MANAGEMENT AND VALUE CHAIN OF NILE TILAPIA CULTURED IN PONDS OF SMALL-SCALE FARMERS IN MOROGORO REGION, TANZANIA

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Abstract

A study was carried out to assess production performance and value chain of Nile tilapia grown in ponds of small-scale farmers in Morogoro region, Tanzania. Information was collected through individual interviews of 30 fish farmers. The main reasons for culturing fish were provision of animal protein food for home consumption (66.7%) and generation of income (23.3%). Fish farming contributed 10.6% of household annual income and was ranked second to crop production (50%). The majority of the farmers were fertilizing their ponds with chicken manure (30.0%) and cattle manure (23.3%). Most farmers (73.3%) cultured pure stand of Nile tilapia and only few (26.7%) practiced polyculture of Nile tilapia and African catfish. All farmers depended on natural food as a source of feed for their fish. Moreover, the farmers were feeding maize bran (96.7%), vegetables (66.7%), and kitchen leftovers (13.3%) as supplementary feeds. Men were responsible for purchasing and stocking fingerlings (60.0%), feeding (40.0%), pond maintenance (53.3%), harvesting (60.0%) and selling (43.3%). Women were mainly involved in fish processing (76.7%). The average period from stocking to harvesting was 5.75 ± 0.18 months for Nile tilapia and the mean yield was 6,946.2 kg/ha per year. About 22.2% of the harvested fish were consumed at home and the remaining (77.8%) were sold. The main actors in the value chain of cultured Nile Tilapia were fingerling producers, fish farmers and consumers. Most farmers sold fresh fish directly to neighbours (70.0%) and consumers in the local market within the village (30.0%). It is concluded that small-scale fish farming is important for provision of animal protein food and income and is done mostly by men, and it is characterized by low productivity due to improper pond fertilization and feeding. The major problems to Nile tilapia farming under small-scale fish farming is lack of funds, stunted growth of stocked fish, inadequate knowledge on fish farming and unavailability of concentrate feeds.

Keywords: Feeding, marketing, Nile tilapia, pond fertilization, yield.

Introduction

In Tanzania aquaculture is still a subsistence activity practiced by small-scale farmers who have low social, cultural and economic status and limited access to technology, markets and credits. At the moment aquaculture is dominated by freshwater fish farming in which small-scale farmers practice both extensive and semi-intensive fish farming. Usually small fish ponds of an average size of 10 m x 15 m (150 m^2) are integrated with other agricultural activities such as gardening, crop production, livestock keeping and chicken production on small pieces of land (Lamtane, 2008; FAO, 2012). It is estimated that there are about 14,740 earthen ponds scattered across the country, mainly in Ruvuma, Mbeya, Iringa, Morogoro, Kilimanjaro and Arusha regions. Nile tilapia (*Oreochromis niloticus)* is the dominant species that is cultured in these ponds, followed by African catfish *(Clarias gariepinus)*(Kaliba *et al*., 2006). Other species with potential for use in aquaculture include milkfish (*Chanos chanos*) and the flathead grey mullet (*Mugil cephalus*) which are cultured in the brackish and marine waters. The emphasis of the national fisheries policy (URT, 1997) is on a semi-intensive integrated mode of fish culture, focusing on Nile tilapia.

The pond culture of Nile tilapia is now viewed as a possible source of livelihood for farmers residing in proximity to the urban markets of cities and towns. Wijkstrom and MacPherson (1990) have shown that small-scale fish farming with commercial orientation can be a very profitable activity and the wealth generated through fish farming may be a powerful tool for poverty reduction for rural poor involved in the sector. Furthermore, the Nile tilapia is popular in consumption markets all over the country. The demand for Nile tilapia is predicted to increase due to population growth, expected economic development and changes in eating habits. This provides opportunities for improvement of fish production and commercialisation of the smallholder production system. In Tanzania, aquaculture has a vast but yet untapped potential. Thus, there is a need to improve fish production from aquaculture to complement the capture fisheries. Before embarking on improvement of productivity of fish farming, it is important to assess the production performance and economic profitability of Nile tilapia in ponds of small-scale farmers. The present study was carried out to determine production performance, market channels of farmed Nile tilapia and constraints facing fish farming in rural areas. In addition, the study examined gender issues in fish farming under the smallholder farming system. This information will help in developing appropriate improvement programmes aiming at improving the productivity of Nile tilapia in rural areas.

