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Economic Factors influencing the Continuation of Fish Farming Technology in Morogoro and Dar es Salaam Regions, Tanzania

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Abstract

Integrating fish farming technology into the existing farming system has shown high potential in improving agricultural productivity. The problem however is that there is high rate of technology abandonment. The probit model was used to identify factors influencing the continuation with fish farming technology. Data were collected from 304 respondents randomly sampled from selected villages. Results indicated that female headed household, religious belief, extension education, income, profitability, palatability and easiness to obtain farmed fish influenced the continuation with the technology. These results suggest that planners and extensinists should incorporate gender, extension education, religious belief and income components as they have influence on continuation of a technology. Moreover, technology developers should strive to improve the profitability of fish farming. Finally, any analysis focusing on continuation of a fish farming technology should not confine itself to agronomic and economic aspects but should also encompass palatability and easiness to obtain fish.

Key words: Fish farming technology, continuation, household resources: Tanzania

INTRODUCTION

Increasing agricultural productivity and income of the majority of farmers in developing countries is untapped opportunity for finding practical solutions to rural poverty (IDE, 2002). Fish farming technology integrated into the existing farming system is viewed as an appropriate option for increasing agricultural productivity (Brummett and Noble, 1995; FAO, 2000; Wetengere, 2008, 2010a). The inclusion of fish farming has improved utilization of resources like water, farm by-products, land and labor. Pond water for instance does not only serve farmed fish but also irrigate homestead crops and supply water for animals. As a source of irrigation, pond water is richer in nutrients than water from wells and also contains nitrogen-fixing blue green algae, which can improve soil fertility (FAO, 2000). While crops like vegetables can be watered directly from pond water, other crops like banana, sugar cane and yams can benefit from pond moisture. As a result, these crops are grown year-round thereby contribute to household food and income security. In this way if one component fails, the other can provide the requirements for survival. After fish harvest, nutrient-rich pond mud can be used as fertilizer or the pond can be used to grow other crops. The different components interact in a symbiotic manner thus enhance overall farm productivity (ibid.). Wetengere et al. (1998) observed that while farmers who intensified farms produced 50-60 kg of fish/are/year, other farmers in the same area produced far below that level (see also ALCOM[1] reports 1996-2000).

Although some farmers adopted fish farming technology as a way to capture the above potentials, the abandonment rate of the technology has been quite high. In the study area more than 25% of adopters abandoned the activity (Wetengere, 2008; 2010b*)*. Researcher's personal observations revealed that several ponds were in bad shape (overgrown by grass, high water transparency, low water levels and collapsed dike) and were likely to be abandoned in the near future (ibid.). Supporting the findings, participants in Participatory Rural Appraisal (PRA) meetings conducted by this study observed that most ponds which were lying dry during this study were

[1] ALCOM was a Food and Agriculture Organization (FAO) of the United Nations aquatic programme which operated in Tanzania between 1993 and 2000.

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unlikely to be re-started. This is consistent with findings by Wijkstrom (1999) who observed that about 1 in 5 fish farmers abandoned their ponds in Zambia.

One of the main challenges therefore, facing fish farming technology is the high rate of the technology abandonment. There are still some gaps in knowledge of why an attractive technology like fish farming has such high rate of abandonment. With all the money and efforts injected in to adoption of the technology, it does not make sense to ignore factors triggering abandonment. The resource poor farmers who have adopted a technology and abandoned it afterwards are more unlikely to adopt another technology. More money and efforts would be required to convince them of the credibility of a new technology regardless of the potential it may possess. This is perhaps one of the reasons why some development projects have been pouring a lot of unwanted money as a way to attract adopters (Wetengere, 2008; 2000).

Various studies on adoption of farm technologies (see for instance Polson and Spencer 1991; Minde and Mbiha 1993; Mattee 1994; Mlozi 1997; Senkondo et al. 1998 and Batz et al. 1999) have focused on factors which influence the decision whether to adopt a technology or not. A review of these studies has revealed that there is hardly detailed and systematic information on factors that influence the continuation with fish farming technology. The reasons why farmers have abandoned fish farming technology despite its high economic potential are not known nor have they been the interest of many researchers (Jones, 2005). It is now known that technology abandonment is a part of the adoption cycle that has historically been overlooked. Technologies that are abandoned are just as ineffective as technologies that have not been adopted (ibid.). Understanding abandonment is needed in order to improve the longevity and efficacy of new technologies (ibid.). By identifying constraints that will lead to the eventual abandonment of a technology, extension programs can be better designed (ibid.). The objective of this article therefore is to identify factors that influence the continuation with fish farming technology.

