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Determinants of Adoption of a Recommended Package of Fish Farming Technology: The Case of Selected Villages in Eastern Tanzania

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Abstract: This study was conducted to identify factors, which determine adoption of a recommended package of fish farming technology in Eastern Tanzania. A total of 234 fish farmers from 25 selected villages were used to provide the required information. A survey design was employed to collect data and respondents were randomly sampled from 600 fish-farmers in the study area. Instruments used for data collection included questionnaire, Participatory Rural Appraisal, researchers' observations and secondary information sources. The research findings revealed that access to resources is a key factor that determines the adoption of a recommended package of a technology and farmers allocate resources to activities, which contribute to household food and income security. Three recommendations were derived from this study. The first is that for the recommended package of fish farming to be adopted, it has to contribute to household food and income security. That means, farmed fish must be eaten more frequently and more important it has to generate income on regular basis. The second recommendation is that the aquaculture department should identify the institutional mechanism through which dissemination of information will operate and strengthened. The third recommendation is that efforts to introduce a package of fish farming should be directed towards farmers who have access to resources necessary to use the technology.

Key words: Adoption, fish farming, resources allocation and Tanzania

INTRODUCTION

A background study conducted in Eastern Tanzania indicated that most farmers were unable to produce food and income to meet their household needs (ALCOM, 1994). The study also revealed that there was poor nutritional content of food produced. This was mainly because most households' diet constituted of cereal crops (ibid.). To meet the rapidly growing food demand and to raise rural income, it is believed that farmers must increase farm production and productivity. Farm production can be increased through putting more land into use or applying new technology. However, given the scarcity of land, application of a new technology remains the best option for increasing farm production. Scarborough (1999) observed that sustainable increases in agricultural productivity could be obtained even with the available land, only through technological and managerial innovations. One of the ways for achieving that goal is to integrate fish farming technology into the existing farming system.

Fish farming technology integrated with agriculture has shown a high potential in increasing food production. ALCOM (ALCOM was a regional aquatic resource management programme of the FAO (Food and Agriculture Organization of the United Nations) based in Harare, Zimbabwe. It covered most of SADC countries with the main objective of improving the living standards of rural population through the practice of improved water resource management. In Tanzania the project started in 1993 and ended in 2000) progress reports revealed that about 20% of farmers who adopted a recommended package of fish farming technology produced up to 40-60/kgs/are/y of farmed fish. According to Wetengere *et al.* (1998) this production is more profitable than other types of crop production. It is profitable even when the crops are rotated three times a year. Furthermore, the production of crops like vegetables, bananas, yams and sugarcane increased and were grown year-round as a result of fertilization through the use of pond water. In Malawi for instance, fish integrated into an existing crop farming system-increased production, overall farm productivity and produced up to 6 fold improvements in profitability (Brummett and Noble, 1995).

However, fish farming as a means to increase agriculture productivity had not had positive effects on the majority farmers' wellbeing because most of the farmers have been selective; adopting only part of the recommended package of the technology (FAO, 1989). This is contrary to the perception of some researchers who perceive technology adoption as the exact coping or imitation of how the innovation had been used previously in a different setting (Rogers, 1995). In reality, choices available to a potential adopter are not just adoption or rejection; selection or rejection of some components of the innovation or modification and re-invention of the innovation may also be options (ibid.).

Many researchers on technology adoption have concentrated on adoption or rejection of technology. There is apparent lack of knowledge on why farmers are selective or why they adopt only some parts of the recommended technology. Consequently only some parts of the technology have been adopted leading to discouraging results. The objective of this paper, therefore, is to identify factors, which determine the adoption of a recommended package of fish farming technology.

Fish farming technology introduced: Westerners basing on traditional European practices developed the fish farming technology introduced in the study area. It was also influenced by Chinese technology. Details of the technology introduced are provided below.

