# The Current Status of Aquaculture and Aquafeed Production in Bangladesh

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Over the last decade, dramatic increases in the production of a variety of species from commercial aquaculture systems and sharp increases in per capita fish consumption have occurred in Bangladesh. This transition has been made possible by widespread adoption of semi-intensive and intensive production practices, accompanied by growth in the production and use of aquafeeds. Findings relating to the current status of aquaculture in Bangladesh have been reported in greater detail elsewhere (Belton and Azad 2012). This article provides a brief overview of the status of aquaculture and fish consumption in the country and presents new information on the status of aquafeed production in Bangladesh, drawn from a recent study of the aquafeed industry. This article is based on key findings of a report published by WorldFish on the status of aquaculture and fish consumption in Bangladesh (Belton *et al*. 2011) and presented at the AQUA 2012 conference in Prague.

FIGURE 1. *Homestead pond with fruit and vegetable cultivation on dykes.*

## The Current Status of Aquaculture and Fish Consumption

Production systems in Bangladesh are characterized and defined as follows:

- Homestead pond culture — carp-dominated low-intensity production conducted on a semi-subsistence basis, using limited management, labor and capital investment.
- Semi-intensive or intensive culture in commercial ponds — entered as a productive investment with moderate to high capital costs and frequently employing hired labor.
- Shrimp and prawn culture — mainly extensive *Penaeus monodon* culture and semi-intensive *Macrobrachium rosenbergii* cultivation in modified ricefields.
- 'Others' — including stocking fish in natural water bodies and enclosed floodplains, rice-fish culture and cage culture (Table 1).

Approximately 4.27 million rural households, or 20 percent of the total, own a homestead pond (average area = 600 $m^2$) excavated close to the family dwelling for multiple uses, including washing and bathing (Fig. 1). Low-intensity carp polyculture in this type of pond has been the traditional mainstay of aquaculture in Bangladesh, usually producing fish on a subsistence basis for home consumption with a small marketed surplus. Despite the large number of homestead ponds, covering a cumulatively large area of over 260,000 ha, more than 70 percent of total aquaculture output now originates from systems operated on a fully commercial basis.

Homestead pond culture is usually a minor component of the overall household farm economy and often makes opportunistic use of existing ponds at low opportunity cost. In contrast, commercial pond culture is usually a distinct enterprise involving a major capital investment. Furthermore, whereas fish produced by homestead aquaculture is generally marketed locally in small quantities, much of the fish produced from commercial pond culture is moved in bulk directly from the farm to wholesalers in divisional cities or Dhaka (Fig. 2).

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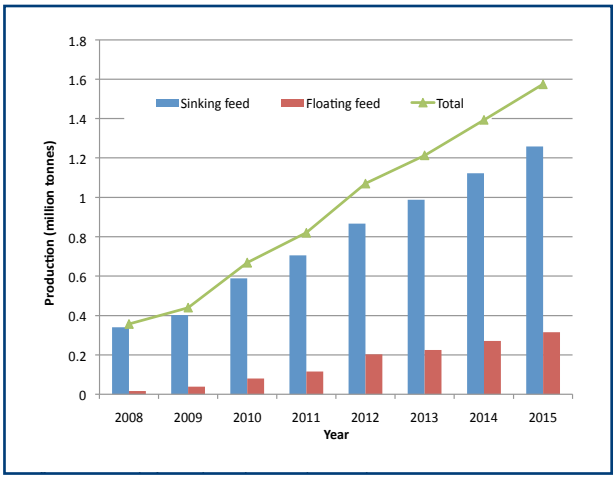
TABLE 1. Estimated annual aquaculture production in Bangladesh for 2010 (Belton et al. 2011).

| *Source* | *Area (ha)* | *Productivity (t/ha)* | *Quantity (t)* | *% of total production* |
|---|---|---|---|---|
| Semi-subsistence homestead ponds | 266,259 | 1.5 | 399,389 | 29 |
| Commercial semi-intensive ponds | 111,950 | 3.5 | 391,668 | 29 |
| Commercial intensive ponds | 15,000 | 10-40 | 395,000 | 29 |
| Shrimp and prawn | 244,294 | 0.4 | 97,746 | 7 |
| Others | 45,063 | 0.2-1.5 | 71,114 | 5 |
| Total | 682,566 | n/a | 1,354,944 | 100 |

The emergence of this type of aquaculture is a relatively recent development in Bangladesh, assuming increasing importance since the late 1990s, subsequent to the import of non-native pangasius *Pangasianodon hypophthalmus* broodfish from Thailand in 1993 (Ali *et al*. 2013), the later establishment of monosex tilapia hatcheries and development of spawning techniques for minor commercial species, including climbing perch *Anabas testudineus*, stinging catfish *Heteropneustes fossilis* and walking catfish *Clarias* spp.