Theoretical Framework of Continuation Choice

Once a technology has been adopted a decision whether to continue or abandon it has to be made. A typical small-scale farmer is never a specialist, but produces different crops and vegetables, rears livestock in combination (FAO, 2000) and carries other off-farm activities. Household resources are allocated over these activities based on resource endowment, farmers' characteristics and technology characteristics (Figure 1). The allocation decision as explained in Temu (1999) is often characterized as a 2-stage process in which first priority is given to meeting food security requirements. The second objective is then to maximize income using the remaining resources (ibid.). In such a situation, a model using both on-farm and off-farm for aquaculture may be needed to improve household welfare (Edwards and Demaine, 1997).

For the purpose of this study it is assumed that farmers make continuation or abandonment decision based upon utility consideration (Batz et al., 1999). Comparing various technologies that are carried out farmers will continue with a technology if its utility exceeds the utility of other technologies. The probability that a farmer continues with a technology is therefore a function of its relative utility (ibid.). Utility of an activity is measured by its contribution to household food and income security.

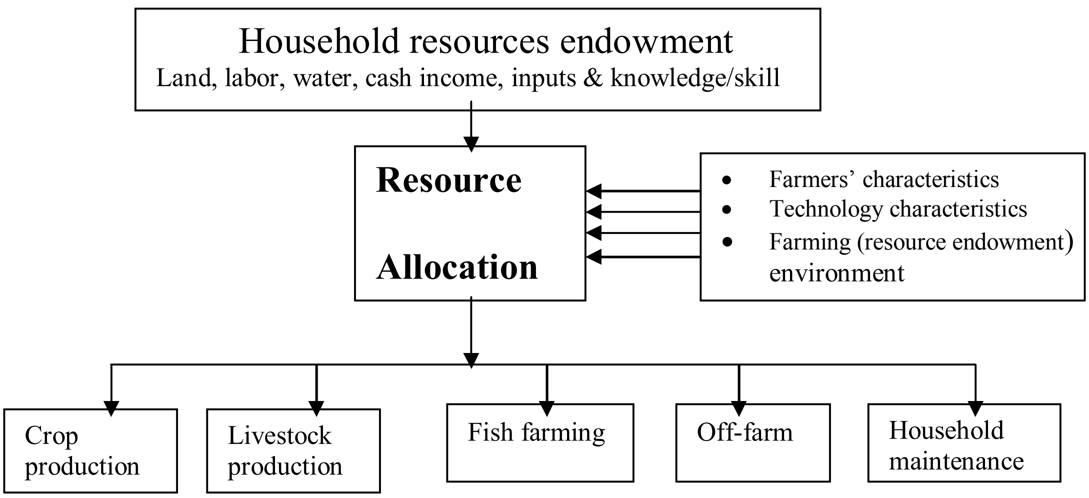

Figure 1: Farmers decision to continue with fish farming technology

This problem was addressed using the probit model as follows;

$$yi = \beta_o + \beta_1 X + \beta_2 Z + \beta_3 U + \varepsilon i;$$

where yi is the probability that a farmer continues with fish farming or abandons it, β are parameters, X is farmers' characteristics, Z is technology characteristics and U is resource endowment factors and ε is an error term. Since variable y can take on only two values: 1 and 0 (adopt or abandon), a binary choice model is used to analyze continue *versus* abandon decision.

First, the expected utility from continuing with fish farming or not given the influencing factors will be determined:

Euiff (continue with fish farming) = *f* (influencing factors) + εi

Euio (abandon fish farming) = *f* (influencing factors) + εi

Where;

Euiff = expected utility of the ith household from continuing with fish farming technology

Euio = expected utility of the ith household from continuing with other competing technologies or abandoning fish farming.

εi = error, which represents unobservable factors, assumed to be independently distributed over the survey period

Second, the expected utility from fish farming will be compared with that of other technologies such that:

$$\frac{Euiff}{Euio} = > 0 \text{ or } \frac{Euiff}{Euio} = < 0$$

Third, using yi as an indicator of whether the ith household continue with fish farming technology (yi=1) or abandon it (yi=0), then:

$$yi=1 \text{ if } \frac{Euiff}{Euio} = >0 \text{ and } yi=0 \text{ if } \frac{Euiff}{Euio} = <0$$

Therefore, the probability that the ith household continues with fish farming technology is the probability that the expected utility gained from continuing with fish farming technology is greater than the expected utility derived from abandoning it or continue with other competing technologies.