In the study area, ponds were to be constructed near homestead for easy supervision, regular visit, proper management and control of fish theft and animal predation. There was minimum pond size recommended which was 100 m^2. A pond of this size could easily be constructed by family labour; it could be managed by locally available inputs and would supply enough fish for home consumption and for sale. Gently sloping areas were the ones appropriate for pond construction. The terrain had to have the depth of 0.5 - 0.8 m. at shallow end and it had to have 0.8 - 1.2 m. at deep end (Wetengere *et al*., 1998). Construction of this kind allows for easier harvest by total drainage. In addition, the relatively shallow water favours the growth of algae, the staple food of tilapia, whilst the variation in depth allows the fish to seek the warmer water during cold times. The fish also gain protection from the deeper water, especially from predatory birds (Hague, 1992). Moreover, the ponds should have water control mechanism at their inlet and outlet (Wetengere *et al*., 1998).

In the study area the fish species introduced was *Oreochromis niloticus* (ibid.). The maximum stocking density was two fingerlings/m^2 (ibid.). Initially, the projects assisted the participating farmers in securing fingerlings at low cost or for free. It was anticipated that after some time farmers would produce their own fingerlings or obtain them from other farmers without assistance from the project (ibid.). Using good quality fingerlings to avoid stocking similarly looking small stunted fish was emphasized (Van der Mheen, 1999).

To ensure availability of sufficient natural food, a pond had to be fertilized with animal manure and plant matter before fingerlings were stocked. To promote production of plankton, manure is spread all over the pond bottom and filled in the compost enclosure before water is filled. After the water developed a plankton bloom - an indication of availability of natural food, fingerlings were stocked, and fertilizer was applied at regular intervals to maintain a greenish watercolour. Moreover, supplementary food was added to boost the growth of fish. Farmers were to apply whatever feeds available, and were to feed the fish at least once per day. The quantities to be fed would depend on the feeding behaviour of fish. That means there was need to increase or decrease the amount of food depending on feeding bahaviour of fish.

To avoid fish overcrowding and stunting, fish had to be harvested in small amount at regular intervals (Murnyak and Mafwenga, 1995) and by total drainage of the pond after 6-8 months. The yield using the above described management strategies for 100 m^2 pond stocked with 200 fingerlings was expected to be 18.5kg (i.e. 3700 kg/ha/y) (ALCOM reports showed that this figure was too small and may be one of the reasons that discouraged farmers from adopting fish farming. Some farmers in the study area harvested between 40- 60 kg/are/y.). The figure was based on a 75 percent survival rate at the end of the cycle, an average fish weight at harvest of 115 grams and approximately 500 fingerlings of 8 - 10 grams being produced (Wetengere *et al*., 1998).

Conceptual framework of adoption process: For the purpose of this study, it is assumed that farmers make adoption decision based upon utility consideration (Batz *et al*., 1999). Comparing various technologies that are used, farmers will adopt a technology if its utility exceeds the utility of others. The utility of an activity is measured by its contribution to household food and income security. Household resources are allocated across various activities based on their contribution to household food and income security. The allocation decision is often characterized as a 2 - stage process in which first priority is given to meet food security requirement (Temu, 1999). The second objective is to maximize income using the remaining resources (ibid.).

When a technology is introduced in a given area, the choices available to farmers are not just adoption or rejection as many researchers think. As said earlier, selection of some parts of a technology or modification and re-invention may be options too. Farmers' choice whether to adopt an entire package of a recommended technology or just some parts of a technology is influenced by the following factors:

- The availability of household resources such as land, labour, cash income, knowledge and other inputs like feeds, fertilizers, water and seeds. If the above resources are forthcoming from the existing farming system, farmers are likely to adopt a complete package of a recommended technology. If, on the other hand, the resources are insufficient or are sufficient but have alternative uses, farmers are more likely to adopt some parts of a recommended package of a technology.
- The degree to which the technology is appropriate for the farmer's farming environment. If some parts of a recommended package of a technology conflict with the existing environment, it is unlikely that those parts would be adopted. On the contrary, if a recommended package of a technology is compatible with the farming environment, it is likely that the entire package of a recommended technology will be adopted.

