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Current aquaculture practices in Dinajpur District: Special emphasis on fish feeds

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Abstract
An investigation was carried out for a period of one year in Dinajpur district, Bangladesh to know the current aquaculture practices with special emphasis on fish feeds. The study revealed that 89.2% fish farmers were male, 88.3% were Muslims, and 55.8% belong to the age group 41-60 years. In case of education, 45.8% farmers had literacy up to primary level and annual income of 63.3% farmers was below Tk. 50,000. The pond areas of 85.8% farmers were less than 0.50 ha with an average depth of 1.5 m and the water color of most fish ponds (95%) was slightly green and 55% respondents used ground water for polyculture of Indian major carps and exotic carps. In the study areas 30% fish farmers used farm made feeds, 40% used commercial feeds and 30% used both farm made and commercial feeds, and the feed was applied manually twice in a day by most of the farmers (95%). The commonly used feed ingredients were: fishmeal, mustard oil cake, rice bran, maize bran, wheat flour etc. and among the commercial feeds, Mega feed was used by the highest percentage of respondents (35%). The prices of feed ingredients and commercial feeds varied from 22 to 62, and 32 to 110 Tk./kg, respectively. The baseline information on the current aquaculture practices can play vital roles in sustainable aquaculture production.

Keywords: survey, aquaculture practices, fish feeds, Dinajpur district, Bangladesh

1. Introduction
The lives of the Bangladeshi people centre around and depend upon fish, fisheries and water. Bangladesh is a transitional zone of many different flora and fauna because of the geographical distribution and climatic characteristics. The mighty Padma, Meghna, and Jamuna rivers flow through the land and the presence of numerous haor, baor, marsh, swamp, pond, lake make the region suitable place for dwelling huge number of aquatic flora and fauna. The areas of closed and open water resources are 0.79 and 3.91 million ha, respectively (DoF, 2017) [11]. There are 260 freshwater fish species in addition to the 23 exotic species and many other vertebrates and invertebrates in the inland waters of Bangladesh (Rahman, 2005) [23].

Inland water bodies in Bangladesh is 4.70 million ha, of which 0.37 million ha of ponds is suitable for aquaculture. The production of fish was 3.88 million MT in 2015-16. Over 80% of the total production came from inland waters, where the contribution of aquaculture was 56.82% (DoF, 2017) [11]. Bangladesh is one of the 15 leading fish producing countries in the world achieving the 5th position in inland aquaculture in 2014-2015 (FAO, 2014; DoF, 2015) [12, 9]. Total fish production has been increased to 3.88 million MT in 2015-16 from 2.22 million MT in 2004-2005 (DoF, 2017) [11]. Per capita annual fish consumption in Bangladesh is about 19.71 kg, whereas the recommended minimum requirement is 21.90 kg, which indicates the necessity of increasing fish production in the country (DoF, 2016) [10].

Aquaculture is one of the fastest growing food producing industries in the world over the last 25 years, and the growth rates were between 6 and 14% during the last 10 years (Chan *et al.*, 2017) [6]. The sector has the potentials of improving human dietary standards by supplementing protein rich food, contributing to 60% of protein of animal sources at present in Bangladesh, and diversifying rural production and aquaculture potential (Dhawan *et al*., 1998; Toppo, 2016) [8, 35].

The aquaculture sector is growing very fast in Bangladesh due to increase in demand for fish and heading towards intensification (DoF, 2017) [11]. On the contrary, production is declining in the capture fisheries because of water pollution, over fishing, high population, habitat destruction, sedimentation, tidal control projects, large scale reclamation of rivers, crop production in haors, beels and other depression areas, construction of barrage and water diversion etc. (Aguero, 1989; Flowra *et al*., 2011) [1, 13]. Therefore, the necessity of increasing fish production in closed waters by aquaculture is increasing day by day.

The farmers are gradually shifting to factory-made feeds from no feed to external inputs through the application of farm-made feeds. Because the success in intensive and semi-intensive aquaculture depends on the provision of suitable fish feeds to the cultured species. Fish feeds should provide maximum production efficiency at a minimum cost. Feed cost is the major constraints to the expansion of aquaculture from the economic point of view, and is the prime element for higher benefits as it accounts for 40-80% of the operational costs in semi-intensive and intensive aquaculture (Kaushik, 1990, De Silva and Hasan 2007) [18, 7]. Moreover, application of fish feeds in terms of appropriate quality and quantity is mandatory, because the growth and feed conversion efficiency

of fish depend upon it. Fish feeds prepared with good quality feed ingredients and better feed efficiency result in higher production, which cut down the feed cost and reduce waste production in aquatic environment. On the other hand, application of low quality feeds and inappropriate feeding strategy create many problems including environmental degradation, outbreak of fish diseases, poor fish growth, high mortality etc. (Toppo, 2016) [35].