Factors Determining Continuation with Adoption

Factors which influence continuation with fish farming are as follows:

Farmer's characteristics

Education: An educated farmer is more likely to continue with fish farming technology than an uneducated one (Meena *et al.,* 2002).

Age: Young and middle aged farmers are more likely to continue with fish farming technology than older farmers. Older farmers are conservative, ris averse, and unlikely to continue with new ideas.

Gender: Females are more likely to continue with fish farming than males because females do not move away from home for longer period.

Belief: Some religious beliefs disallow eating certain fish species and using some inputs for fertilization and feeding fish. Farmers with such beliefs are unlikely to continue with fish farming technology and vice versa.

Income: The continuation with fish farming is financially demanding rich farmers in terms of income are more likely to continue with fish farming than poor farmers. Conversely, if the expected contribution of income from fish farming is higher than other activities, farmers are more likely to continue with fish farming and vice versa.

Knowledge and skills: Farmers who have acquired knowledge on fish farming are more likely to continue with it than those who have not acquired the knowledge.

Technology characteristics

Profitability: For the purpose of this study, 'profit' is defined as the difference between total revenue received and total cost of inputs. Farmers are more likely to continue with fish farming technology if the technology promises higher returns to investment than other farm technologies and vice versa.

Marketability is defined as the ease with which a product can be sold relative to other competing products. Farmers are more likely to continue with fish farming if farmed fish is more marketable than other competing products and vice versa.

Risk is defined as a situation in which the probability of obtaining some outcome of an event is not precisely known (Todaro, 1982). Farmers' are more likely to continue with technologies that reduce risk in their farming operations and vice versa.

Immediacy of reward is defined as the speed with which a farmer receives income or fish for consumption after starting fish farming. If fish farming rewards faster than other competing activities it is more likely to be continued and vice versa. Resource-poor farmers cannot afford to wait for too long to earn a return on their investments.

Complexity can be defined as the number of activities that have to be performed to adopt and use the technology relative to other technologies (Batz et al., 1999). If continuation with fish farming requires the adoption of a number of activities than other farm technologies require, it is less likely to be adopted and vice versa.

Operational costs are defined as day-to-day costs of keeping the activity running. If the costs of running fish farming are lower than other competing activities, fish farming will likely be continued and vice versa.

Status is defined as the social position that fish farming as an activity or fish as a relish is assigned by participating farmers. If fish farming and fish are assigned high status compared to other competing activities or sources of relish, fish farming is more likely to be continued and vice versa.

Palatability can be defined as the preference of fish in terms of taste. If demand changes in favor of farmed fish, fish farming is likely to be continued and vice versa.

The easiness to obtain farmed fish can be defined as the ease with which farmed fish can be obtained from the pond for consumption and for sale. Easiness to obtain farmed fish is dependent on harvest methods in practice. If the harvest method allows farmed fish to be obtained easily than other competing relishes particularly during animal protein shortage, fish farming is more likely to be continued and vice versa.

Frequency of consumption can be defined as the number of times farmed fish is consumed in a given period relative to other competing relishes. The frequency with which fish is consumed depends on the management, availability of fish in the pond, palatability, easiness to obtain, status, cheapness, preparation and preservation advantages. If farmed fish can be consumed regularly relative to other competing relishes of animal meat, fish farming is more likely to be continued and vice versa

Farming (resource base) environment

Certain amounts of inputs are required to be able to continue with fish farming (see Figure 1). When the above inputs are forthcoming from the farming environment - that is, they are readily available and do not have alternative uses, farmers are more likely to continue with fish farming and vice versa.

METHODS AND MATERIALS

The data reported here were collected to identify economic factors critical to continuation with fish farming technology. This study was conducted from November 2005 to May 2006 in selected villages of Morogoro and Dar es Salaam regions. Given the nature and complexity of this problem, a field survey design that focused on the individual farmers as the unit of analysis was employed. This method is capable of describing the existing perception, attitude, behavior or values of individuals within a household (Mugenda and Mugenda, 1999).

The sampled population in each village was stratified into two categories, fish adopters - those who adopted and continue to practice fish farming and disadopters - those who adopted fish farming but abandoned afterwards. From each village list a systematic random sampling approach was used to select the respondents. This sampling technique was used to avoid conscious or unconscious biases in the selection of sampled households and ensured that the selected sample was the representative of the population. In total 304 respondents of which 234 (77%) were fish adopters and 70 (**23**%) adopters-abandoned were selected. Of the total sample size, 277 respondents (91%) came from Morogoro region and 27 (9%) came from Dar es Salaam region. A large sample was required to produce salient characteristics of the population to an acceptable degree and also reduce the sampling error (ibid.).