- Economic motivation. If a technology is perceived to be profitable, an entire package of a recommended technology is likely to be adopted. If, on the other hand, a recommended package of a technology is perceived to be unprofitable, it is unlikely to be adopted or only some part of a technology will be adopted.
- Farmers' characteristics (e.g. belief and gender). Women farmers unlike men frequently lack access to both information and technology inputs and this affects their adoption behaviour (Kimenye, 2001). This means women are more likely to adopt some parts of a recommended package of a technology than men. Similarly, certain beliefs may hinder the adoption of some parts of a recommended package of a technology making it difficult for the farmers to adopt the entire technology.
- The farmers' objective for undertaking the activity. If a technology is undertaken to spread risk or diversify food and income generation, some parts of a recommended package of a technology are likely to be adopted contrary to when a technology is adopted for profit maximization. Actions of farmers in managing risk in fish farming include diversification, allocate fewer resources in the activity, operate ponds in groups and produce fish for family consumption and stock at low density.

MATERIALS AND METHODS

The data reported here were collected as part of a large survey conducted to identify economic factors critical to adoption of fish farming technology. This study was conducted from November 2005 to May 2006 in 25 selected villages of Morogoro and Dar es Salaam regions in Tanzania. Given the nature and complexity of this problem, a field survey design that focuses on the individual farmers as the unit of analysis was employed. This method is capable of describing the existing perception, attitude, behaviour or values of individuals within a household (Mugenda and Mugenda, 1999).

The study population consisted of (women and men) fish farmers. 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 entire population. In total 234 farmers were selected for interview from 600 fish farmers. Given the nature and diversity of the study, a large sample was required to produce the salient characteristics of the population to an acceptable degree and also to reduce sampling errors (ibid.).

The instruments used for data collection were questionnaire, Participatory Rural Appraisal (PRA), personal observations and secondary information sources. A structured questionnaire was prepared and given to aquaculture experts to check its 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 researcher and his assistant. In each village a PRA meeting was conducted covering various topics on fish farming adoption.

Data analysis was based on descriptive statistics and presentation by means of Statistical Package for Social Sciences (SPSS) computer programmes. For each research question, means percentage was produced to validate it. In PRA meetings, a question was discussed and a point was taken after the consensus among members was reached. In case there was disagreement among members, the report was given.

RESULTS

This section explains factors that impede the adoption of a recommended package of fish farming technology.

Pond Construction: The minimum recommended pond size of 100 m^2 was considered easier to construct by the family labour. It was also considered to be manageable using available inputs. Furthermore, technology developers thought it would supply enough fish for home consumption and for sale. The study revealed that only 39% of the ponds met that condition. Similarly, the result revealed that while 64% of ponds in Morogoro were smaller than the recommended minimum size, 76% of ponds in Dar es Salaam were bigger than the recommended minimum size. Moreover, about 73% of female owned ponds which were smaller than the minimum recommended size compared to 57% of men owned ponds.

Table 1 show that the main reasons for constructing ponds less than the recommended size of 100 m^2 include the following. First, there was lack of information on the minimum size recommended (54%). Second, there was inadequate household labour force (48%). Third, there was no suitable land (39%) (A big part of Morogoro land had steep terrain and too many rocks, which made it difficult for farmers to construct bigger ponds). Fourth, the profitability of fish farming was unknown which made it difficult for farmers to allocate productive land for fish farming (23%). Fifth, there was water shortage (13%). Finally farmers lacked cash to hire labour (10%).

Table 1: Reasons for Constructing Ponds Smaller than the Recommended Minimum Size of 100^2 m

Reasons for constructing smaller pond	Frequency (n=142)	% of farmers
Lack of knowledge on the minimum pond size required	76	54
Inadequate household labour force	68	48
Lack of suitable land (steep slope or too many rocks)	55	39
Profitability of fish farming is unknown	32	23
Water shortage	18	13
Lack of cash to hire labour	14	10
Others (initially a breeding pond and advised to start with small pond)	6	4

Source: Survey Results, 2006

Water Allocation: Water is the most important factor in fish farming. The access to water, especially during dry season, is often complicated. Competing demands from other farming areas may restrict the quantities of water available for farmers (Hague, 1992). In some villages, fish farmers were blamed for over-using or miss-using water; leading to shortages (Wetengere *et al.*, 1998). This was sometimes justified, particularly for ponds with high seepage loss. Sometimes conflicts arose due to jealousy (ibid.). In other villages, the village authority discouraged fish farming as it was seen as something causing water shortage. Unfortunately, fishponds are required to be located near a reliable source of water; sites, which were very productive and capable of supporting valuable crops and yielding 2-3 harvests per season.

