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THE ACTUAL VALUATION OF FISH PONDS: THE CASE OF SELECTED VILLAGES IN MOROGORO AND DAR ES SALAAM REGIONS, TANZANIA

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ABSTRACT

The actual value of resources is a key element in designing policies that aim at sustainable management of those resources. Often, however, the valuation has been based on market benefits. This approach to resource valuation is inadequate and represents the "tip of the iceberg," necessitating need for actual valuation. Fish ponds are one of the resources that require the actual value of their benefits. This can lead to sustainable management so that the community can enjoy their long-term benefits. This study was conducted in Morogoro and Dar es Salaam Regions, Tanzania to identify the actual benefits of fish ponds, taking into consideration the use and non-use benefits. A survey design was adopted to collect data from 410 respondents randomly sampled from selected villages. Instruments used for data collection were: a questionnaire, Participatory Rural Appraisal (PRA) and secondary sources. Data were analysed with the Statistical Package for Social Sciences (SPSS). Results indicate that fish ponds have a variety of benefits ranging from direct and indirect to intrinsic benefits. Traditionally, however, valuation has been based on direct monetary statistics, which represent a meagre value of fish ponds. The reason why most of the indirect and intrinsic benefits have not been incorporated in the valuation is because some of the benefits were unknown and, if known, were difficult to be assigned a value. This result suggests that the first step in actual valuation should be to identify benefits accruing to fish ponds and then to devise an adequate mean of pricing the non-marketed benefits. Knowing these will enable planners and decision-makers to accord fish ponds the importance they deserve. Similarly, efforts should be directed toward: (a) improving fish production through the reduction of the risk of losing fish, shortening the culture cycle to target market size fish, use of low cost inputs and integrating fish farming within the farming system, (b) increasing the market for farmed fish through improving roads, providing information on fish prices and the nutritional value of fish, and forming marketing groups to lower transport and transaction costs, and (c) identifying "farmer-friendly" harvesting strategies which will make farmed fish readily available. All these together would increase the value of fish ponds.

Key words: Fish pond benefits, actual valuation

INTRODUCTION

The acceptance of sustainable development has intensified the focus on the actual value of resources. Sustainable development is a result of proper allocation and management of resources so that long-term benefits enrich the community. Central to the resource allocation process is to understand actual valuation of resources and ways that they serve the community's objectives. One resource that merits proper valuation so it receives the importance it deserves is fish ponds.

Fish ponds contribute to household well-being in a variety of ways, most of which are unknown. The most known uses include: providing fish for home consumption as well as for sale to earn income, improving on-farm resource utilisation, thus increasing overall farm production and productivity; diversifying the existing farming system, thus reducing the risk associated with small scale farming; creating highly-needed employment, thus helping increase income and providing an ideal solution to stabilised or declining marine and inland fisheries [1, 2]. Through these contributions, fish ponds, directly and indirectly, produce economic value [3].

Despite the high potential of fish ponds, the Department of Fisheries (DF) has for many years neglected the aquaculture sub-sector and given more priority to capture fisheries due to their immense monetary contributions. This attitude has contributed much to the present underdeveloped state of aquaculture [4]. The low priority given to the aquaculture sub-sector is reflected in terms of meagre funds allocated to extension work, training and research. One reason for the low priority accorded to this sub-sector is that most official statistics look only at the marketed commercial output of farmed fish products. These statistics, however, represent the "tip of the iceberg" [5]. As a consequence, there is little appreciation of what fish ponds can do. Fish ponds contribute a wide range of non-fish products, most of which are unknown and thus not recorded.

Proper valuation of fish ponds is, therefore, essential for sound decision-making in allocating resources. Traditional decision-making on resource allocation usually is based on financial factors, which market imperfection make inadequate. In recent years valuing, or at least being aware of, non-marketed goods has become a major area of concern due to greater recognition of the social importance of such goods and losses associated with their inadequate accounting [6]. Absence of markets for such goods results in the need for public intervention, which in turn, requires accurate valuation in order to design socially optimal policies [6].