Materials and methods

Description of the study area

The study was carried out in Morogoro region,Tanzania. Administratively Morogoro region has seven districts and the study was conducted in four districts (Kilombero, Morogoro Urban, Morogoro Rural and Mvomero). In each district two to six villages were included in the study depending on the availability of fish farmers. The villages selected were Njage, Lufulu and Chita (Kilombero district), Bigwa and Msavu B (Morogoro Urban district), Mlanga, Kibwaya, Changa, Bamba and Kiloka (Morogoro Rural district), Langali and Mgini (Mvomero district). Morogoro Region lies between latitude 5^o 58" and 10^o 0" South of the Equator and longitude 35^o 25" and

35^{o} 30" to the East. The annual rainfall in the region ranges from 600 mm in lowlands to 1200 mm in the highland plateau. The average annual temperature varies between 18^{0}C on the mountains to 30^{0}C in river valleys. In most parts of the region, the average temperatures are almost uniform at 25^{0}C. The hottest period runs from September to March while the coolest period is between June and August.

Sampling procedures

In this study a purposive sampling procedure was used to select four districts in which fish farming is predominantly practised. In each district two to six villages were randomly selected making the total number of villages to be 12. Within a village one to five farmers were randomly selected from the list of fish farmers depending on the number of fish farmers in the village, making the sample size of 30 households.

Data collection method

A household survey was conducted and heads of the households were the main respondents. However, other members of the households were requested to attend the interview so as to supplement information. Face to face interviews of the selected farmers were conducted using structured questionnaires and personal observation was also done. Both closed and open-ended questions were included in the questionnaire administered to the respondents. The questionnaire was designed to gather information on households' socio-economic characteristics, pond size, fish management practices, production yield and marketing of Nile tilapia. In addition, information was collected on responsibilities of different household members in fish farming. Also, the fish ponds of the small scale fish farmers were observed visually and the physical conditions and water quality were judged by the researchers.

Data analysis

Data from questionnaires were coded and recorded into the spreadsheets for statistical analysis. The Statistical Package for Social Science computer software was used to generate means, standard deviations, and percentages.

Results and Discussion

Socio-economic characteristics of the respondents

Most of the household heads were men (76.7%) and only few households were headed by women (23.3%). Also most fish ponds were owned by men. This is because local customs and cultural practices in many farming systems in Tanzania make it impossible for a woman to own assets and land as these are acquired mainly through inheritance which favours men to own assets. The observation in this study with regard to heading the households and ownership of fish ponds is in agreement with the findings of Seki and Maly (1993) who reported that almost all fish ponds in Ruvuma region, Tanzania are owned by males, often the household heads. There

are few women who own fish ponds and most of these are widowed, divorced or unmarried women. Most of the people interviewed had primary school level of education (66.7%), while 23.3 and 10% had secondary school education and no formal education, respectively. The majority (63.3%) of the respondents were 25 to 50 years old, implying that they were in the active working group. Average household size was 6.29 ± 0.5.

The majority (73.3%) of the interviewed small scale fish farmers owned only one pond and only few farmers had two to four ponds (Table 1). This might be due to small size of land they owned coupled with low knowledge on importance of fish farming. Most of the ponds were small with an average size of 116.41 m^2, and were located near the homesteads. According to FAO (2012), most small-scale farmers own small ponds of an average size of 150 m^2, covering an estimated area of 221.5 ha. The majority of the ponds were stocked with *O. niloticus* (80%) and few had either *Clarias gariepinus* or both *O. niloticus* and *Clarias gariepinus*. Most of the respondents said that they got their original stock of fingerlings from research/development projects which persuaded and encouraged them to start fish farming enterprise. Most farmers depended on rivers as sources of water for their ponds, but few fish farmers used spring water. Most of the respondents reported that the land currently under fish farming was previously used for cereal crops production (83.3%), vegetable production, and for some few farmers the areas were an idle land.