Improving transport and communications, growing urban markets and rising incomes have been other key drivers of this growth. Approximately equal portions of aquaculture output are now accounted for by semi-intensive and intensive commercial aquaculture, each of which accounts for close to 400,000 t (29 percent) of total output (Table 1). Although highly significant, commercial semi-intensive carp culture has seldom been recognized as a distinct form of production on its own but, by our reckoning, covers an area of approximately 111,905 ha, with an average productivity of 3.5 t/ha. The average productivity of intensive commercial operations ranges from ≥10 t/ha for tilapia to around 40 t/ha for pangasius, but covers an estimated combined total area of only 15,000 ha.

The rapid growth of commercial aquaculture has been reflected in changing patterns of fish consumption. The Household Income and Expenditure Survey is implemented every five years, with assistance from the World Bank, to determine key national statistics such as poverty rates. The survey indicates a remarkable 18 percent increase in per capita fish consumption between 2005 and 2010 at the national level, with annual fish consumption increasing by 2.7 kg to 18.1 kg/capita (Table 2). This quantity is similar to the estimated average global fish consumption of 18.6 kg/capita (FAO 2012). Urban areas posted an even sharper rise, up 3.8 kg (21 percent) to 21.9 kg/capita. Consumption growth in rural areas, which lagged behind from 2000 to 2005, also began to catch up with that in cities between 2005 and 2010. Between 2000 and 2010, national fish consumption increased by 26 percent and consumption in urban areas by a massive 38 percent, while rural consumption grew by 20 percent. Expenditure on fish among consumers in major cities is nearly twice that of those in rural areas because of income differentials. Consumers in the poorest income quartile continue to consume less than half as much as those in the wealthiest.




TOP, FIGURE 2. *Harvesting pangasius from an intensive pellet-fed pond.* BOTTOM, FIGURE 3. *Actual and projected aquafeed production (2008-2015).*

## Present Status of Aquafeed Production

The massive growth in commercial aquaculture reported in the preceding section has been made possible, in large part, by concurrent growth in the production and use of aquafeeds, with commercial pelleted feeds replacing 'farm-made' and 'raw' unformulated feeds. Production of commercial aquafeeds increased by 32 percent per year from 2008 to 2012, reaching about 1.07 million t in 2012. Sinking feeds, accounting for 81 percent of total manufactured output, dominate over extruded floating feed (19 percent). Growth in the production of floating aquafeed has been most rapid, averaging 89 percent per year over the last four years. Based on demand forecasting, total aquafeed production is projected to increase to 1.57 million

TABLE 2. National, rural and urban annual per capita fish consumption, 2000-2010 (BBS 2007; BBS 2011).

| | *Annual fish consumption per capita (kg) 2000* | *Annual fish consumption per capita (kg) 2005* | *Annual fish consumption per capita (kg) 2010* | *Change in consumption (kg) 2000-2005* | *Change in consumption (%) 2000-2005* | *Change in consumption (kg) 2005-2010* | *Change in consumption (%) 2005-2010* |
|---|---|---|---|---|---|---|---|
| National | 14.1 | 15.4 | 18.1 | 1.3 | 9.4 | 2.7 | 17.6 |
| Rural | 13.8 | 14.5 | 16.7 | 0.7 | 5.0 | 2.2 | 15.3 |
| Urban | 14.9 | 18.1 | 21.9 | 3.2 | 21.2 | 3.8 | 20.8 |

TOP LEFT, FIGURE 4. *Producing farm-made aquafeed.* LEFT, FIGURE 5. *Drying farm-made aquafeed.* TOP RIGHT, FIGURE 6. *Bagging aquafeed at a commercial mill.*

t by 2015 (Fig. 3). By then, floating feed is expected to constitute 31 percent of all formulated aquafeeds.

In addition to commercial pelleted feeds, more than 0.3-0.4 million t of farm-made pelleted feeds are also produced in farming areas. The number of farm-made pellet mills is difficult to estimate, but there are at least 1000 (Fig. 4). Simple pellet mills can be easily manufactured in local workshops for around $2500. It is used to crush ingredients such as dried fish and maize that are then mixed manually with other feed ingredients and mechanically forced through a die to produce long 'strings' that are later air-dried and broken into small pieces before feeding (Fig. 5). Operators of these machines often face difficulties with inadequate pellet binding and drying, and lack the knowledge and awareness needed to formulate feeds that provide sufficient nutritional value.