The objective of this paper is to investigate the actual benefits of fish ponds, taking into consideration their use benefits (direct and indirect benefits) and non-use benefits (intrinsic benefits).

Conceptual framework for valuing fish ponds

The actual valuation of fish ponds, like the valuation of any other resource, is a difficult concept for most people.[1] Valuation includes both direct and indirect benefits and intrinsic benefits obtained from the resource. It is common and relatively easy to allocate value to goods and services that are marketed. In fish farming, the valuation of fish ponds is based on marketed farmed fish output. In reality, however, the valuation of fish ponds not only is measured in the monetary value of the fish output, but also by volume of fish consumed, the frequency and time period when farmed fish is consumed. Similarly, the value of fish ponds not only is measured by the income earned but also by the frequency and time period when income is earned. These benefits are fundamental to household food and income security.[2]

The problem, however, arises in the valuation of non-marketed benefits. They are difficult to value because most of them are not recorded. Moreover, considerable benefits which do not accrue directly from fish ponds are also not included in the valuation of fish ponds. For instance, when fish pond also enhances crop production indirectly through the use of nutrient-rich pond-bottom mud or pond-water or moist pond-soil, it may be difficult to associate such benefits with fish ponds. Likewise, intrinsic benefits like status and prestige, aesthetic purposes and fish ponds that preclude other users on communal land are important to farmers, but they are difficult to value. Consequently, the real value of fish ponds is underestimated and thus accorded a low priority in resource allocation. There is a growing recognition that non-marketed benefits do have real value and that this value needs to be ascertained and included in the decision-making process.

The first step, therefore, in recognizing the actual benefits of fish ponds is to recognize and identify that both use benefits and non-use benefits do exist, and that non-marketed benefits are as important as marketed products. The second and most important step is to assign a value to the non-marketed benefits. Table 1 shows that, besides marketed fish products, fish ponds offer a wide range of non-marketed benefits, which include: medicinal fish oil; nutrient-rich bottom-mud used as farm fertiliser; moist soil supporting waterlogged crops like yams, bananas and sugarcane. In addition, pond-water serve as a reservoir for watering vegetables and animals and a duck swimming area; properly constructed pond dykes control erosion; fish ponds constructed on communal land preclude other users;[3] and extra fingerlings used to formulate animal feeds and ponds make use of unutilised and/or underutilised on-farm by-products, leading to efficient use of resources.

[1] http://www.on.ec.gc.ca/wildlife/factsheets/fs_wetlands-e.html

[2] Food security is hereby defined as the access of all people at all times to food they need for an active and healthy life. Access to food can be seen as from own farm production, but also as availability and access of food at the market at affordable prices to all households [7].

[3] According to the agricultural policy of Tanzania [9], all land in Tanzania is publicly owned and vested in the state. In practice however, most land held under both customary or communal system and most agricultural land is not properly surveyed or mapped. Land owned by a household is that land which is used in perpetuity by a household to the exclusion of others.

In fact, all these benefits must be considered when assessing the actual benefits and value of fish ponds. By putting value on non-marketed benefits before making decisions on resource allocation, we recognise all benefits from fish ponds and thereby put aquaculture development in its proper place.

METHODS

The data reported here was part of a larger survey, which identified economic factors critical to the 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. For the nature and complexity of this problem, a field survey design that focuses on individual farmers as the unit of analysis was used. This method is capable of describing the existing perception, attitudes, behaviour or values of individuals within a household [8].

In total, 410 respondents were selected out of whom 234 were fish adopters (those who adopted and continued with fish farming), 70 adopters-abandoned (those who abandoned fish farming after adopting it) and 106 non-adopters (those who did not adopt fish farming). Three hundred and seventy three respondents of the total sample size were from Morogoro Region, and the remaining 37 were from Dar es Salaam. A systematic random sampling approach was used to select the respondents from each village.