The instruments used for data collection were *questionnaire, Participatory Rural Appraisal (PRA), personal observations and secondary sources.* A structured questionnaire was prepared and given to aquaculture experts to check content and validity. After incorporating experts' comments, it was pre-tested, and then a final version incorporating pre-test results was produced. All questionnaires were administered through face-to-face interviews by the author and an assistant researcher. In each village a PRA meeting was conducted covering various topics such as ranking of different technology characteristics and why farmers are doing what they are doing.

Data analysis was conducted with stata 8 and Statistical Package for Social Sciences (SPSS) computer programmes. Only significant variables were considered to have influence on continuation with fish farming technology. In analyzing technology characteristics the scoring approach was used to assess all activities carried out by farmers. The scoring approach was chosen because a quantitative assessment for each technology would have involved high cost and much time. The same approach was used by Batz et al. (1999) and Polson and Spencer (1991). Farmers' assessment was scored on a scale of 1-7 depending on the number of activities carried out by the farmer. Score 1 meant best and 7 worst. For instance, in assessing the profitability of vegetable gardening and fish farming, a score of 1 for vegetable and 2 for fish farming indicated that vegetable gardening was more profitable than fish farming. Unlike Batz et al. (1999) who used extension officers to represent farmer's perception on adoption, this study used the perception of the farmers themselves. This process ensured that the views of the farmer, the ultimate users and beneficiaries of the technology, were considered in the evaluation process.

Description Statistics of the Study Area

Table 2 presents the demographic characteristics of 304 respondents sampled from Morogoro and Dar es Salaam regions. Male respondents comprised of 79% with more or less equal proportions in the two regions. About 81% of respondents were household head a fact which ensured that detailed household information searched for was obtained easily. About 83% of respondents were married, 12% were single and 4% others (widowed, divorced and separated).

As expected, 99% of households do farming as one of their livelihood earning activities. However, 42% of respondents indicated that farming was the household main activity. About 50% of the respondents derived their livelihood from farming and business, 6% derived livelihood through farming and employment and others [farming and business, student and employment only] (2%). While 44% of full time farmers and, 52% of farmer and business came from Morogoro, 41% of farmer and employee and 15% of others [farmer and business, and employee only] came from Dar es Salaam. The percentage of full time farmers is relatively lower than the national average of 63% (TNBS, 2002). This is likely due to lack of permanent cash crops along Uluguru Mountains. As a result farmers engage in other income earning businesses to supplement income. The main type of business carried out particularly in Morogoro region is local brew making. Other businesses include; small shops, selling of timber, charcoal, bricks and crops.

Table 1: Demographic characteristics of the sample

Respondents characteristics		***Sampled regions***		***Total sample n= 304 (%)***
		Morogoro n= 227 (%)	***Dar es Salaam n= 27 (%)***	
Gender/sex	Male	78	85	**79**
	Female	22	15	**21**
Household head	Yes	80	89	**81**
	No	20	11	**19**
Marital status	Married	82	89	**83**
	Single	12	7	**12**
	Others	6	4	**4**
Main occupation	Full time farmer	44	18	**42**
	Farmer and business	52	26	**50**
	Farmer and employee	2	41	**6**
	Others	1	15	**2**
Education level	No formal education	11	0	**11**
	Less than Standard 7	17	4	**15**
	Standard 7	66	37	**63**
	Secondary and post secondary	6	55	**10**
	Others	0	4	**.3**
Religion	Roman Catholic (RC)	72	26	**68**
	Muslim	18	37	**20**
	Others	10	37	**12**
If obtained fish farming knowledge	Yes	68	81	**69**
	No	32	19	**31**
If adopters received fish farming knowledge	Yes	71	88	**73**
	No	29	12	**27**
If disadopters received fish farming knowledge	**Yes**	**53**	**70**	**44**
	No	**47**	**30**	**56**

Source: Survey Results, 2006

Table 2: Definition of variables that influence continuation with fish farming technology