Household economic activities and their contribution to income

The main economic activities in the study areas were crop production, livestock keeping, fish farming and petty businesses. Among these enterprises, crop production was ranked as the first most important economic activity and contributed 42.7% of the household income (Table 2). This was followed by livestock production which contributed 21.5% of the household income. Fish farming was ranked either second (50%) or third (30%) in terms of importance, though its contribution to household income (10.6%) was less than that of livestock production. However, this assessment did not consider the amount of fish consumed by the household. According to the respondents, the most important purposes for culturing fish were provision of animal protein food (66.7%), cash income (23.3%) and an investment to be drawn upon need (10%), in that order of importance to the households. It seems that crop production is the most important economic activity in the study areas as it is practiced by almost all farmers. This observation concurs with the findings of Seki and Maly (1993) who found that, over 80% of the pond owners are primarily engaged in agriculture and consider fish farming as a secondary activity. There were quite a few fish farmers who were temporary employed as casual labourers.

Table 1: Characteristics of small-scale fish farming in Morogoro region

Variable	Factors	n	Percentage/mean
Pond size (m^2) (mean ± se)		30	116.41 ± 22.59
Distance to ponds (km) (mean ± se)		30	0.56 ± 0.183
Period from stocking to harvesting (months) (mean ± se)		30	5.75 ± 0.18
Number of ponds (%)	One	22	73.3
	Two	6	20.0
	Three	1	3.3
	Four	1	3.3
Species cultured (%)	Nile tilapia	24	80.0
	African catfish	1	3.3
	Both	5	16.7
Species preference (%)	Nile tilapia	25	83.3
	African Catfish	3	10
	Both	2	6.7
Water sources (%)	Rivers	19	63.3
	Springs	3	10.0
	Underground water	8	26.7
Water availability (%)	All year round	17	56.7
	Seasonal	13	43.3
Pond water quality (%)	Very good	6	20
	Fair	15	50
	Bad	6	20
Use of pond site before (%)	Crop production	25	83.3
	Vegetable garden	1	3.3
	Idle land	4	13.3

Table 2: Households economic activities and their contribution to income

Enterprise	Rank				Contribution to household income per year (%)
	1st (%)	2nd (%)	3rd (%)	4th (%)	
Crop production	76.7	10.0	3.3	-	42.7
Livestock production	3.3	33.3	20.0	3.3	21.5
Small businesses	3.3	-	10.0	-	16.6
Fish farming	6.7	50.0	30.0	6.7	10.6
Casual employment	6.7	-	-	-	8.6
Total					100

Fish feeding

Table 3 indicates that most of the respondents provided maize bran (96.7%) and vegetables (66.7%) as supplementary feeds to their fish. This is because these materials were readily available and low in price. Protein concentrates such fish meal, soybean meal and oil cakes were not used for feeding fish due to the fact that their supply is irregular and most farmers cannot afford to buy them. Generally, the feeds fed to fish in the ponds were of poor quality and this resulted into low productivity of the cultured fish. The amount of feed recommended is usually 5 – 10% of the body weight of the cultured fish (Bahnasawy *et al.*, 2003). However, in the present study most fish farmers said that they do not weigh the fish cultured in the ponds, hence, do not feed their fish according to body weights, but provide feeds based on rough estimates of the feed required. This concurs with El-Sayed (2008) who reported that small-scale farmers manage their fish ponds by trial and error. According to FAO (2012) fish production under small-scale production system is low due to small pond size coupled with poor management. In the present study poor management was a common problem for the majority of the fish farmers. This was characterized by poor feeding and irregular pond fertilization.

Pond fertilization

Management strategies of fish ponds under small-scale systems involve the use of fertilizer to encourage growth of natural food and to improve the level of dissolved oxygen. Most farmers reported that they fertilize their ponds using manure from domestic animals before stocking the fingerlings. This is supported by the observation that 70% of the fish farmers (Table 1) had ponds with greenish water, indicating good water quality. The dominant types of fertilizers used were chicken (30%) and cattle (23.3%) manures (Table 3). This is because almost all households kept chicken rather than cattle, pigs or goats. On the other hand cattle manure was readily available and could be obtained from the neighbours for free. Other types of manure used in pond fertilization included pig manure and composite. Most of the respondents applied manure to their ponds either once (46.7%) or twice per month (33.3%). The average amount of the manure applied in the ponds was 1.40 ± 0.14 t/ha. This is in agreement with the observation of

El-Sayed (2008) who reported that small-scale farmers rarely adopt scheduled fertilization, instead fertilize their ponds with single application of 1.5–3.0 mt/ha of dry poultry manure.