The instruments used for data collection were: a *questionnaire, Participatory Rural Appraisal (PRA) and secondary sources.* A structured questionnaire was prepared and given to aquaculture experts to check content and validity. After incorporating the experts' comments it was pre-tested, and 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 including direct and indirect value of fish ponds, sources of animal protein and income.

Data analysis was conducted with the Statistical Package for Social Sciences (SPSS) computer software. For each research question cross-tabulations, percentage, frequencies and means were produced to validate the research question. In the PRA meeting, a question was discussed and a point was accepted after consensus among members was reached. Disagreements among members also were reported.

Description of the survey data

Table 3 presents the demographic characteristics of 410 respondents sampled from Morogoro and Dar es Salaam Regions. Male respondents comprised 76.1% with more or less equal proportions in the two Regions. About 79% of the respondents were household heads, a fact which ensured that detailed household information sought was obtained easily. Ninety-two percent of all household heads were male and only 8% were female.

As expected, 99.3% of households did farming as one of their livelihood earning activities. However, 44% of the respondents indicated that farming was the only household main activity in the study area. About 49% of the respondents derived their livelihood from farming and business, 4.1% lived through farming and as employees, and other combinations [farming and business, student, and employee only] (2%). The percentage of full-time farmers is relatively lower than the national average of 63% [10]. This is likely due to a lack of permanent cash crops along the Uluguru Mountains. So as a result farmers work in other income-earning businesses to supplement incomes. The main type of business, particularly in Morogoro Region, is making local brew. Other businesses include: small shops, and selling timber, charcoal, bricks and crops.

Sixty-two percent of the respondents had their primary education, about 15.1% had less than Standard VII education, 14.4% had received no formal education and 8.3% attained secondary and post-secondary education. The percentage of those with no formal education (14.4%) is relatively lower than the national average (33.0%). This is probable because most parts of Morogoro highlands were centres for Missionaries who had emphasised formal education. While a majority of those who had attained Standard VII and below came from Morogoro, a majority of those who attained secondary and post-secondary education came from Dar es Salaam (Table 3).

About 58% of the respondents had acquired knowledge on fish farming. Of those who received no fish farming knowledge, 74% were non-adopters, followed by 44% of adopters-abandoned and 27% of adopters. The average age of the respondents was 43. About 55% of the respondents were 31-50 years old, followed by 24% of the respondents 51 and above years older and 21% of the respondents were less 30 years old.

RESULTS

Direct Benefits of Fish Ponds

a) Income generation

The advantages of fish ponds include income generation on a regular basis and at a period when there is shortage of other sources of income [11]. The real value of fish ponds is, therefore, better analysed on the basis of these two attributes.

The volume of Cash income earned from fish ponds

Like other cash crops, fish farming is adopted to generate cash income [11]. Table 3a shows that, in total, an estimated cash income of TZS 5,134,590 million was earned in the 2005/06 farming season from fish farming, with a mean cash income of TZS 12,523. In comparison with other farming activities, fish ponds contributed only 2% of the total cash income earned in the area. Table 3a further indicates that crop production and others (salary, consultancy, lumbering, carpentry, building, casual labour and pension) earned the most share (26%), followed by business (22%) and

animal husbandry (16%). However, Table 3b shows that TZS 125,038,620 in total was earned from the direct sale of fish and payments made from carrying out various activities of fish farming. In addition, a number of indirect benefits could not be valued (Table 3b).

Number of months in which income was earned

One of the postulated advantages of farmed fish as a cash crop over others is that it is a source of cash income for the majority of farmers, and income from it can be earned on a regular basis [11]. In reality, however, Table 4 shows that fish ponds ranked fourth, with only 32% of the farmers earning cash income from that activity. Most of the respondents (85%) earned their cash income from seasonal crops, followed by business (51%), permanent crops and animal husbandry (43%), others (16%) and remittances (9%). Moreover, fish farmers earned cash income from fish ponds for only two months of the year on average. Conversely, business, permanent crops and others earned income in more months (9) of the year than other activities. This was followed by remittances (5), seasonal crops (4) and animal husbandry (3).