Variable	*Variable meaning*	*Type of measure*	*Types of responses*
CONTINUE	If respondents adopt fish farming or not	Binary	**1, if adopted; 0 otherwise**
Farmers' characteristics			
h	If respondent is household head	Binary	**1, if household head, 0 otherwise**
Hhf	If household head is female	Binary	**1, if household head female, 0 otherwise**
sex	If respondent is male	Binary	**1, if male; 0 otherwise**
age	Age of respondents	Years	**Number of years in age**
age2	Age of respondents squared	Years	**Number of years squared**
edu1	Education level of respondents	Years	**Years of formal education**
rom	Religion of the respondents	Binary	**1 if belonging to faith that does not impede the practice of fish farming or eat fish; 0 otherwise**
Household resource endowment			
know	If respondents received knowledge on fish farming	Binary	**1, if received fish farming knowledge; 0 otherwise**
land	Household farm size	Acres	**Number of acres**
hhs	Household family size	Number	**Total household number**
hhlf	Household economically active members	Number	**Total number of economically active household members**
move	Member of the household moves away for longer period	Number	**Total number of household members moving away for long**
Income	Household cash income per year	Amount	**Total household cash income**
Technology characteristics			
• **Production part of the technology**			
prof1	Respondent ranking of activities in terms of profitability	Binary	**1, if profitability of fish is ranked higher; 0 otherwise**
opc1	Respondents ranking of activities in terms of operation cost	Binary	**1, if operational cost of fish farming is ranked lower; 0 otherwise**
rew1	Respondents ranking of activities in terms of immediacy of reward	Binary	**1, if immediacy of reward of fish farming is ranked higher; 0 otherwise**
mark1	Respondents ranking of activities in terms of marketability	Binary	**1, if marketability of fish is ranked higher; 0 otherwise**
comp1	Respondents ranking of activities in terms of complexity	Binary	**1, if complexity of fish farming is ranked higher ; 0 otherwise**
status1	Respondents ranking of activities in terms of status	Binary	**1, if status of fish farming is ranked higher; 0 otherwise**
risk1	Respondents ranking of activities in terms of risk	Binary	**1, if risk of fish farming is ranked higher; 0 otherwise**
• **Consumption part of the technology**			
pala1	Respondents ranking of relishes in terms of palatability	Binary	**1, if fish palatability is ranked higher; 0 otherwise**
freq1	Respondents ranking of relishes in terms of consumption frequency		**1, if fish consumption frequency is ranked higher; 0 otherwise**
easob1	Respondents ranking of relishes in terms of easiness to obtain	Binary	**1, if the easiness to obtain fish is ranked higher; 0 otherwise**
statue1	**Respondent ranking of relishes in terms of status**	**Binary**	**1, if the status of fish is ranked higher; 0 otherwise**

About 66% respondents had attained standard seven educations, about 15% had less than standard seven educations, 11% had not undertaken any formal education and 10% had attained secondary and post secondary education. The percentage of those who had no formal education is relatively lower than the nation average (33.0%). This is likely because most parts of Morogoro highlands were centers of Missionaries who put emphasis on formal education. While majority of those who had attained standard seven and below came from Morogoro, majority of those who attained secondary and post secondary education came from Dar es Salaam (Table 2).

About 68% of respondents belonged to Roman Catholic (RC) faith; followed by 20% Muslims and 12% were of protestant denominations (Anglicans, Lutherans, Seventh Day Adventists (SDA's), Moravians, Pentecost, Assemblies of God, Christian Life Church, New Apostolic Church, Prophet Church and Mennonites). Whilst 72% of the RC's came from Morogoro, 37% of Muslims and 37% of other Christian religions came from Dar es Salaam. The distribution of these religions reflect the historical occupancy of the colonialists: Christian missionaries concentrated on the highlands and the Arab Muslims on the coastal areas. About 37% of respondents in Dar es Salaam were Protestants, compared to 10% in Morogoro.

About 69% of respondents had received knowledge on fish farming. Of those who received fish farming knowledge 81% came from Dar es Salaam and 68% from Morogoro. Of the adopters 73% received fish farming knowledge while only 44% of the disadopters received fish farming knowledge. Most adopters and disadopters in Dar es Salaam received fish farming knowledge than in Morogoro.

Model Specification

The binary regression model that is used to estimate the determinants of continuation or abandonment of fish farming technology is specified as follows:

$$Continue = \begin{pmatrix} 1 & if\ the\ farmer\ continue \\ 0 & if\ the\ farmer\ abandon \end{pmatrix}$$

The dependent variables are decision to continue (assigned value 1) or abandon (assigned value 0); and the independent variables are the influencing factors. Since the dependent variable assumes only two values, 1 and 0, both probit and logit models can be used for analysis. The two models differ in terms of the distribution and the identifying assumptions employed. There is no basis for preferring one over the other. One can make choice based on test and familiarity of which the author choose probit model. It is important to note that marginal effects of either model tend to be identical when values are calculated at mean.

