Chapter 16

MANAGING HOMESTEAD AQUACULTURE FOR FOOD SUFFICIENCY AND POVERTY ALLEVIATION

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Abstract:
This chapter discusses the management practices that are crucial in ensuring food sufficiency and poverty alleviation through homestead aquaculture. Fish is a very good source of high quality animal protein. Availability through production and accessibility to food fish which are crucial in ensuring household food sufficiency can be achieved through homestead aquaculture. Homestead fish farmer like any other fish farmer needs to get good quality aqua seeds; rearing facility should be made clean, free of predators and any unwanted and competitive fish species; fish seeds should be transported when the weather is cool; ensure the fish is supplied with the nutrients required for its optimum growth and survival in a controlled and secured environment. With good management practices that are economically viable, environmentally friendly and technically appropriate, homestead aquaculture has great potential to improve household income. Aquaculture for poverty alleviation and food security is a means to secure nutritional gains and income directly for the smaller holder farmers and a means to increase domestic fish supply to low-income consumers, develop opportunities for employment, as well as to generate revenue. About 25-40% of the total fish produced in homestead ponds are sold into market to generate income for the households while the remaining is consumed. Homestead aquaculture is profitable if managed properly, especially when unconventional feeds are used to supplement the expensive commercial feeds.

Keywords: Fish, homestead aquaculture, income, food security, management practices

Introduction

Fish is a very good source of high quality animal protein. FAO-WHO (2011) reported that fish consumption is beneficial for individual growth and development and that consumption of certain amount of fish (fatty fishes in particular) is associated with reduced risk of coronary heart disease and stroke. It has been reported that individual s fed intervention diets containing significantly more soft-boned fishes had lower incidences of anaemia and common infections than those not fed (Gibson et al., 2003). Recognizing that eating fish is beneficial is not enough to solve the problem of under-nutrition; ensuring availability of fish and other food, accessibility to them, utilization and stability of these food products are very crucial for food security. Accessibility to food fish is crucial in ensuring household food sufficiency. Access to food is determined by power relations, poverty, lack of assets and prices that are increasingly governed by globalized markets (Beveridge et al., 2013). All these can only be achieved when fish and

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other food are readily produced within the immediate environment and people have access to it at all times. The widespread availability of household ponds suitable for small-scale production of fish in many parts of Bangladesh have been reported to enable many households to have easy access to various fish species (Fiedler et al., 2016).

Aquaculture

Aquaculture is the growing of animals and plants in water. Examples of animals and plants that are grown in water include fin fish (e.g. Tilapia, catfish, and carp), Shell fish (e.g. oysters, mussels, abalone, clam and scallop), Crustaceans (shrimps, prawn, lobsters and crabs); Amphibians (frog), and Aquatic plants (water lettuce, water spinach, arrow head, duckweed, etc.). This chapter shall mainly discuss production of fin fish.

Aquaculture can improve household food security and food sufficiency directly providing fish and other food aquatic organisms, which make the farmer have access to them for consumption as well as for sale and indirectly by increasing the purchasing power of the household from sale of aqua products. The purchasing power increases when an individual or household engages in aquaculture and other related activities such as processing and marketing. Hence, sufficiently spend greater proportion of their income on food and have access to other food items.

World capture fisheries reached approximately 93.7 million tonnes in 2011 (FAO, 2014). Table 1 shows reduction in total world fish production from capture fisheries while human population and the demand for aquatic resources continue to increase. Optimizing and increasing production will bridge the gap between demand and supply for aquatic resources. This is achievable through aquaculture as demonstrated by continual growth in the world aquaculture production (Table 1). The continuing expansion of global fish supplies in the past three decades has been attributed primarily to the sustained, rapid growth in aquaculture (Beveridge et al., 2013).

Aquaculture provides livelihoods and feeds the ever increasing global population if practiced efficiently. There is need for more efficient use of the material and human resources as well as production practices so as to reduce production cost, produce safe products for consumers and make more profit. Sustainability of aquaculture will be enhanced if the management practices cater for the environment, profitability as well as its contribution to the well-being of the members of the community in terms of nutrition, food security and health. Aquaculture for poverty alleviation and food security is a means to increase fish supply for low-income consumers, develop opportunities for employment, generate income, improve nutrition and combat health problems (WorldFish Center, 2011; Kawarazuka, 2010).