Most of the respondents (31%) earned cash income for many months (9 - 12 months) from permanent crops (bananas in particular), followed by business (29%), livestock husbandry (7%), remittances (3%), seasonal crops (2%), fish farming (0.7%) and others (0.5%). On the other hand, activities which earned cash income in fewer months (1 - 4 months) were seasonal crops (60%); followed by livestock husbandry (34%), fish farming (30%), permanent crops (11%), business (6%), remittances (6%) and other (3%).

Seasonality in income generation

Another postulated advantage of farmed fish as a cash crop over others is the continuous flow of income (non-seasonal) as a result of planned production and harvest [11]. This advantage is rarely found in many other farm cash crops. The results from this study indicate that most respondents (93%) faced greater income-shortage in some months of the year than in others. Months of acute shortage include January (74%), February (72%) and March (59%); months of moderate shortage include November and December (42%), April (42%), May (33%) and June (31%), and months of low or no shortage were October (19%), July (15%), September (9%) and August (9%). Since a majority of farmers derived their income from agriculture, the availability of income exhibited a seasonal trend. Income shortage was prevalent during the farming season (November - June) while income was readily available during postharvest months. During the farming season, income was low because off-farm activities either were temporarily stopped or done infrequently to comply with the food-first strategy.

This result indicates that few farmers (below 20%) earned cash income from fish ponds on a monthly basis, and the earnings did not show any defined trend but increased slightly during big occasions like Christmas (December), Easter (April), and New Year (January) and traditional celebrations, which occurred post harvest. Of all income-earning activities, seasonal crops exhibited a stronger seasonal trend than

other sources. This is not a surprise, as rural agriculture depends on seasonal rains. Other income-earning activities, such as business and livestock sales also showed a slight seasonal trend. Permanent crops had a lesser fluctuation than other activities.

b) Farmed fish consumption

Another postulated advantage of fish ponds is that farmed fish can be consumed frequently and at a period when there is shortage of animal meat relish. The real value of fish ponds, in terms of relish supply, is better analysed on the basis of the two attributes.

Number of farmers who ate animal meat and months when it was eaten

Table 5 shows that fish farming ranked third in terms of the number of farmers (73%) who ate fish. D*agaa* or sardines were the main source of meat from animals in the study area. Chicken meat ranked second (96%) and was followed by pork (68%), beef (63%), eggs (57%) and goat/sheep (45%). Other sources of meat (rabbits, ducks and salt fish) were consumed by only a few villagers (6%).

Sardines or dried fish were the only source of meat consumed at least once in each month of the year. It was hard to see any farmer who was not eating sardines. This was followed by eggs and chicken (6 months), pork (5 months), beef (4 months), farmed fish (3 months) and others (1 month). On average, fish farming adopters consumed farmed fish in more months (4 months) than adopters-abandoned (1.4 months) and non-adopters (1.2 months). A majority (92%) of the respondents consumed sardines and/or dried fish 9-12 months, followed by eggs (51%), chicken meat (29%), pork (26%), beef (21%), farmed fish (11%), other (6%) and goat/sheep meat (5%). A majority (56%) of the respondents consumed farmed fish in fewer months than they did other sources of meat. This was followed by chicken meat (48%), beef (38%), goat/sheep meat (37%), pork (33%), eggs 3%), sardines and/or dried fish (1%) and others (0.2%).

Seasonality of animal meat consumption

Most of the respondents (83%) indicated that they faced greater meat shortages in some months of the year than in others. Months of acute shortage include March (70%), January (66%) and February (62%); months of moderate shortage include May and June (35%), December (34%), November (27%) and April (27%), and months of low or no shortage are October (22%), July (16%), September (13%) and August (7%). The consumption of meat at the household level was determined by the availability of relish and income patterns which was, in turn, dependent on the farming season. During the farming season (November - June) a majority of farmers have limited income to buy animal meat.

c) Employment generation

Besides cash income earned from fish farming, about TZS 119,904,043 was spent to hire labour, particularly for pond construction (Table 3b). This amount was, in turn, the earning of the pond constructors. The amount spent on pond construction was

unnecessarily high, particularly in Dar es Salaam Region, where construction of many ponds was financed by donor agencies.