Besides using water for fish farming, only 32% of the respondents used water for irrigation. Of those using water for other activities, 99% mentioned gardening and 1% watering animals as activities competing for water. During water shortage, 51% of the respondents gave more priority in terms of water allocation to gardening, 35% gave to fish farming and 14% used for both activities. Water was in short supply between October and February, particularly if short rain commenced late or if it did not fall at all.

Table 2 shows the reasons for allocating water to garden. These include the following. First, the garden was more profitable or generated bigger income (41%). Second, the garden produced food (32%). Lastly, the garden rewarded immediately or frequently (20%). While reasons for allocating water for gardening were directly related to meeting household needs, reasons for allocating water for fish farming were not. For instance, 35% of farmers allocated water for fishponds because fish could not live without water and because both activities needed water (15%). Other reasons could include the fact that fish farming was more profitable and pond water could also be used for irrigating crops.

Land Allocation: Land suitable for fish farming is also suitable for the cultivation of other valuable crops (Hague, 1992). Unlike the views of some researchers who contend that fish farming could be implemented on land that has very low or zero opportunity cost, this study found that most ponds were located near homesteads. The land near homesteads has many competing uses, particularly for high value crops or those needing regular attention (ibid.). The cultivation of such crops for household food and income security is often preferred to fish if the latter do not meet that objective.

The majority of fish farmers (86%) owned land where ponds were constructed. Of the 14% farmers who operated ponds on land which was not their own, the lands belonged to relatives (62%), one of the group members (32%) and government farms (6%). The terms of operating a pond on land which did not belong to the fish farmers ranged from that of given free (47%), owned

Table 2: Reasons for Allocating Water Among Competing Users

Reason for giving priority	(n=75)	%
Garden is more profitable or generates big income	31	41
Fish cannot live without water	26	35
Garden produces food (maize, sweet/irish potatoes and bananas)	24	32
Garden rewards immediately or frequently	15	20
Both need water	11	15
Pond water is used for irrigation	7	9
Others	5	7

Source: Survey Results, 2006

by one of the group members (18%) or rented for a short period (15%). In some cases, land owners were given few fish every harvest (15%). There were others cases where farmers were given lands on neighbourhood basis (12%).

Most respondents (85%) indicated that the area where ponds were constructed was formerly used for cultivating crops. The crops formerly grown included bananas, maize, beans, sugarcane, sweet & irish potatoes, coffee, yams, fruit trees, coconut plants and vegetables. Only 15% of the respondents constructed ponds on land that had "nothing done" on it before. Other economic activities that could be carried out on the land where ponds were constructed included pot and brick making, building houses, animal keeping, trading, or planting wind breaker trees. Participants in PRA meetings indicated that most land labeled, as "nothing done on it" was land that was a source of roofing materials, grazing animals and government reserved land for other purposes.

Labour Allocation: Almost all farmers used family labour as the source of labour, 45% hired labour for cash and 28% exchanged labour for goods. Labour was mainly hired for crop farming (79%), while less was hired for fish farming (31%), animal husbandry (1%) and trading (1%). Activities for which labour was hired in fish farming included pond construction (31%) and to lesser extent pond cleaning, mud removing as well as major pond repair (4%). In crop farming, labour was mainly hired for tilling land (28%), weeding (21%), harvesting and transporting crops (10%) and others (planting, land clearing and selling of produce) (4%).

Most respondents (97%) reported to have faced labour shortage in some months of the year. Months of acute labour shortage included January (86%), February (85%), March (75%), December (63%), November (61%) and April (57%. Months of moderate labour shortage included October (43%), May (32%) and June (25%). Months of low or no labour shortage were July (9%), August (8%) and September (8%).

Allocation of Farm by-Products: Because fish are animals they need food to grow. Fish production, among other things is dependent on food available in the pond. Adding feeds directly or indirectly can increase the productivity of a pond. Direct feeding involves adding food, which is eaten by fish directly. A large variety of inputs can be fed. However, most farmers did not have access to much feed. The by-products used to feed fish were also used to feed other animals and to make local brew. This made it difficult for most farmers to have enough feed for fish. At the same time, most poor farmers could not afford to buy the feeds. That means, the best alternative left for farmers was to enhance naturally produced food through fertilization.