The parameter estimates of the probit model do not offer much information; apart from the sign, not much can be gleaned from these estimates. Moreover, these parameter estimates are not marginal values. Marginal values from the probit model can be obtained, given the change in the probability that the dependent variable is equal to one for a unit change in the explanatory variable. However, it must also be noted that probit model is non-linear, and therefore the marginal effects will depend on the values of the explanatory variables. As a default, most software gives marginal effect at the mean values of the explanatory variables.

The survey covered information on farmers' characteristics household resources endowment and technology characteristics. The empirical model specified was:

The empirical model was specified as follows;

CONTINUATION = $\beta_0 + \beta_1 hhh + \beta_2 hhf + \beta_3 age + \beta_4 age2 + \beta_5 edu + \beta_6 rom + \beta_7 know + \beta_8 land + \beta_9 hhs + \beta_{10} hhlf + \beta_{11} move + \beta_{12} income + \beta_{13} prof1 + \beta_{14} opc1 + \beta_{15} rew1 + \beta_{16} mark1 + \beta_{17} comp1 + \beta_{18} status1 + \beta_{19} risk1 + \beta_{20} pala1 + \beta_{21} freq1 + \beta_{22} easob1 + \beta_{23} statue1 + \varepsilon i$

Explanation of the above variables is in Table 2 and εi is the error term

RESULTS AND DISCUSSION

This study found that seven variables namely female headed household (hhf), religious faith (rom), fish farming knowledge (know), income (income), profitability (prof1), palatability (pala1) and easiness to obtain fish (easob1) were significant in explaining the continuation with fish farming technology (Table 3).

Farmer's characteristics and continuation of fish farming technology

Two variables namely female headed household (hhf) and religious faith (rom) were significant in explaining the continuation with fish farming technology.

Female headed household (hhf) was positively related to the continuation with fish farming. The sign of the variable was consistent with prior expectation. This result suggests that female headed households were more likely to continue with fish farming than male headed households. This should not come as a surprise as fish farming was mainly undertaken to produce fish for home consumption - an objective which suit female than male (Wetengere, 2010c). Women were responsible for fetching relish including animal protein which was in short supply in the area. Similarly, because of their responsibility for children and home crops, women were less likely than men to be away from home for a long period. As a result they could give continuous attention to ponds close to homestead. This study revealed that 62% of men, 38% of children and 27% of women moved away from home for longer period (Wetengere, 2008).

Religious faith (rom) was positively related to continuation with fish farming. The sign of the variable was consistent with prior expectation. This means farmers belonging to religious faith (Roman Catholic, Anglican, Lutheran and Moravian) which did not impede the practice of fish farming were more likely to continue with fish farming technology. Farmed fish can be fed and fertilized by varieties of inputs available locally. Some inputs were obtained easily than others, some were cheaper than others and some fertilize the pond faster than others. Pig manure, for instance, was easily obtained and fertilized pond faster than plant matter. Some religious faith however prohibited the use of pig manure to fertilize ponds and local brew leftovers to feed fish. It is likely that farmers prohibited by their faith may adopt fish farming intending to use inputs other than pig manure and brew leftovers, but may abandon afterwards simply because the inputs used failed to fertilize the pond properly to make fish grow faster. Participants in PRA meetings mentioned that failure of plant matter to fertilize the pond (produce greenish water colour) and make fish grow faster was mentioned as one of the reasons for abandoning fish farming. Similarly since a considerable number of farmers belonged to these religions (Muslims and some Protestants) they may also affect continuation of fish farming by discouraging fish farmers or by not eating farmed fish. A study by Gleave (1966) is among few studies that have associated pagan religion to inhibit abandonment of hill settlements.

When Dar es Salaam data was dropped from the sample, both variables namely female headed household (hhf) and religious faith (rom) retain their significance. The level of significance of religious faith was less when Dar es Salaam was dropped. In addition, formal education became significant but was inversely related to continuation of fish farming. That is farmers with higher formal education were less likely to continue with fish farming technology.