Indirect (non-marketed) benefits accruing from fish ponds

Besides direct benefits or marketed value, this study shows that 58% (136) of the adopters acknowledged benefiting indirectly from fish ponds in the following ways (Table 3b).

***i*) Moist pond-soil and pond-water supported waterlogged crops**

Table 6 shows that 48% (113) of the respondents planted waterlogged crops within or near their ponds. There are two ways pond-water supports waterlogged crops: one is by planting crops like yams on the inside of the pond dyke and the other is by planting crops like yams, bananas and sugarcane on the outside of the dyke. In the first instance, the crops benefited directly from the pond-water; in the second, the crops benefited from pond moisture on the outside of the dyke.

ii) Pond-water used for watering crops and animals

Table 6 indicates that 32% (75) of the respondents used pond-water for watering crops and animals. Pond-water not only served farmed fish but also irrigated homestead fruits and vegetables and watered animals.

iii) Nutrient-rich bottom-mud used for fertilising the farm

Table 6 also shows that 20% (47) of the respondents used bottom pond-mud to fertilise their garden. When manure is applied in the pond, the nutrients like phosphorous, nitrogen and potassium dissolve in water and thereafter are absorbed by phytoplankton and the water weeds (macrophytes).[4] The nutrients, which are not absorbed by the plants, are rapidly absorbed by the mud on the pond-bottom. This means the pond-bottom is rich in nutrients which can be used to support the growth of agricultural crops.

d) Other indirect benefits

Table 6 shows that pond-water serves as swimming area for ducks, farmed fish provides oil which was used as medicine, properly constructed pond dykes on mountain slopes control soil erosion and extra fingerlings are used to formulate fish feeds. Similarly, participants in PRA meetings reported that integrating fish into farming systems improved resource utilisation. Resources normally underutilised like water, farm by-products, land and labour were used more efficiently when fish farming is included [11]. Normally unused resources found their way into fish farming. The different components interacted in a symbiotic and synergetic manner, enhancing overall production, optimising resource use and thus providing for the subsistence needs of the household [1]. In addition, fish ponds constructed on communal land precluded other users.

[4] ALCOM pond management training manual

Participants in PRA meetings agreed that fish farmers in some villages preserved water sources by planting trees and prohibiting farming activities near water sources to ensure sustainable supply of water for fish farming.

Non-use (intrinsic) benefits of fish ponds

Participants in PRA meetings also said that some farmers adopted fish farming because of the status and prestige they gained from it. This is consistent with findings by Wetengere *et al*. [12], who found that some farmers practiced fish farming expecting recognition from government officials or project officials, particularly the "*whites officials.*" [5]

DISCUSSION

Results indicate that direct monetary earnings from fish sales, number of months in which income was earned and non-seasonality of income generation from fish farming are fairly low. This is perhaps why fish farming is accorded a low priority in resource allocation at both household and national levels. PRA meetings conducted by this study revealed that income generated from fish farming depended on, (among other factors), production technology, harvest strategies and nature of the product. Concerning production technology, farmed output was low due to the small sizes of ponds, the high risk of losing fish in various ways, poor markets and poor management [11]. Regarding harvesting strategies, a lack of well defined harvesting strategies due to lack of nets, presence of weir[6], projects advocating harvest by total drainage of the pond (which was not accepted by most farmers) and a condition imposed by extension workers (that they have to be present during harvest to collect output data) made frequent harvest difficult [11]. By the nature of the product (that is farmed fish is just a relish) it is not comparable to other cash and food crops in terms of its contribution to food and income. Similarly, farmed fish is perishable and not easily transportable to profitable markets, and most people in the study area were not used to eating fresh fish [11].