Table 3: Supplementary feeds and pond fertilization

Variables	Factors	n	Percentage/mean
Feeding			
Type of feeds used (%)	Maize bran	29	96.7
	Kitchen left over	13	43.3
	Vegetables	20	66.7
Amount of feed (kg/day) (mean ± se)			2.80 ± 0.327
Feeding frequency (%)	Once per day	16	53.3
	Twice per day	14	46.7
Fertilization			
Pond fertilization (%)	Yes	29	96.7
	No	1	3.3
Type of fertilizer (%)	Cattle	7	23.3
	Chicken	9	30
	Pigs	3	10
	Chicken &pigs	3	10
	Composites	6	20
	Goats	1	3.3
Frequency of application (%)	Once	14	46.7
	Twice	10	33.3
	Thrice	1	3.3
	Tetra	1	3.3
Amount of manure applied (mean ± se) (t/ha)		1.40 ± 0.14	

Gender issues in fish farming

The responsibilities of different household members on fish farming was assessed and the results showed that the majority of adult males were responsible for purchasing fingerlings (60%), stocking (53.3%), pond maintenance (53.3%), feeding (40%), harvesting (36.7%) and selling (43.3%) (Table 4). However, in some few households women were also involved in feeding, pond maintenance and fingerling stocking. With regard to children, boys were somehow involved in doing some activities in the ponds while girls were not involved in any activities. It was reported that adult males and boys worked together especially during harvesting period so as

to make the exercise easier. Some households hired labourers, particularly when purchasing fingerlings, stocking and harvesting. This is because some farmers purchased fingerlings from hatchery that are far away from their home and thus needed assistance for transporting the fingerlings. It seems that most of the activities in fish farming are performed by men, except for processing, which is done mainly by women. Similar observation has been made by Adebo and Alfred (2008) who reported that in Nigeria males are engaged in pond construction, pond installation and maintenance, disease control, fish sorting and fingerling production whereas females are involved in fish marketing, drying and smoking. According to Adebo and Alfred (2008) men are involved in the tedious aspects of tilapia production while women are mostly involved in activities that are related to their domestic duties in the households.

Table 4: Responsibilities of different household members in fish farming

	Adult males (%)	Adult females (%)	Boys (%)	Girls (%)	Laborers (%)	Adult males/boys (%)	Adult Males/ Laborers (%)
Fingerlings purchase	60.0	13.3	3.3	0	6.7	6.7	0
Stocking	53.3	16.7	3.3	0	6.7	13.3	0
Feeding	40.0	26.7	3.3	0	0	26.7	0
Maintenance	53.3	23.3	3.3	0	0	10.0	3.3
Harvesting	36.7	10.0	0	0	3.3	23.3	3.3
Processing	3.3	10.0	0	0	0	0	0
Selling	43.3	13.3	0	0	0	0	0

Production yield and value chain of Nile tilapia

Mean yield of Nile tilapia was estimated at 6,946.2 ± 568.3 kg/ha per year. This yield is higher than the yield of 2089 and 4704.27 kg/ha/year reported by Kaliba *et al*. (2006) and Shoko *et al.* (2011), respectively, but it is low compared to the yield of 10,000 kg/ha/year which can be achieved if improved strains are used (Eknath and Acosta, 1998; Hussein *et al*., 2000). In this study the respondents reported that 22.2% of the harvested fish were consumed at home and the remaining (77.8%) were sold (Table 5). The value chain of cultured Nile Tilapia in the present study was very short and comprised of fingerling producers, fish farmers and consumers in the neighbourhood or local markets. The sources of fingerlings for the fish farmers were research/development project (40%), other fish farmers (33.3%) and government hatchery (26.7%). Most of the fish produced by the small-scale fish farmers were sold and consumed locally. Table 5 shows that the majority of the fish farmers sold their fish directly to the neighbours (70%) and local markets (30%). Thus, the major consumers of cultured Nile tilapia are the neighbours and this is because the quantity of fish produced is low and is exhausted by neighbours and local markets within the villages. This indicates that the market for the fish produced by the small-scale fish farmers is readily available within the villages and there is no

amount that is left for selling to secondary markets and external markets. Most of the respondents sold fresh fish (70%) and very few sold processed fish (10%). The main processing methods were smoking and frying. The highest price was obtained from selling fried fish (TZS 2750/kg), followed by smoked fish (TZS 2500/kg). The price of fresh fish was lower than that of processed fish and differed with the type of buyer. The highest price for fresh fish was offered by vendors while the price offered by the neighbours was the lowest. The study has revealed that the farmers can gain more by selling processed fish rather than fresh fish.