Table 3: The marginal effects of factors influencing the continuation with fish farming technology

Variable	dy/dx*	Z**
hhh	-.0328029	**-0.46**
hhf	.0979521	**2.44**
age	-.0061016	**-0.85**
age2	.0000314	**0.45**
edu	-.012105	**-1.3**
rom	.1907451	**2.02**
know	.2075341	**2.86**
land	.006895	**0.63**
hhs	.0074649	**0.58**
hhlf	.0118034	**0.45**
move	.0083057	**0.24**
income	-2.6908	**-2.3**
prof1	.1508047	**2.48**
opc1	.0237647	**0.25**
rew1	-.0540495	**-0.7**
mark1	.0161629	**0.34**
comp1	.0381113	**0.58**
status1	.0545617	**1.13**
risk1	-.0524037	**-0.64**
pala1	.2795661	**1.92**
easob1	.1389928	**4.17**
statue1	**.0067236**	**0.14**

*dy/dx is for discrete change of dummy variable from 0 to 1
**Bolded z designate significant variable

Household resource endowments and continuation of fish farming technology

Fish farming knowledge (know) and cash incomes (income) were significant in explaining the continuation with fish farming. While Neill and Lee (2001) show insignificance of availability of labour, Jones (2005), Moser and Barrett (2002) and Moser and Barrett (2006) indicate the variable to influence the continuation with farm technology. Other studies show the proportional of land sown to maize is positively and significantly associated with the continuation of maize-*mucuna* use (Neill and Lee, 2001). Jones (2005) and Moser and Barrett (2006) on the other hand, show that the availability of land is associated with continuation of farm technology. Similarly, Gleave (1966) and Rahim *et al*. (2005) have attributed lack of land to influence abandonment of hill settlements and gum agroforestry respectively.

Cash income was negatively related to continuation with fish farming technology. The sign of the variable was, surprisingly, inconsistent with prior expectation. This result suggests that farmers earning bigger cash income were less likely to continue with fish farming. Possible explanation for this is that small-scale farmers earn their living (cash income) from various activities, which means as a household earns bigger income from other activities than from fish farming, the probability of abandoning fish farming increases. In such a situation cash income earned from other activities replaces fish farming income. Given that income generated from fish farming is low (2.4%), dropping it will not significantly affect household income. Income earned from other activities could be used to purchase other sources of animal meat to replace farmed fish. Similarly, when income earned from other activities was higher than that earned in fish farming it becomes rational to re-allocate household resources in favor of higher income earning activities. This result supports earlier finding by Bragg and Dalton (2004), Rahim *et al*. (2005) and Moser and Barrett (2006) which reported that off-farm income provides a pulling force on the abandonment when it contributes a greater proportion to total farm income than on-farm income. A study by Gleave (1966) attributed income to influence abandonment of hill settlement and Phillips-Howard (1994) associated abandonment of intensification practices with scarcity and expenses of inputs.

Knowledge on fish farming (know) was positively related to the probability of continuing with fish farming. The sign of the variable was consistent with prior expectation. This means farmers who acquired knowledge on fish farming were more likely to continue with fish farming than unknowledgeable farmers. The result supports earlier findings by Neill and Lee (2001) which showed the influence of knowledge on technology abandonment. This result is contrary to findings by Rahim *et al*. (2005) and Moser and Barrett (2006) which shows that extension was insignificant in abandonment of gum agroforestry and rice intensification respectively. This study found that 44% of disadopters had not acquired knowledge on fish farming compared to 27% adopters. It is possible to adopt fish farming without having knowledge (that is through seeing a pond), but it is difficult to continue with fish farming without having knowledge about it. Lack of knowledge on various aspects of fish farming led to problems like animal predation, overcrowding, leakages and fish stuntedness which ultimately led to pond abandonment.

Only fish farming knowledge (know) retained its significance in explaining the continuation of fish farming even when Dar es Salaam was dropped. However, the level of significance was a bit lower.

Technology characteristics and continuation of fish farming technology

Three technological factors namely relative profitability (prof1), relative palatability (pala1) and relative easiness to obtain fish (easob1) were significant in explaining the continuation with fish farming technology. A study by Neill and Lee (2001) show that (marketability) road access to community residence is a powerful factor explaining abandonment of maize-*mucuna* use.

The study revealed that relative profitability (prof1) was positively related to the continuation with fish farming. The sign of the variable was consistent with prior expectation. This means higher profit makes it more likely to continue with fish farming than other competing activities. This is consistent with Basarir and Gillespie (2006) who indicated that dairy producers are likely to exit when profits are low. Studies by Bragg and Dalton (2004) and Rahim et al. (2005) have also indicated that producers attaining higher returns reduced the likelihood to abandon a technology. Similarly, Jones (2005) indicated that farmers expecting a high price for soybean (an indication of profitability) are more likely to continue farming the crop. These results are in line with Price (2005) who observed that the removal of support price on dryland peanut production increased the abandonment rate.