Fish feeds are broadly classified into natural food and artificial feed. Availability of natural foods for fish can be stimulated in a culture system through fertilization. On the other hand, artificial feeds, both supplementary and balanced, are formulated with predetermined nutritional contents and supplied to the cultured species in order to meet the essential nutritional requirements. Supplementary feeds (found in various forms such as powder, flake, crumble, pellets etc.) alone cannot fulfill the nutritional requirements of cultured species (Tacon, 1996) [33]. Therefore, the fish farmers are advised to use supplementary feeds along with pond fertilization.

Aquaculture has become an extremely diverse industry. With the intensification of aquaculture practices, the importance of fish feed is increasing day by day. In aquaculture, fish feed plays a vital role because it directly controls the production and quality of fish. It has become critical for the food safety as well as efficient high quality feeds that ensure optimal growth for different fish species farmed under different conditions. Cost of fish feed generally constitute the highest single operational cost in semi-intensive and intensive culture systems. It is necessary for the fish farmers to utilize their investments in feeds as optimal as possible for successful aquaculture operation. Different farmers formulate fish feed without proper knowledge on fish feed formulation and different feed manufacturers produce feeds using low quality feed ingredients. Although Bangladesh Government has legal legislations, there is very little or no control over feed formulation. There is a great possibility of deceiving the farmers both in terms of nutritive value and cost. Therefore, the study was undertaken to know the present aquaculture practices and the different types of feeds being applied for the aquaculture species.

2. Materials and Methods

2.1. Selection of the study area

The study was conducted for a period of 12 months commencing from July 2016 to June 2017. Six upazilas namely Birgonj, Birol, Chirirbandar, Dinajpur sadar, Kaharol, and Khansama under Dinajpur district were chosen to conduct the study based on the aquacultural development, problems and potentialities (Fig. 1).

