to yield correct predictions on Kenya farmers' use of credit was 79%. These measures indicate that the model had satisfactory explanatory power and fitted the data reasonably well.

Table 2 shows that six out of the nine estimated coefficients were statistically significantly different from 0 at 0.05 level. For example, the estimated coefficient on farmers in the Western province is 0.87 and statistically significant. The positive sign for the variable suggests that the probability of using credit facilities for farming activities increases when farmers are located in the Western province compared with other provinces. Specifically, the estimated 0.19 marginal effect of this variable reported in Table 2 implies that, compared with farmers from the other provinces such as the Rift Valley, Central, and Eastern provinces, farmers in the Western province will have a 19% more probability of

Table 2 Estimated coefficients and marginal effects of explanatory variables

Variable	Estimated coefficient	Coefficient t-ratio	Marginal effect
Constant	−1.089[b]	−1.699	
Western region	0.871[a]	2.473	0.190
Age	0.005	0.435	0.001
At least secondary education	−0.318	−0.903	−0.088
Pond acreage	0.001[a]	2.028	0.000
Tilapia sales	0.261[a]	2.733	0.067
Catfish sales	0.086[b]	1.751	0.022
Direct sales to customers	−0.082	−0.277	−0.021
Labor cost per day	−0.006[a]	−2.628	−0.001
Number of observations	131		
McFadden pseudo-R^2	0.20		
Correct prediction	79%		
Chi squared	29.77		

[a, b] Estimated coefficient is statistically significant at the 5% and 10% level, respectively

using credit facilities for their fish farming operations. This finding may be true because a greater proportion of fish farming activities takes place in the Western province, and with good sources of water supply, lending institutions, particularly commercial banks have shown interest in financing fish farming operations in the Western province.

The second variable that showed a positive effect on credit use is the value of tilapia sales (Table 2). This result suggests that the probability that a farmer will use credit facilities for fish farming activities increases with the level of tilapia sales. The estimated marginal effect of 0.067 suggests that a Ksh 1 (US $0.013) increase in tilapia sales is likely to increase a farmer's use of credit by about 7%. The model shows that the effect of tilapia sales on probability of credit use is about three times more than that of catfish sales (0.067 for tilapia sales compared with 0.022 for catfish sales). Kenyan fish farmers who sold more tilapia were more likely to utilize credit facilities for their fish operations. These findings highlight the importance of keeping good sales records for the purposes of business management, especially if credit is to be used for farming activities. The result makes intuitive sense in terms of the ability of farms that generate higher sales revenues to have a better cash flow and consequently the ability to pay back loans. Tilapia is a major species that is produced by Kenya farmers, and a farmer who sells more of this product will be seen by lending institutions/agencies as having a better chance of paying back their loans.

The effect of higher sales may be linked to farm size or pond acreage as well, and the ability to utilize credit facilities. Larger farms have a greater output over which to spread the cost of borrowing and it may be economically more viable for them to utilize credit compared with smaller farms. Results from Table 2 also suggest that, the larger the pond acreage a farmer has, the higher the probability that this farmer will use credit. However, the magnitude of the effect on credit use is very small. From Table 2, the estimated coefficient for total pond acreage is 0.001, and is statistically significant at the 5% level. The positive effect associated with this variable suggests that farmers who have larger acreages would have a greater probability of using credit facilities. However, the estimated marginal effect is almost zero, as can be seen in Table 2. This suggests that, on the margin, the effect is very small and negligible. The effect of production capacity is probably captured in the value of fish sales and not total acreage. This highlights the importance of other production-related factors such as efficiencies in production and management skills. The characteristics of the decision to utilize credit may be the same among farmers, but the magnitudes of these characteristics differ across farmers because of heterogeneity of the fish farmers. Both tilapia and catfish sales have positive estimated coefficients, though only that of tilapia sales is statistically significant at the 5% level. It is likely that farmers may have large total acreage but not all ponds may have been under fish production.

From Table 2, the estimated coefficient on labor cost per day is negative and statistically significant, implying that the probability that a fish farmer will use credit facilities for fish farming activities decreases with the level of cost of labor he paid. The estimated marginal effect of −0.001 suggests that a Ksh 1 (US $0.013) increase in labor cost would lead to an increase in a farmers' use of credit by about 0.1%. Though the effect is relatively small, one possible explanation for the negative relationship between labor cost and the use of credit may be that farmers are not willing to pay hired labor but would rather utilize other sources such as own, household, and/or family labor to minimize costs. Many farmers are risk averse and may not want to increase the variability of profits by borrowing to pay labor. This is especially true when labor cost is rising. The result means that, as labor cost per day increases, fish farmers would not use credit. The constant term is also negative, −1.089, and is statistically significant at the 5% level of significance, suggesting that Kenya fish farmers will generally not utilize credit for growing fish.

Summary and concluding remarks

Kenyan fish farmers located in the Western province were found to have a strong likelihood of using credit facilities for their fish farming activities. The survey results suggested that 87% of farmers who used credit facilities were located in the Western province. However, considering the overall sample size of respondents, farmers in general had a low likelihood of using credit for fish farming activities. The survey found that as many as 76% of respondents did not utilize credit facilities. Analysis of the summary statistics also shows a wide range of pond acreage and fish sales among these farmers.

A binary probit model was formulated and used to estimate the probabilities of farmers using credit facilities for fish farming. The analysis suggests that Western province fish farmers will have a 19% greater probability of using credit facilities for their fish farming operations compared with farmers from the other provinces such as the Rift Valley, Central, and the Eastern provinces. The results also show that for Kenyan fish farmers a Ksh 1 (US $0.013) increase in tilapia sales will increase a farmers' use of credit by about 7%, *ceteris paribus*, while a Ksh 1 (US $0.013) increase in catfish sales will increase a farmers' use of credit by about 2%. The effect of tilapia sales on probability of credit use is more than three times that of catfish sales. These findings highlight the importance of keeping good sales records for the purposes of business management, especially if credit is to be used for farming activities. Though total pond acreage was found to have a positive effect on credit use, the effect is very small and negligible.

Some policy ramifications emerge from this study. The level of fish farmers' use of credit facilities is very low, and there is probably the need to educate farmers on credit use and availability and also for the government agricultural lending agency and other commercial agricultural lenders to invest in this enterprise. Kenyan lending institutions have financed traditional agricultural enterprises, and with the growing production of farmed fish, more research is needed to document the aquaculture business model to assist in assessing the profitability potential in aquaculture.

As far as the authors are aware, this study is one of the first analytical attempts to measure the use of credit facilities for fish farming in Kenya. This study used a smaller sample size; therefore any attempts to generalize and apply the results to a broader context of aquaculture in sub-Saharan Africa should be exercised with caution. Further studies on this subject should attempt to utilize a much larger sample to allow better applications of conclusions and implications from the study to similar countries in sub-Saharan Africa. In addition, future studies should attempt to collect information on why farmers do not utilize credit facilities for their fish farming operations. Such information would provide further insight for studying the decision-making processes of Kenyan fish farmers and further the development of a better model for predicting their choice behavior. With continued interest by some commercial banks in fish farming, and the Kenya government offering credit through the AFC, future research in this area should consider interviewing commercial lenders as well.

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