There are private aquaculture consultants who earn income for their services (Table 3b). This amount often is not included in valuation, leading to under-estimation of fish pond value. Participants in PRA meetings reported that some labourers were hired to perform various fish farming activities and were paid in kind. For instance, some

[5] The ALCOM project team described this as "*mzungu (white mans') effects*" meaning that farmers adopted or performed some activities of fish farming extremely well in order to be visited or praised by "*mzungu"*

[6] This is a structure made of short sticks or small poles constructed in the pond to divide the pond into 2 to 4 halves. One row of sticks constructed along the pond length divides the pond into half and another row of sticks constructed along the pond width divides the pond into another half. This forms a cross like structure. The spacing of the sticks allows fish to swim through one halve to another but the spacing is too small for an otter to pass. If an otter enters one half of the pond fish will swim through the stick space into another half. In this way it prevents otters from eating fish.

farmers were hired to harvest fish or to do pond repair and received a few fish in return. Such payment was difficult to value but certainly had some economic value.

Results also show that relishes, which were produced locally and/or obtained cheaply were frequently eaten by a majority of the farmers. For instance, farmed fish was produced locally and therefore was easier to eat than to slaughter a goat, a pig or a cow [11]. Farmed fish was consumed by most farmers probably because fish farmers were ready to give a few fish to their neighbours and relatives every time they had a harvest. Sardines, on the other hand, were consumed by a majority of farmers because they were one of the cheapest and most readily available sources, particularly in remote areas like the study area.

Because it can be produced and harvested any time of the year, farmed fish could fill the meat shortage gap. However, results revealed that, only eggs, sardines or dried fish and others (salt fish) were easily available in the study area, all other relishes exhibited a seasonal consumption trend. Most of the study villages are located in remote areas connected to small towns by poor roads impassable at most times of the year. Their inaccessibility to small towns means that the farmers have to depend on their own animals for meat. This study found that few animals were kept in the villages [11]. It is not surprising, therefore, that meat consumption in the area was low. Some respondents indicated that they consumed relish like beef, goat and farmed fish only on special occasions.

The consumption of farmed fish is surprisingly low and follows a seasonal trend similar to that of other relishes. A similar trend was also shown by fish adopters when separated from the rest of the sample. Consumption of farmed fish during the farming season was low because some farmers moved away from home for longer periods to attend distant farms. Other reasons include: that fish may have not bred or may have just bred, lack of fishing nets, unwillingness to harvest by total drainage and water shortage as net harvest also required to reduce the water. Fish consumption was high between June and October because the farmers were in the village, and there was enough water to allow frequent harvests. Similarly, it should be noted that due to poor management of fish ponds, animal predation, poor harvesting strategy and small size of ponds, there were inadequate fish to be consumed regularly all year round.

The results further indicate that fish ponds have varieties of indirect benefits, which often are not recorded. First, production of waterlogged crops increased and happened all year round as a result of directly benefiting from fertilised pond-water and/or moisture. For instance, while crops like yams were planted on the inner side of the pond dike, thus, benefiting directly from pond water, crops like bananas and sugarcane were planted on outside of the pond dike, thus, benefiting from pond water moisture. Although these benefits existed but were difficult to evaluate, they need to be known and incorporated during valuation. Second, as a source of irrigation, pond-water is richer in nutrients than well or river water and also contains nitrogen-fixing blue green algae, which improves soil fertility [1]. The result is increased production. Pond-water for watering crops like vegetables and animals was important, particularly

in areas where water was rationed due to shortage or where water was in short supply during the day. In such a situation, farmers filled their ponds during the night when water was in low demand and watered crops and/or animals using pond-water during the day when water was in high demand. Third, after fish have been harvested, nutrient-rich pond-mud was used as a farm fertiliser or the pond was used to grow other crops (ibid.). The PRA meetings conducted in the study area revealed, for instance, that banana trees fertilised with bottom pond-mud thrived and increased banana production. Although the increased banana production is a result of pond-mud use, it was not incorporated during fish pond valuation. Finally, the availability of water not only benefited fish farming, it also benefited a variety of activities such as the irrigation of crops, domestic water use and watering animals, all of whose value was not incorporated when evaluating fish farming. Similarly, participants at the PRA meetings indicated that farmers gained considerable knowledge and skills from fish farming study tours in other villages. For instance, during these visits farmers leant: how to make terraces to control soil erosion, water management, integration of fish farming with other on-farm activities and training on the management of fish ponds, which was also applicable to the management of other farm activities. In reality, all these benefits need to be known and taken into account when considering the valuation of fish ponds.