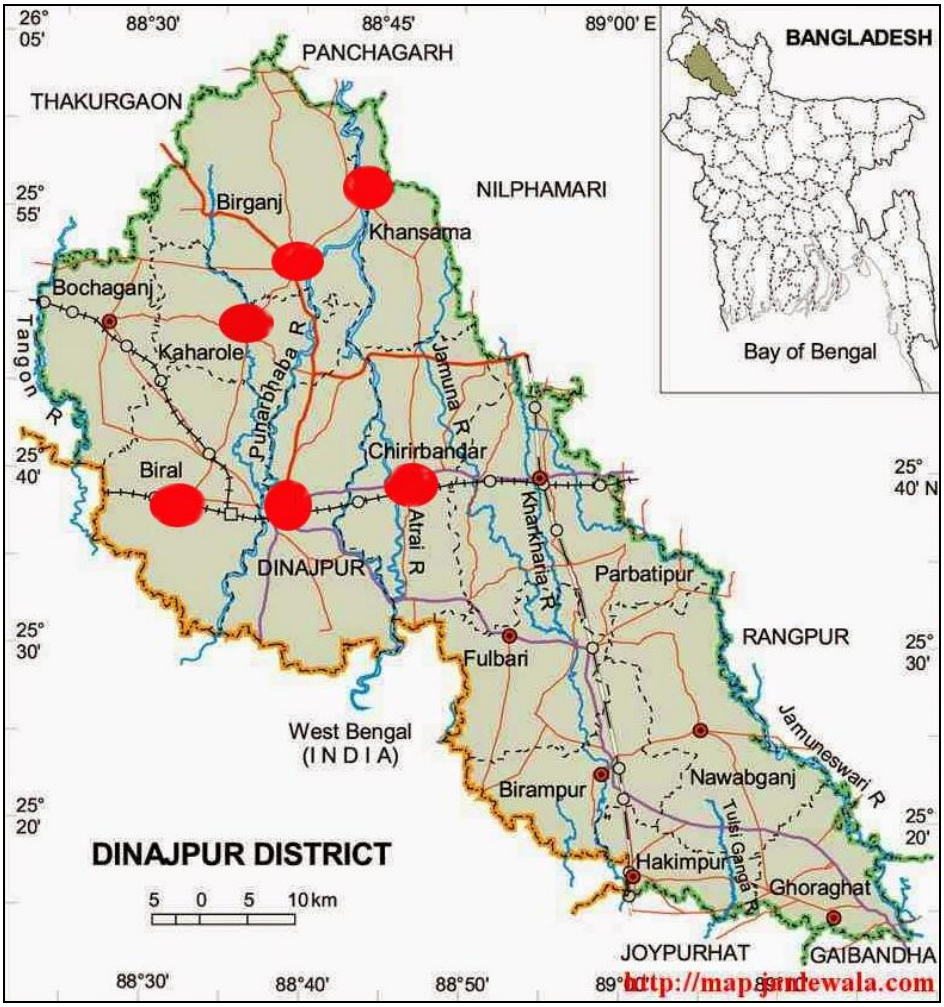

Fig 1: Map of Dinajpur district showing the study areas.

2.2. Questionnaire Preparation and Data Collection

A questionnaire was prepared with the intention of getting the complete picture of the current aquaculture practices and the fish feeds and feed ingredients used in the selected areas. Data were collected from both primary and secondary sources. Primary data were collected from the respondents by direct interview using the questionnaire, and the secondary data were obtained from different published literatures and statistical data from District and Upazila Fisheries Offices, Non-Government Organization (NGO) officials etc. Focus Group Discussion (FGD) was used to acquire an outline of particular issues such as existing fish composition, pond management practices, feeding methods feed ingredients and feeds, and socio-economic conditions of the fishermen. Three FGD sessions were conducted and each group consisted of 10-15 fish farmers. Cross-check interviews were conducted for the reliability of the collected data with key informants such as District and Upazila Fisheries Officers, school teachers, local leaders, NGO workers etc.

2.3. Data Processing and Analysis

First of all, the collected data were coded, summarized and processed for analysis. All possible errors and inconsistencies were eradicated for verification of the data. Then the collected data were analyzed with a computer based software - SPSS (Statistical Package for Social Sciences) version 22, and tables and graphs were prepared with MS Excel (Microsoft Excel 2010).

3. Results and Discussion

3.1. Demographic Information

3.1.1. Age Group

In the study area, more than half of the farmers (55.80%) were found in the 41-60 years age group, while 16.70 and 27.50% of farmers were fell into the age groups 20-40 and above 60 years, respectively (Fig. 2). Understanding of the age structure of fish farmer is significant in estimating potential creative human resources. Adequate data relevant to age structures is required for planning of education, health, employment generation etc. The age distribution of fish farmers has a vital influence on labor and also on their opinions of the future. Kundu (2007) [19] observed that 40% of the prawn farmers belonged to 41-50 years age group, followed by 29% in 31-40 years and 19% below 30 years category. The causes of differential participation of farmers of various age-groups in aquaculture are likely to be personal choice, ease of operation, physical capabilities, social interactions etc. (Mia *et al.*, 2015) [21].

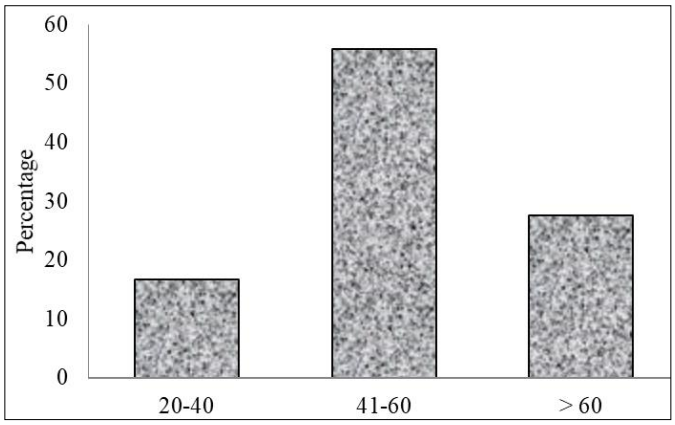

Fig 2: Age distribution (years) of fish farmers in the study areas.

3.1.2. Gender

Almost all the farmers were male (89.20%) (Fig. 3). In Bangladesh context, a very low percentage of females are not involved in income generating activities. Their main function is looking after children and maintaining household activities (Neeraja, 2003) [22].