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Table 1: World Fisheries and Aquaculture Food Fish Production (Million tonnes)

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Capture Fisheries	90.5	94.6	94.6	92.0	90.8	90.2	90.1	89.1	93.7	91.3
(% of total production)	(67.9)	(69.3)	(68.1)	(66.0)	(64.5)	(63.0)	(61.8)	(60.2)	(60.2)	(57.8)
Aquaculture	42.7	41.9	44.3	47.3	49.9	52.9	55.7	59.0	62.0	66.6
(% of total production)	(32.1)	(30.7)	(31.9)	(34.0)	(35.5)	(37.0)	(38.2)	(39.8)	(39.8)	(42.2)
Total	133.2	136.5	138.9	139.3	140.7	143.1	145.8	148.1	155.7	157.9

Adapted from FAO (2009, 2010, 2012, 2014)

Homestead aquaculture

Homestead aquaculture involves the production of these organisms in the immediate area surrounding the household (Figure 1a-f). The produce may be for both household consumption and sale. Some households in Nigeria and some African countries have small pits or pond(s) and other facilities for raising fish located next to their homestead or dwelling areas. Examples of aquaculture fish species commonly reared in African country, and in Nigeria in particular, are African catfish, *Clarias gariepinus* and *Heterobranchus longifilis* and tilapia species. The number of small household ponds across Bangladesh was estimated to be about 3.9 million, dominated with carp production (Fiedler *et al.*, 2016). Homestead ponds are typically small in size, ranging from 0.04-0.2ha. In Bangladesh, homestead ponds are a small portion of the households farming systems used for multiple purposes such as washing, bathing, irrigation, watering livestock, flood control and fish culture (Belton et al., 2011).

Poverty exists among individuals and rural communities (Adeniyi et al., 2014) especially in developing countries. Homestead aquaculture is also small scale in nature. The purpose of homestead aquaculture may be to generate income or produce fish for household consumption or both (Belton et al., 2011). It can play important roles in the livelihood of the poor: as a livelihood option undertaken by the poor people; source of employment for the poor and source of high quality food for consumption and purchase by poor people (Philip, 2010). Homestead aquaculture has great potential to improve income and alleviate poverty (Marttin and de Graaf, 2001). It builds the capacity of poor householders to generate income with the resources they have such as a pit and water for fish culture. The income generated could in turn be deployed in acquiring essential resources to generate more income. Poor members of the community might find it difficult to get capital to start aquaculture. However, integrating crop production with aquaculture can provide regular sources of income. The waste water from the aquaculture sites could be used to irrigate vegetable lands; this is more profitable in dry season.

Sustainable aquaculture entails continuous production of safe aquatic organisms to meet the demand by the growing population in a controlled environment using good management

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practices. Such production should be economically viable, environmentally friendly, technically appropriate and socially acceptable by the society (Wurts, 2007).

The following factors are to be considered for sustainable homestead aquaculture:

i. Availability of water in terms of quality and quantity
ii. Availability of land space for a small pit or other culture facilities
iii. Take-off capital, at least to buy catfish fingerlings
iv. Availability of good quality fish seeds, preferably catfish
v. Availability of good quality feed or waste food around the home, ants, snails, bivalves and even waste from the abattoir, for fish
vi. Biosecurity of the culture site

Fish rearing facilities

Open dug-out pit

A pit of about 1 m^2 could be dug in the ground (Fig. 1a) by the householder to accommodate about 50 fingerlings. Water is filled from stream, rain water harvesting or near-by bore hole and renewed often twice weekly, if fouled.

Concrete pond

The wall of concrete pond is made with blocks and the holes of the blocks (preferably 9 inches) are filled with concrete (made from thoroughly mixed gravel, sand and cement) in such a way that will prevent cracking and ensure it can hold water (Fig. 1b). A fish culturist using this type of facilities must have access to enough water that will permit renewing the water fortnightly for optimal production. The pond must always contain water even when not stocked with fish to avoid cracking.

Earthen pond

An earthen pond can only be constructed around homes (Fig, 1c) only if the place is waterlogged or has underground water. Burrow pits abandoned by road construction firms around residential areas could be improved upon and converted to this purpose. Before stocking the pond with fish, liming of the pond water, followed by addition of fertilizer could be done to enhance high production of natural food for the fish. The wall should be well built and effort should be made to ensure it is not situated on the erosion pathway to avoid flooding. The water in the earthen pond may or may not be renewed. However, if the water source is perennial and the flow rate is high, the water may be renewed for better production.