Finally, the results show that some fish farmers in some of the villages became popular and attained some political posts (Ward Councillor) because of their participation in fish farming. Similarly, some farmers constructed fish ponds for recreational purposes. The researcher's personal observation revealed that some farmers constructed small huts and fixed chairs near their ponds where they sat particularly during the afternoon and observe the fish swimming. In practice, although these non-use benefits were difficult to discern and value, they were satisfying and need to be included in the process of evaluating the actual value of fish ponds.

CONCLUSION

The important conclusion drawn from this study is that fish ponds have numerous benefits ranging from use benefits (direct and indirect benefits) and non-use benefits (intrinsic benefits). Often, however, the valuation of fish ponds focuses only on direct value of farmed fish that is marketed, which is too small to have a significant impact economically. Other indirect and non-use benefits are not included; as a result, fish farming is accorded a low priority.

Furthermore, from the results, also concluded that the valuation of fish ponds should not only focus on the volume of income earned from fish farming but should also include fish consumed domestically, the frequency of income flow and/or farmed fish consumption, and the time of the year income was earned and/or farmed fish was consumed. The frequency and timing of farmed fish are important for household food and income security and adds to the value of fish ponds.

RECOMMENDATION

One important policy implication is that, if planners, decision-makers and farmers would recognise the actual benefits of fish ponds, they would accord them the right priority. This would mean increased allocation of resources for the activity, which would in turn increase its contribution to household food and income security. The present *laissez faire* attitude on management of fish farming can be changed if planners, decision-makers and farmers' thinking would be re-oriented to integrate the actual benefits of fish ponds in valuation. This implies that attempts should be made to find out how various benefits of fish ponds - particularly the non-marketable benefits - can be incorporated into the actual valuation of fish farming.

This study also discovered that the direct value of fish ponds is dependent on production technology and harvest strategies. This implies that efforts should be directed towards improving (a) fish production through reducing risk of losing fish, shortening culture cycle to target market-size fish, use of low cost inputs and integrating fish farming in the existing farming system, (b) the market of farmed fish through improving roads, providing information on fish prices and the nutrition value of fish, and formation of marketing groups to lower transport and transaction costs, and (c) identifying "farmer- friendly" harvesting strategies as a way of increasing the value of fish ponds.

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Suggestion for future research

Efforts should be made to assign value on non-marketed benefits of fish pond that were identified by this study in order to accord fish ponds the importance it deserves.

Table 1: The Actual Benefits of Fish Ponds

USE BENEFITS		NON-USE BENEFITS
DIRECT BENEFITS	**INDIRECT BENEFITS**	**INTRINSIC BENEFITS**
-Farmed fish output, that is fish consumed domestically or marketed for cash -Cash earning from Pond employment	-Medicinal fish oil -Water reservoir for watering animals and vegetables -Bottom mud used as farm fertilizers -Pond dike control soil erosion -Moist soil supports waterlogged crops -Extra fingerlings produce animal feeds -Pond utilizing on-farm products -Preserve water sources to ensure constant supply of pond water	-Preclude other users on communal land -Gain status and prestige -Aesthetic purposes

Sources: Modified from Karanja [5]