There are around 100 mills producing commercial aquafeeds in Bangladesh, among which 8-10 large operators account for 60-70 percent of market share (Table 3, Fig. 6). Almost all mills also produce poultry feeds. Fifteen companies have installed extruders in their factories and two companies import floating feed from India and Thailand.

There are around 20 commercial feed mills around the country that manufacture feed on a rental basis. These mills are used by large farmers to produce feed to meet their requirements and by feed traders who brand and sell feed in the local area at relatively low cost. They customize their formulation and pricing depends on the buying capacity of local farmers. The rental or processing cost for use of these mills is US$ 26-38/t for sinking feed. Few extruders are available for rent, although there are two or three mills with extruders that charge US$ 103-128/t to produce floating aquafeed. Poor knowledge of formulation often leads to the production of low-quality, poor-performance feed from these facilities.

Vertical integration has been increasing recently, with feed companies expanding the range of support services and inputs provided to farmers and dealers to capture greater market share. Eight feed companies currently supply customers with aquafeed and monosex tilapia fingerlings from their own hatcheries, a marketing concept that originated in the poultry sector. Two large industrial groups have already established vertically integrated operations encompassing hatchery, feed manufacture, grow-out and processing, although processing capacity is not fully satisfied by fish produced within the group.

## Aquafeed Ingredients

Based on favorable temperatures and water availability, the main season for commercial fish culture generally starts in March and continues until November, so the greatest volumes of aquafeeds are produced from April to September. Aquafeeds are specially formulated and/or branded for specific species in the following proportions: pangasius (60-65 percent), tilapia (35-45 percent), climbing perch (10-15 percent), carp and others (2-5 percent), shrimp and prawn (2-3 percent). Aquafeeds are produced for different production phases: nursery (2-3 percent), starter (20-30 percent), and grower/finisher (60-70 percent). Extrusion technology is mainly used to produce floating feed for tilapia, accounting for around 40-50 percent of total tilapia feed production and retailing for US$ 90-130/t

TABLE 3. Feed mill type, capacity and number.

| *Type of feed mill* | *Production capacity (t/h)* | *Number* |
|---|---|---|
| Large | 20-40 | 8-10 |
| Medium | 10-20 | 15-20 |
| Small | 5-10 | 70-75 |

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more than sinking feed. The production rate of grower feed is 1-2 t/h greater than that of starter feed, while energy consumption in machine operation and protein inclusion costs are greater for starter feed than for grower feeds.

The price of aquafeed increased 20-25 percent between 2011 and 2012 from increases in the price of most major raw materials. The main raw materials used for aquafeed production and their inclusion rates are rice bran (20-50 percent), maize (5-20 percent), soybean meal (10-20 percent), mustard oil cake (10-25 percent), fishmeal (5-15 percent) and meat and bone meal (10-20 percent).

FIGURE 7. *Dried 'chewa' fish – a local source of high-quality fishmeal.*

Three types of rice bran are used: de-oiled rice bran (DORB), grade A rice bran (85-90 percent bran), and grade B rice bran (40-50 percent husk and 60-50 percent bran). The protein content of DORB (15-17 percent) is greater than that of grade A rice bran (10-13 percent). Rice bran is produced mainly locally.

Maize originates from local (75-80 percent) and imported (20-25 percent) sources.

Soybean is mainly imported from South America, although around 150,000 t was grown in Bangladesh in 2012. Soybeans are used primarily for the extraction of oil for human use, and the meal or cake byproduct is used in feeds. There are two solvent extraction mills in Bangladesh, providing 35-40 percent of soybean meal/cake supply, with the remaining 60-65 percent imported from India. Incorporation rates of soybean meal/cake are less in sinking (10-20 percent) than floating (20-30 percent) aquafeeds.

Meat and bone meal is a source of cheap protein (48-52 percent crude protein) and is imported, particularly from Australia and Paraguay. Inclusion rates for all major protein sources — soybean meal, meat and bone meal, mustard oil cake and rapeseed meal — vary according to their respective prices, nutritional value and availability. These products are available in different quality grades.