Plastic tanks

There are various sizes of plastic tanks in the market which could be used to rear fish. Figure 1d shows a typical 2, 500 litres capacity plastic tank fitted with inlet and outlet. This type of facility is more expensive to buy than concrete and earthen, but it is more durable and could be made mobile. Also more water is required when opting for this facility.

(c), plastic tank (d), a set of laminated wooden tanks (e), and collapsible tank (f)

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Figure 1: Contemporary fish culture enclosures used around homes – open dug-out pit (a), concrete pond (b), earthen pond (c), plastic tank (d), a set of laminated wooden tanks (e), and collapsible tank (f)

Wooden tanks

Fish can also be raised in wooden tanks (Fig. 1e). This is a box-like structure fitted with plumbing work for inlet and outlet and constructed using hard wood with the inner surface lined with high quality tarpaulin or laminated with resins. It is also important to renew the water. Wooden tanks are commonly used for grow-out, as wooden troughs for hatchery operations and for indoor nursing of fry before outdoor grow-out. With good quality wood and proper care, these tanks are durable and cheap.

Collapsible tanks

Fish could also be reared in collapsible tanks (Fig. 1f). These types of tanks are in the market in various sizes. Their main advantage over plastic tank is that it could be folded when not in use. Water renewal is also important when a farmer opts for this facility.

Management Practices

Pre-stocking activities

Aquaculture homestead farmer like any other fish farmer should look for reputable hatchery to get good quality aqua seeds, fingerlings/juveniles, for production. The species of choice should possess the following qualities:

i. Fast growth rate
ii. Ability to convert artificial feed to flesh
iii. Healthy and disease-free fish seed
iv. High disease resistant attribute
v. Ability to withstand adverse conditions
vi. Fish seeds of close range of weight to avoid cannibalism in case of African catfish
vii. Availability of the fish seeds
viii. Market value and demand of the fish
ix. Consumer acceptability

If good quality fish seeds are used better disease resistance, high survival rate, high production and high profit will be obtained.

Preparation for stocking

Before the arrival of the fish seeds, the following preparations should be made:

i. Rearing facility should be made clean, free of predators and any unwanted and competitive fish species and stocked with water preferably a day to stocking. Old ponds should be repaired to prevent leakage and any holes, which may serve as hidden places for predators in the wall and environment of the pond should be blocked.
ii. If it is a new earthen pond, the farmer might want to apply lime or fertilizer. Application of lime (agricultural lime, $CaCO_3$ at 2000kg ha^{-1}, or slaked lime, $Ca(OH)_2$ at 1400kg ha^{-1} or quick lime, CaO at 1100kg ha^{-1}) is necessary to lessen acidity and to disinfect the pond water and bottom as well as increase the effectiveness of fertilizer application. Fertilizers enhance production of natural food such as phytoplankton, small insects, small crustaceans, worms which have nutritive value for the fish.
iii. Cover the facility with net to avoid entrance of predators into the facility

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iv. Ask for or weigh to know the average weight of the fish seed. This will guide the farmer on feeding and assessment of growth rate of the fish
v. Get fish feed ready

Transportation of fish seed

Fish seeds should be transported when the weather is cool at low temperature: this could be done early morning or late in the evening. The fingerlings could be transported in plastic jerry cans with both sides of the head cut open leaving the handle only. Aerated oxygen bags could also be used for transport if the hatchery has oxygen cylinder. This system of transport allows for better survival of fingerlings and for long distance transportation. If oxygen bags are used, the bags should be punched at the stocking site to allow escape of oxygen before releasing the fish fingerlings.

Stocking of fish seeds

Stocking is a delicate process in which the fingerlings are introduced into their rearing containers or ponds. It is achieved by first stabilizing the water temperature of the tank in which the fish is transported with that of the rearing pond so as not to stress them. Some water in the rearing facility, where the fish is to be stocked is scooped and introduced into that containing the fish seed with the water from the hatchery, and left alone for about fifteen minutes before releasing the fish into the rearing facility by place the fish transport container or bag on the surface of the rearing facility to allow the fish swim freely on their own into the water in the rearing tanks. The transport containers should be free of contaminants. Figure 2a and c show the sizes of fingerlings to be stocked. On no account should homestead fish enthusiast accept fingerlings less than this size, rather bigger sizes may be stocked to reduce challenge of management. As seen in the figure fingerlings should be of the same size; stocking different sizes will encourage cannibalism and loss of fish, hence loss of food and money.