Table 2: Demographic Characteristics of the Sampled Population

Respondents characteristics		*Sampled regions*		*Total sample n= 410 (%)*
		Morogoro n= 373 (%)	*Dar es Salaam n= 37 (%)*	
Gender/sex	Male	76.1	75.7	76.1
	Female	23.9	24.3	23.9
Household head	Yes	78.8	81.1	79.0
	No	21.2	18.9	21.0
Main occupation	Full time farmer	47.7	18.9	44.1
	Farmer and business	49.9	37.8	48.8
	Farmer and employee	1.6	29.7	4.1
	Others	.8	13.5	2.0
Education level	No formal education	14.7	10.8	14.4
	Less than Standard 7	16.1	5.4	15.1
	Standard 7	64.3	37.8	62.0
	Secondary and post secondary	4.8	43.2	8.3
	Others	0	2.7	.2
If obtained fish farming knowledge	Yes	57.1	64.9	57.8
	No	42.9	35.1	42.2
Age	Average years	42.2	46.7	42.6
	≤ 30 years	22.0	5.4	20.5
	31 – 50 years	55.0	56.8	55.1
	51 ≤ years	23.1	37.8	24.4

Table 3a: Different Sources and the Volume of Income Earned from the Sampled Population in the Study Area

Sources of income	Total income earned (in TZS)	Percentage	Mean Income
Farm activities	**99,134,590**	**44**	**241792**
• Crop production	58,000,000	26	141,463
• Animal husbandry	36,000,000	16	87,805
• Fish farming	5,134,590	2	12,523
Off-farm activities	**127,949,000**	**56**	**312,071**
• Business	49,000,000	22	119,512
• Remittances	1,949,000	0.9	4,754
• Borrowing	19,000,000	8	46,341
• Others	58,000,000	26	141,463
Total	**227,083,590**	**100**	**553,862**

1 US$ = 1500 TZS

Table 3b: Actual income of Sampled Population from Fish Ponds in the Study Area

Actual Income from fish Ponds		Income (in TZS)
Direct Income	• Fish sale • Cash earned from Pond employment	5,134,590 119,904,034
Indirect Income	• Money saved on fish food • Increased farm output as a result of using pond-water and mud • Reserve water for various uses • Increased farm output as result of integration of household activities	These benefits are not easily quantifiable
Total Income		**125,038,624**

1 US$ = 1500 TZS

Table 4: Sources of income, Mean and Total Number of Months income was Earned

Sources of income	Percentage of respondents who earned income from the activity (n= 410)	Mean months income Was earned (in months)		Total number of months income was earned (in %)		
		n = 410	Only for farmers who earned cash from a source of cash income	1- 4	5- 8	9-12
Seasonal crops	85 (n= 348)	3	4	60	22	2
Permanent crops	43 (n=176)	4	9	11	2	31
Animal husbandry	43 (n= 175)	1	3	34	2	7
Business	51 (n= 210)	5	9	6	16	29
Fish farming	32 (n= 131)	0.6	2	30	1	0.7
Remittances	9 (n= 39)	0.4	5	6	0.2	3
Others	16 (n= 65)	2	9	10	5.5	0.5

Table 5: Sources of Animal Meat, Average and Total Number of Months Animal Meat was Consumed

Sources of animal meat	Percentage of respondents who consumed the source (n = 410)	Average months animal meat was consumed (in months)		Total number of months animal meat was consumed (in %)		
		n = 410	Only for farmers who ate a source of animal meat	1- 4	5- 8	9-12
Beef meat	63 (n= 257)	4	6	38	4	21
Pig meat	68 (n= 279)	5	7	33	9	26
Goat/sheep meat	46 (n=187)	2	4	37	4	5
Chicken meat	96 (n= 395)	6	6	48	20	28
Eggs	57 (n= 233)	6	11	3	3	51
Farmed fish	73 (n= 301)	3	4	55	7	11
Dagaa or dried fish	99 (n=406)	12	12	2	5	92
Others	6 (n= 26)	1	12	0.2	-	6

Table 6: Indirect (non-marketed) Benefits of Fish Ponds

Indirect benefits of fish ponds	No. of farmers (n = 234)	% of farmers
Pond-water supported logged crops	113	48
Pond-water used for watering crops & animals	75	32
Pond mud was used for gardening	47	20
Others	33	14

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