Table 5: Production yield and marketing of Nile tilapia

Variables	Mean ± standard error
Estimated yield for total harvest per year (kg/ha)	6,946.2 ± 568.3
Proportion consumed (%)	22.2
Proportion sold (%)	77.8
Selling by weight (%)	33.3
Selling by pieces (%)	66.7
Selling to neighbours (%)	70
Selling at local market (%)	30
Fresh fish price from neighbours (TZS)	2210 ± 265.2
Fresh fish local market price (TZS)	2440.0 ± 277.6
Fresh fish price from venders (TZS)	2500.0 ± 100.4
Distance to market (km)	1.68 ± 0.57
Price of smoked fish (TZS)	2500 ± 110.2
Price of fried fish (TZS)	2750 ± 150.3

Constraints to fish farming

The observation from this study has revealed that a relatively higher percent of small-scale fish farmers in the study areas were faced with several constraints (Table 6). Most small-scale fish farmers reported lack of funds, stunted growth of stocked fish, inadequate knowledge on fish farming and unavailability of concentrate feeds as the major constraints to fish farming. Other minor constraints included irregular water supply, predation, unavailability of fingerlings, floods, theft, and lack of transport. Other studies (Brummett and Noble, 1995; Abiona, 2011) have shown that high input price, price fluctuation, shortage of land, drought, lack of credits, poor roads, high transportation cost, theft and poor extension services are the main constraints to development of aquaculture in Africa. These challenges need to be addressed in order to improve fish productivity and make fish farming more profitable under small-scale production system.

Table 6: Constraints to fish farming

Problems	Most important (%)	Important (%)	Negligible (%)
Lack of funds	56.7	23.3	20.0
Stunted growth	43.3	23.3	33.3
Inadequate knowledge on fish farming	43.3	33.3	23.3
Lack of concentrates	40.0	26.7	33.3
Irregular water supply	36.7	23.3	40.0
Unavailability of fingerlings	33.3	10.0	56.7
Predation	33.3	40.0	26.7
Drought	23.3	23.3	53.3
Lack of transport	13.3	16.7	70.0
Floods	6.7	0.0	90.0
Lack of manure	3.3	10.0	86.7
Theft	3.3	6.7	90.0
Poor tools	3.3	36.7	56.7

Conclusions

The present study has revealed that Nile tilapia farming is important to household food consumption and income, ranking 2nd or 3rd to crop production, depending on the location.Yield of Nile tilapia cultured in ponds of small-scale farmers is relatively low due to small pond size and poor feeding and irregular pond fertilization. Almost all fish ponds are owned by men, often the household heads. Women are mainly involved in tilapia processing. The main actors in the value chain of cultured Nile Tilapia are fingerling producers, fish farmers and consumers. Most farmers sell fresh fish directly to neighbours and consumers in the local markets within the village. Fried and smoked fish fetch higher price than fresh fish in the local markets. The major constraints to Nile tilapia farming under small-scale fish farming is lack of funds, stunted growth of stocked fish, inadequate knowledge on fish farming and unavailability of concentrate feeds.

Recommendations

Based on the findings of this study it is recommended that:-

(i) Local government authorities should officially recognize fish farming as an important economic activity and extend water use right to fish farmers to allow them to use water for fish farming, especially in irrigation schemes.

(ii) Extension services for aquaculture should be strengthened up to the village level.

(iii) Gender sensitivity training programmes should be conducted to increase women roles and extent of participation in aquaculture value chain.

(iv) More research is needed to develop better quality and cost-effective fish rations from locally available feed resources.

(v) Efforts should be made to provide credits to small-scale fish farmers to enhance fish farming under small-scale production system.

(vi) There is a need to establish fish farmers' associations that will help the farmers to improve inputs availability and marketing capacity of small-scale farmers.

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