Post-stocking management

Feeding

The essence of feeding the fish is to. Most household aquaculture are usually either intensive, where the fish are fed only with artificial feeds or semi-intensive, where the fish are given artificial feeds but also feed on the available natural foods in the water body. There are several commercial feeds that are available in the market e.g. Aquafeed, Coppens, Durante, Rannan, Multifeed, Vitalfeed, and Topfeed, among others. The cost of feeding fish is reported to be between 60-70% of the cost of production. Hence, it is important to select good feeds considering their:

a. Availability in the immediate environment
b. Nutritional benefits
c. Cost

To make optimal profit, the farmer should not feed the fish mainly with the imported commercial floating feeds. Feed millers formulate cheaper sinking pellets, which may be used during the last two months of production. Homestead fish farmers could also utilize waste food, worms,

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tadpoles, ants, termites, rice bran, and waste from slaughter houses, etc. found around the home. Fish should be fed to satiation daily (till they show no interest to eat anymore).

Water quality management

Water quality is the most important limiting factor in pond aquaculture. Water is not just where fish live; its quality directly affects feed efficiency, growth rates, health and survival of the aquatic organisms in it. Water quality refers to anything in the water which may be:

.i. ***Physical,*** such as dissolved oxygen, temperature, pH, turbidity: Dissolved oxygen should not be lower than 4mg L-1, the pH range within 6.5 – 8.5, while the water may be greenish but not too turbid with high organic load. When many fish are gasping at the water surface, it's a sign they are deficient of oxygen, therefore the water should be renewed to save the fish. When the water is acidic with lower pH, lime could be applied.

ii. ***Chemical*** such as hardness, alkalinity, ammonia, nitrite, nitrate, chlorine. Water hardness should be moderate. This can be easily noticed when concrete or plastic tanks are used, after evaporation of water whitish particles are seen at the previous water level: this consists of salt which is not harmful. If well water or bore hole water is used, a farmer should be able to drink from such water. Ammonia and nitrite are harmful to fish and they are products of decomposition of uneaten feeds and faecal materials, effort should be made to renew the water when culture facilities different from earthen ponds are used. Water is naturally renewed in earthen ponds by soil. Whenever the water is smelling foul or putrid, it should be changed.