Fertilizer Allocation: In small-scale fish farming the most important source of food for fish is the naturally produced food (plankton) enhanced through fertilization. To ensure availability of sufficient natural food, farmers were advised to fertilize the pond with animal manure or plant matter before fingerlings were stocked. To promote quick production of plankton, manure was spread all over the pond bottom and filled in the compost enclosure before filling water. When water developed a plankton bloom - an indication for the availability of natural food - fingerlings was stocked, and afterwards fertilization was applied at regular intervals to maintain the greenish water colour.

This study revealed that out of 234 fish farming adopters, about 36% did not apply manure in their ponds. More farmers in Morogoro (37%) did not apply manure in their ponds than in Dar es Salaam (23%). In addition, slightly more women (39%) did not apply manure than men (36%). Looking at the the quality of fertilization, it was found that 42% of ponds had transparent water colour, 32% green, 21% brown and 6% dry. Most ponds (47%) in Dar es Salaam were greener than those in Morogoro (31%) and men's ponds (34%) were greener than women's ponds (24%). In addition, most ponds located within less than 100m from homestead were greener than those located away from homestead.

Table 3 shows that farmers did not fertilize their ponds due to lack of time to collect and apply manure in ponds (59%), insufficient manure (47%), the belief that fish farming was not profitable (38%), and the fact that some ponds were too far from homesteads (25%). Other reasons included; pond owner traveled for longer period (19%), fish had been predated by animals and/or stolen (18%), lack of knowledge on the use of manure in ponds (12%) and pond did not have crib (8%). Other minor reasons included lack of money for buying manure, the belief that fish was only a relish, water flow in and out the pond continuously and "going slow" among group owned ponds.

Among the fish farmers (149) who applied manure in fish farming, 38% also applied manure in other competing activities. Farming of crops was an activity, which competed with fish farming for manure. Manure allocation was ranked in the following order; garden produced food (maize, yams, banana etc,) (39%), vegetable farming was more profitable (32%), fish farming generated little income and relish (23%), vegetable generated income (18%), activities which provided both relish and income (11%) and others (18%).

Table 3: Reasons for not Applying Fertilizer in Fish Ponds

Reasons for not applying fertilizer in fish pond	Responses (n=85)	Percentages
Lack of time to collect and apply manure	50	59
Lack of enough manure	40	47
Profitability of fish farming is unknown	32	38
Ponds are located far from home steady	21	25
Pond owner moved away for other business	16	19
Most fish predated by wild animals	15	18
Lack of knowledge on the use of manure in the pond	10	12
Ponds do not have crib	7	8
Others	14	16

Source: Survey Results, 2006

Table 4: Reasons for not Feeding Fish Ponds

Reasons for not feeding fish ponds	Responses (n=26)	Percentages
Most fish have been eaten by animals or stolen by human	20	77
Fish are stunted or poor quality of fingerlings	10	38
Poor profitability of fish farming	9	35
Ponds are located far from homestead	8	31
Lack of time to collect and feed fish	8	31
Lack feeding knowledge	4	15
Pond manager moves away for long time	4	15
Others (lack feed and going slow in group ponds)	3	12

Source: Survey Results, 2006

Feed Allocation: Farmers were advised to apply supplementary food, which was available to boost the growth of fish in their ponds. Farmers were to use whatever feeds were available for fish feeds and they were to feed at least once per day. Of the inputs used in fish farming, grain bran was the input that had high opportunity cost. This input did not only have many competing uses, but was also insufficient and seasonal in supply. The input was readily available immediately after harvest (July - October) when grains were plenty and most farmers' hulled grain before milling. During shortage, people hardly hulled as a result grain bran became unavailable. Sometimes the shortage of feeds was made worse by farmers' preference to use certain types of feeds (i.e. maize bran) to feed fish while other feeds were readily available.