Local fishmeal is manufactured from a variety of trash fish, crabs and other aquatic animals. Thus, the nutritional composition is variable. Large quantities of salt are added during drying to aid long term preservation, increasing the weight of dried fish by up to 20 percent. Fishmeal is sometimes intentionally adulterated with salt to increase product weight by up to 35-40 percent. The crude protein content of meal derived from this dried fish varies from 35 to 45 percent. There is a domestic source of better-quality fishmeal (44-52 percent crude protein), made from 'chewa' *Pseudapocryptes elongates* produced in southern Bangladesh in Kuakata and the islands of Hatia and Bohala, but supply is insufficient to meet the demand of the aquafeed sector (Fig. 7). However, almost 80-85 percent of fishmeal used in the production of aquafeeds originates from local sources.

Alternative (conventional and unconventional) raw materials are used when the price of regular raw materials rises but feed prices cannot be increased further because of market competitiveness. Alternative raw materials used include cassava, millet, pulse meal, broken rice, shrimp shell, small dried crab, dried fish offal from processing plants, canola meal, blood meal, sorghum meal, copra meal, wheat bran, groundnut meal, cottonseed meal, guar meal, feather meal and poultry offal. Use of lower-quality alternative or unconventional raw materials often occurs as a result of shortages or price hikes of standard ingredients. Wide variation in the crude protein content and amino acid profiles of meat and bone meal and fishmeal also affects the performance of feed. Mycotoxin problems arise from May to August from high humidity, procurement of raw materials with high moisture content, such as rice bran and maize, and poor storage.

Variations in the price of aquafeed ingredients are linked to commodity price fluctuations in international markets, changing import policies and foreign relations with exporting countries. Imported raw materials contribute more than 50 percent of the total cost of aquafeed production. Raw materials are generally supplied to feed mills by a number of distributors, but large feed mills open letters of credit that allow direct import of ingredients, thereby reducing costs. Feed mills also procure domestically produced ingredients such as rice bran and maize through their national network of feed dealers and sales representatives during the post-harvest period when prices are lowest.

## Service Providers to Feed Mills and Farmers

More than ten multinational feed additive companies currently operate in Bangladesh. Five human medicine companies manufacture customized vitamin premixes for local feed companies, although the raw materials are imported. Some feed companies and traders pay for use of these processing facilities to produce their own premixes.

About half (10-12) of the commercial feed companies have laboratory facilities to conduct proximate analysis, among which 2-3 have near infrared spectroscopy (NIRS) technology for rapid determination of proximate analysis. A small number of private service providers also offer proximate analysis, as do some government organizations, which support these facilities at lower charge. Analysis of mycotoxins, amino acid profiles and antibiotic testing are not available to feed mill operators.

The most commonly used brands of pellet and extrusion machines are Chia Tung , Muyang, Andriz, Ideah, Awila , Bowler, Jiangsu Zhengchang. Machine suppliers provide maintenance services during the warranty period, generally one year. There are 2-3 local machine service providers that assist feed companies in solving common mechanical problems.

Feed from mills is distributed to farmers by feed dealers, who earn a commission of 6-7 percent (Fig. 8). Most companies provide credit to feed dealers. Farmers may also receive feed on credit from dealers and the quantity of credit extended from dealers to farmers is much higher than the amount received by dealers from feed manufacturers. Dealers typically add an extra 1-3 percent to the retail price when extending credit to farmers, depending on the duration over which the credit is extended and the characteristics of the customer. Large feed companies typically partner with around 450-500 dealers, while medium-size companies work with 200-300 and mills with only regional coverage typically work with 20-100. Most dealers sell feed from several companies, although some dealers work exclusively for a single company.

TOP, FIGURE 8. *Loading aquafeed at a large mill for distribution.*
BOTTOM, FIGURE 9. *Feeding pangasius on a large farm.*

Feed dealers, retailers and technical representatives of commercial feed companies provide embedded services to farmers. Use of commercial pelleted feed is now very common among commercial fish farmers (Fig. 9). Most farmers feed twice daily but feed requirements are rarely calculated properly according to body weight through timely sampling. However, farmers using floating feed are able to measure feed requirements through satiation feeding.

## Outlook

The growth of commercial aquaculture and commercial aquafeed production in Bangladesh over the preceding 5-10 years has been remarkable and yet there is considerable room for further expansion of both sectors over the medium to long term. The rate of expansion in the production and uptake of manufactured feeds has been so rapid that the industry has not yet matured fully. It is likely that considerable consolidation will take place among feed producers over the coming years as farmers become more sophisticated in feed management and preferences and the benefits of higher quality feeds become more readily apparent, forcing companies producing inferior product to raise the bar or exit the industry. In the meantime, educating farmers on good feed management practices and enforcing existing regulations designed to ensure the quality of manufactured feed can help to support the aquaculture sector in Bangladesh as it continues to expand and modernize.

## *Notes*

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