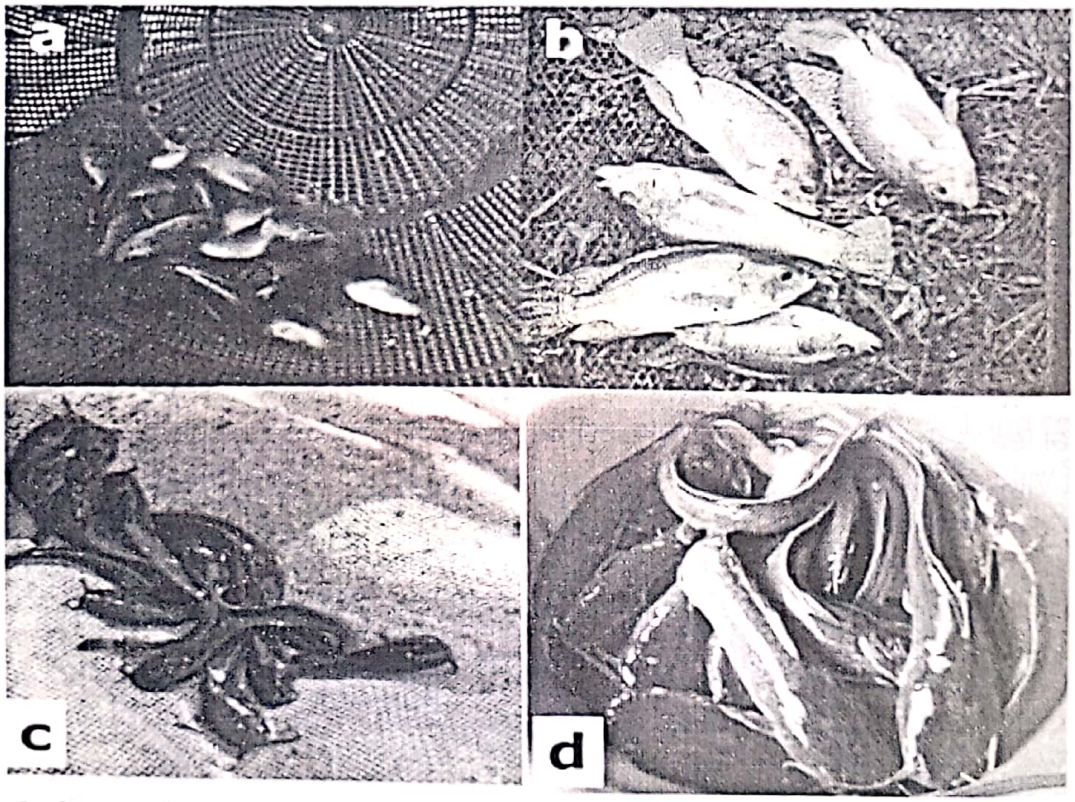


Fig. 2: Sizes of Tilapia seeds at stocking (a) and size at harvest six months later (b) Sizes of catfish seeds at stocking (c) and size at harvest four months later (d)

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iiii. ***Biological*** such as phytoplanktons, predators, insects, aquatic weeds, beneficial and pathogenic microorganisms. Phytoplanktons are the microscopic plants which make pond water green. They are good but algal bloom should be avoided. Beneficial microorganisms help in natural water treatment, but pathogenic organisms are harmful and effort should be made to ensure clean culture environment and biosecurity. Ponds may be covered with net to prevent entrance of predators while weeds should be removed.

To ensure water of good quality for aquaculture:

i. The water must come from hygienic and unpolluted source, well aerated, with neutral to low alkaline medium.
ii. Prevent the pond from entrance of eroded water,
iii. Avoid excessive use of fertilizer, overstocking and overfeeding.
iv. Ensure you have reservoirs or tanks to store water in case of emergency. You will need to change the water when many of the growing aquatic organisms are gasping for air, or when there is mass mortality.

Sorting

Sorting is the process of separating fish or any aquatic organisms during their growing stage according to their sizes into different rearing facilities. This is very important when rearing predatory fishes in which cannibalism is common, example of such is African catfish. It is preferable to sort from the hatchery into fingerlings or juveniles of close size. Sorting should be a continuous process especially during water exchanges. Shooters or fingerlings with faster growth should be separated and removed entirely from the homestead pond and introduced elsewhere.

Harvesting and marketing

It is important for the homestead farmer to have good marketing strategy. The farmer should create enough awareness in the neighbourhood and to good wholesalers on his/her production ahead of harvesting and marketing time. Harvesting of fish in homestead aquaculture could be total or partial. Sorted bigger fish could be harvested and sold earlier. This should be planned from the beginning of production is such a way that the products will always be available to consumers.

Aquaculture-vegetable production

Integrating production of aquatic organisms with vegetable enhances food sufficiency and poverty alleviation. Vegetables with high nutritional contents and of economic important such as fluted pumpkin, Amarantus, jute mallow, water leaf and okro could be planted on the land surrounding the ponds. The land could be enriched with livestock manure if readily available. Waste water from the pond should be used to irrigate the land at regular intervals. The vegetable portion should be divided and seeds planted at intervals that will ensure year-round availability for consumers and retailers. It is possible for the farmer to generate the expenses on production of fish from the vegetables. Figure 1d shows integration of fish culture with flutted pumpkin and other vegetables around the tank.

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Benefits of integrating fish production with crops/vegetables

i. Proper use of resources: growing of fish and other aquatic organisms with vegetables around home can yield multiple products in small area of land at very low cost
ii. Reduction in expenditure: A minimum expenses is required for integrated aquaculture due to synergistic relationship resulting to mutual benefits from each product. This enhances higher profitability and poverty alleviation.
iii. Additional nutritious food production: Diversification in the integrated culture results to optimal production of more nutritious food if well managed. This ensures food sufficiency.
iv. Maintaining balance in the ecosystem: Wastes from livestock and aquatic organisms, which are source of pollution in the environment, are used to produce food.
v. Generation of all-year round income: It takes some months before revenue is generated from aquaculture, however through integration with vegetables that requires lower inputs and reap faster income, the farmer is able to generate income regularly throughout the year. This also lessens the risk in management cost by poor households.