The result of this study showed that 89% of respondents supplied feeds into their fishponds. The most common used feeds were maize and rice bran, local brew-leftovers, kitchen-leftovers, plant leaves and spoiled fruits. Table 4 shows that 11% of the farmers did not feed their fish because most fish were eaten by animals or stolen (77%), some fish were stunted due to poor quality fingerlings (38%), fish farming had not proved to be profitable (35%), ponds were located too far from homesteads (31%) and some farmers lacked time to feed (31%). There were also farmers who did not know whether fish needed to be fed (15%), pond owner traveled away (15%) and other (lacked feeds).

Most respondents (64%) utilized inputs used for feeding fish in other competing uses. Most respondents used fish feeds for feeding animals (84%), to make local brew (8%) and both uses (8%). These activities were considered more profitable than fish farming.

Fish Harvest: To avoid fish overcrowding and stunting, farmers were advised to harvest fish in small amount at regular intervals and by total drainage of the pond every 6-8 months (Van der Mheen, 1999). The study revealed that 94% harvested their ponds. More farmers (96%) in Morogoro harvested their ponds than in Dar es Salaam (71%). Of those who harvested, 92% did so by partial harvest. More farmers (89%) who harvested partially came from Morogoro compared to Dar es Salaam (65%).

Table 5 shows that most farmers did not harvest fish by total drainage of the pond due to the following reasons. First, they lacked knowledge on how to drain ponds (25%). Second, pond drainage was difficult or was impossible due to flatness of land (21%). Third, fish in the pond had not multiplied enough or farmer feared that fry and eggs would die (18%). Fourth, there was water shortage or feared to waste the fertilized water (15%). Fifth, there was lack of storage pond to keep fingerlings (5%). Six, there was no time for some farmers to do drainage (5%) and others (water not allowed to flow in other farms, did not like to see pond dry and will not have fish to eat when the pond is dry).

Few farmers (13%) did not harvest partially because they did not have harvesting nets. Moreover, fish were not big enough to be harvested and there was too much mud in the pond making harvest by net difficult.

Table 5: Reasons for not Harvesting Fish by Total Drainage of the Pond

Reasons for not harvesting by total drainage of the pond	No. of farmers (no =204)	% of farmers
Lack of knowledge on how to drain the pond	51	25
Pond drainage is difficult or impossible due to flat land	42	21
Fish have not bred or fear of killing fry and eggs	37	18
Water shortage or wastage of fertilized water	31	15
Do not have storage pond to keep fingerlings	11	5
Lack of time to drain the pond	10	5
Others	9	4

Source: Survey Results, 2006

DISCUSSION

The fact that most ponds were smaller than the recommended size did not come as a surprise as access to information about a certain technology and profitability is key factors that determine adoption of that technology. This implied that farmers who had acquired knowledge on the minimum size of pond were more likely to practice that requirement than those who did not have such knowledge. This result is similar to those of Polson and Spenser (1991) and Kimenye (2001), which show the influence of extension services on adoption of a technology. Furthermore, farmers allocate land to activities, which are more profitable. Similarly, access to other resources necessary to undertake fish farming like water, feeds, fertilizers, labour, cash income etc. were needed in order to meet the minimum pond size recommended. For instance most well off farmers in Dar es Salaam met the minimum size because they could hire labour and could get information on the minimum pond size. Also, they did not face problems of steep terrain or too many rocks and had relatively larger household labour size.

Similarly, most women owned smaller ponds, did not apply manure and their ponds were less green than those of men. Participants in PRA meetings indicated that this might be due to the claim that most women were already overburdened with other home activities. They also lacked cash to hire labour and purchase inputs. Furthermore, they lacked access to fish farming information. Another reason is that women did not own big pieces of land.