Although relative profitability of fish was significant in explaining the continuation of fish farming, adopters and disadopters were more concerned with the volume of profit (or income) generated. Wetengere *et al*. (1998) indicated that one of the disadvantages of fish farming compared with other income earning activities was the low volume of profit (at most Tshs. 20,000) generated per annum. This volume of income was obtained from many (3-5) intermittent harvests, each harvest earning Tshs. 3,000 – 8,000 (ibid.). This amount was too small to contribute to household livelihood (ibid.). If fish farming is to be adopted it has to be profitable and should be able to generate a sizable profit relative to other competing activities. It is only then that it can attract resources in its favor. Other activities such as crop sale and business earned between Tshs. 50,000-100,000 in one occasion – a reasonable amount that can be invested in development projects.

When Dar es Salaam data was dropped from the overall sample relative profitability (prof1) retained its significance in explaining the continuation with fish farming. The level of significance was however higher. This shows the higher need for profitable activities in the study area. In addition, status of fish farming (status1) became significant in explaining the continuation of fish farming.

Relative palatability of fish was positively related to the probability of remaining in fish farming. The sign of the variable was consistent with prior expectation. This means the higher the relative palatability of farmed fish, the more likely fish faming will be continued compared to other competing activities. This is not a surprise as taste of a product has strong influence on its consumption. This result is corroborated by Minde and Mbiha (1993) who reported that poor taste was the main reason for abandonment of the improved seed of sorghum and millet. Most fish farming projects concentrated on fish production technology, neglecting the consumption side. Participants in PRA meetings testified that before knowing how to prepare and cook farmed fish, fish palatability was ranked low relative to other sources of relish, but after they were taught how to prepare, cook and preserve, they ranked farmed fish high. This concurs with what most consumers of fish mentioned that they preferred buying fried fish to fresh fish because they did not know how to prepare and cook farmed fish.

The relative easiness with which fish can be obtained was positively related to the probability of remaining in fish farming. The sign of the variable was consistent with prior expectation. This demonstrates that relative easiness to obtain farmed fish makes it more likely to continue with fish farming technology. The easiness to obtain farmed fish not only contributes to household animal protein intake but also relieve already high burdened women from fetching relish. One of the advantages of farmed fish was that it is easier (i.e. economically less burdensome) to catch a few fish than to slaughter domesticated animal and therefore farmed fish could be eaten more often. This was never the case in the study area: farmed fish was not easily obtainable and was eaten more infrequent than other sources of relish. Once farmers' aspirations are not met, the technology is likely to be abandoned (Minde and Mbiha, 1993). The easiness to obtain fish depended on production and harvest strategy employed.

When Dar es Salaam data was dropped from the overall sample both variables were significant in explaining the continuation with fish farming technology. However, the levels of significance for both variables were relatively lower.

Conclusions

The objective of this study was to identify factors which influence the continuation with fish farming technology in Morogoro and Dar es Salaam regions, Tanzania. This study found that farmers who continue with fish farming are more likely to be female headed household, farmers belonging to religious belief which does not impede any practice of fish farming, less wealthy in terms of income and farmers who acquired fish farming knowledge. Similarly, the results observed that farmers were more likely to continue with fish farming if the technology is profitable, farmed fish palatable and easier to obtain.

Recommendations

The results have some interesting and important Recommendations. The first is that the continuation with fish farming technology appeared to be particularly attractive to disadvantaged groups (women and less wealthy farmers in terms of income), thus helping to address positively inequality issues. This suggests that technology developers and extension officers should incorporate a gender dimension and income to technology continuation rather than taking for granted that the technology is neutral as many used to think. The second is that efforts should be made to identify community's belief that may conflict with a new technology before it is introduced. In some cases technology package need to be altered from one place to another depending on belief. For instance, composite rather than pig manure should be advised in Muslim dominated communities or tilapia rather that catfish should be introduced in SDA's communities. The third is that efforts should be made to disseminate fish farming knowledge through various channels to farmers. The fourth is that technology developers should strive to improve the profitability of fish farming through investigating the possibility of reducing the risk of loosing fish, shortening culture cycle to target market size fish, use of low cost inputs and/or integrating fish farming with other activities. Efforts should also be made to improve access to peri-urban or urban markets by improving roads, providing information on fish prices and nutrition value of fish, and formation of marketing groups or cooperative union to lower transport and transaction costs. Finally efforts should be made to impart knowledge on fish preparation, preservation and cooking all of which improve the palatability of farmed fish and thus enhance longevity and efficacy of the technology. Similarly, attempt should be made to devise 'farmer friendly' methods of harvesting fish to make farmed fish easily obtainable and therefore eaten more frequently.

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