Record keeping

Most farmers do not have good records of day to day activities, expenses, products and revenue generated from their farming activities. To manage homestead aquaculture for food sufficiency and poverty alleviation, it is very essential to keep adequate records so as to be able assess the profitability and efficiency of the management practices at the end of each phase of production.

Extension and training

Capacity building of homestead fish farmers is a key to achieving food sufficiency and poverty alleviation through aquaculture. Intending farmers should receive instruction and follow-up visitations from the government or private consultants. Extension agents should supply or give direction on where to pick healthy fish seeds and follow-up on feeding and other management practices.

Contribution of homestead aquaculture to household income and fish consumption

Aquaculture for poverty alleviation and food security is a means to secure nutritional gains and income directly for the smaller holder farmers and a means to increase domestic fish supply to low-income consumers, develop opportunities for employment, supply local economic multipliers as well as to generate revenue from the venture (WorldFish Center, 2011). Tables 2, 3 and 4 exemplify the profitability and cost-benefit analysis of homestead fish farming, highlighting the quantity of fish produced (food sufficiency) and profit derivable (poverty alleviation). It has been recognized that aquaculture generally contributes to poverty alleviation directly and indirectly by providing food, income and employment for both the fish farmers and other value chain actor households (Bene et al., 2016). Belton et al. (2011) analyzed the contribution of homestead fish production to income and fish consumption of households who practiced homestead fish production in Bangladesh (Table 2); indicating that household income and consumption increases with increase in size of homestead ponds. This corroborated by the reports of Jahan et al. (2015) that 25-40% of the total fish produced in homestead pond are sold into market to generate income for the households indicating that 60 – 75% is consumed by such households.

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Table 2: Contribution of homestead aquaculture to household income and fish consumption

Pond size (Ha)	Household income (%)	Household fish consumption (%)
0.04	10	29
0.08	13.2	NA
0.09	3	37
0.1	10	26
0.1- 0.2	15.5	47

Adapted from Belton *et al.* (2011) NA-Not Available

Table 3: Homestead fish producers and percentage of fish utilization

Total	Homestead fish producers	Fish production
	3,719,991 (kg yr^{-1})	346,583,572 (kg yr^{-1})
Eaten fish only (%)	76.1	35.75
Sold fish only (%)	0.1	0.11
Eaten and sold fish (%)	23.8	64.14

Modified from Fiedler *et al.* (2016)

Table 4: Cost-benefit analysis of homestead aquaculture in Nigeria

Pond type	Fish species	Feed type	Cost of production (₦)	Net profit (₦)	Source
Concrete/ earthen	Catfish	Kitchen waste + pelleted feeds	18, 213.64	44, 887.27 yr^{-1}	Fapohunda, 2005
Concrete	Tilapia + *Heterobranchus*	Natural and pelleted feeds	27, 556.63	102, 666.65 yr^{-1}	Olawumi *et al.* (2010)
Concrete/ earthen	Tilapia + *Heterobranchus/ Clarias*	Commercial feeds	710, 060.00	117, 970.00 $cycle^{-1}$	Kainga and Adeyemo (2012)

In addition, Fiedler et al. (2016) report that larger percentage of households (Table 3) which engage in homestead fish production in Bangladesh eat the fish produced while 64.14% of the fish produced are eaten and sold. The reports of Fapohunda (2005), Olawumi et al. (2010) and Kainga and Adeyemo (2012) also show that homestead aquaculture is profitable (Table 4) if properly managed, especially when unconventional feeds are used to supplement the expensive commercial feeds. The net profit reported by Kainga and Adeyemo (2012) will increase maximally with additional production within the year and excluding fixed cost from cost of production.

Conclusion

Production of fish using various homestead fish rearing facilities with appropriate management practices that enhance food sufficiency and poverty alleviation of homestead fish producers are

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discussed in this chapter. It could be concluded that homestead aquaculture is profitable with good management practices and can contribute significantly to the nutritional improvement and economic status of homestead fish producers.

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