The results of this research, further, revealed that household resources were allocated to those activities which produced food and those which were thought to be more profitable and/or generated big and/or frequent income, and rewarded quickly. This finding is similar to those by Temu (1999), which show that resources allocation is often characterized as 2-stage process, which first priority is given to meeting food security and the second objective is to maximize income using the remaining resources. Gardening, animal husbandry and local brew industry satisfied these conditions. For instance, gardening produced food, which was in line with household priority. While animals like pigs generated big income, small animals like rabbits and chicken generated small but frequent income. It is important to note that generating big income did not necessarily mean that the activity was profitable. Participants in PRA meetings indicated that although pig husbandry was not profitable and actually sometimes led to losses, it was preferred to fish farming simply because it generated bigger income at a time than fish farming. This is supported by Brummett & Noble (1995) who found that many farm enterprises in Malawi were carried out from year to year despite continually losing or earning only negligible amount of money. PRA participants labeled pig husbandry as a “profitless bank” but the one, which generated big money at a time that could be invested or spent in other important things, like school fees or buying iron sheets, bicycles or a pieces of land. In contrast, fish farming generated small income on irregular basis. Local brew making was also preferred because it generated small income but on daily basis.

The researchers’ observation revealed that sometimes farmers did not allocate resources for fish farming even when there were no shortages of those resources. For instance, even when there was enough water some fishponds remained dry or with low water level, a fact showing low priority attached to fish farming. In addition, participants in the PRA meetings revealed that during farming season more priority in terms of resource allocation was given to crop farming than fish farming. Most farmers, for instance, were willing to guard maize, rice and cassava against wild animals until they were ready for harvest. The same farmers were unwilling to fill water in their fishponds during the night when water was in low demand. They were also not ready to guard fishponds against predators. Participants in PRA meetings indicated that while maize and cassava were staple food;

they could be eaten on their own and generated big income, on the contrary fish was only a relish and could not be eaten on its own and generated meager income. During this survey, (farming season i.e. November-June) most farmers were in the field guarding maize and rice against wild animals while most fishponds looked deserted. Other crops like beans and vegetables, which are also relish earned a considerable amount of income because they are durable and were sold in distant peri-urban markets where customers had good income (Wetengere, 2008).

Finally, the harvesting strategy that was advocated was not farmer-friendly. For instance, participants in PRA meetings indicated that unavailability of nets and the presence of weir (This is a structure made of sticks or small poles and is constructed in the pond to divide the pond into 2 halves. The spacing of the poles allows fish to swim through from one half to another but the spacing is too small for an otter to pass. In this way the weir prevents an otter from eating fish) to control otter predation and crib for composite manure made harvest by net difficult. Most farmers in Morogoro harvested partially mainly because most projects in Morogoro provided harvest nets and seemed to be more organized than the ones in Dar es Salaam. Harvest by total drainage of the pond was impractical due to shortage of water and/or fear of wasting fertilized water. Some ponds were constructed on flat or high water table sites, which were impossible to drain totally. Furthermore, since most ponds in Dar es Salaam used piped water, it was uneconomical to drain water on regular basis.

CONCLUSION

The objective of this study was to identify the determinants for adoption of a recommended package of fish farming technology. It is expected that identifying these factors will enable planners in research and extension to advice farmers on aspects, which are compatible with their environment. This will in turn make farmers adopt the recommended package of a fish farming technology. The important conclusion to be drawn from this study is that farmers' access to information about a technology, economic motivation and resources endowment are important in adoption of a recommended package of fish farming technology. The results show that farmers allocate resources to those activities, which meet household needs, more than others.

RECOMMENDATION

- The findings of this study have shown that farmers allocate resources to those activities, which contribute to household food and income security. Those activities, which did not meet that objective attracted some parts of a recommended technology. This finding suggests that if a recommended package of fish farming technology is to be adopted, it has to contribute to household food and income security. Thus, farmed fish must be eaten more frequently. More importantly fish farming has to generate big income on regular basis if it is to be valued.
- The results have, similarly, shown that access to information about fish farming technology is a key factor that determines the adoption of a recommended package of a technology. This underscores the importance of disseminating information to the potential farmers about the technology, as any rational individual will adopt a recommended package of a technology once it has been conveyed to him/her.
- The findings further showed that access to resources such as land, labour, water, seeds and on-farm inputs is an important factor that determines the adoption of a recommended package of a technology. Thus, farmer's access to resources should be the target of extension information services regarding technology adoption.
- The results also showed that profitability is a key factor that determines the allocation of household resources. Since fish farming does not meet the objective of food security as it is a relish and not staple food like "ugali", cassava etc. For a recommended package to be adopted, it has to be profitable. To increase its profit, production technology has to improve and farmers must access peri-urban markets.

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