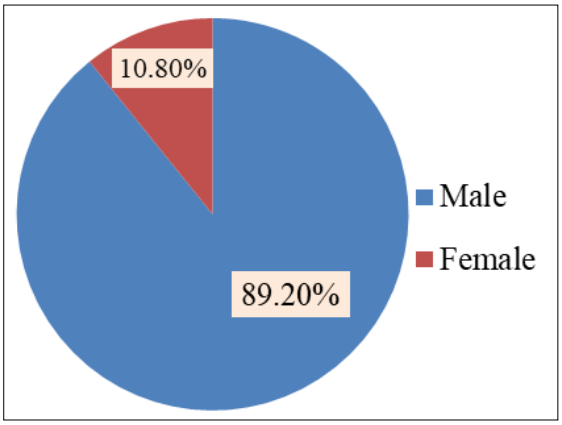

Fig 3: Percentage of genders involved in fish culture in the study areas.

3.1.3. Educational Status

No fish farmers were illiterate among the respondents. The educational level of the majority fish farmers was primary (45.8%) followed by higher secondary (19.2%), secondary level (17.5%), graduate (15%) and can sign only (2.5%) (Fig. 4). It implies that educated persons, even graduates, are being involved in fish aquaculture in the recent time as aquaculture is a profitable business. Rahman (2001) [26] stated that 68% fish farmers were illiterate, 28% had education up to primary level, and 4% had secondary level of education.

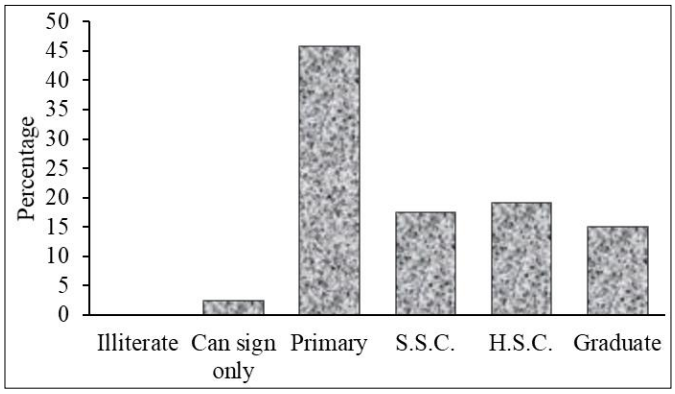

Fig 4: Educational status of fish farmers in the selected areas.

3.1.4. Family Type and Size

Two types of families were identified in the study areas such as nuclear family (64.20%) and joint family (35.80%) (Fig. 5). Nuclear family was predominant in the study areas. The family size has considerable influence on the income and expenditure of the family. The family size of the fish farmers in the selected areas was divided into three categories according to the number of the family members. Data revealed that half of respondents (50%) belonged to small family size of 2-4 members followed by 5-6 member family (35%), and more than 6 member family (15%) (Table 1). The family size and composition of member are closely related to income. The size of the family has a direct control on the expenditure and income patterns of the family. At the same time as the fish production is a labor intensive activity hence family size influences the fish production. The family members of fish farmers ranged between 2 and 7. Similar types of family structure were noted by Shahjahan *et al.* (2003) [32].

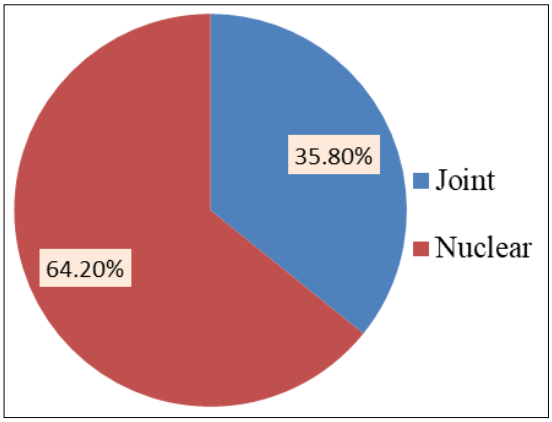

Fig 5: Family status of the fish farmers in the study areas.

Table 1: Family size of the fish farmers in the study areas

Family size	Respondents (Number)	Respondents (%)
2-4	60	50
5-6	42	35
>6	18	15
Total	120	100

3.1.5. Annual Income

Analysis of income levels of the fish farmers exposed that annual income varied from Tk. <50,001 to >700,000. The selected fish farmers were grouped into six categories based on the level of their annual family income (Fig. 6). Annual income of the most farmers (63.3%) was up to Tk.50,000. Employment and income are the twin decisive factors mostly used for determining the living standard of any community or area in general. Reasonable distribution of income further improves the social synchronization among different sections of population in an area. The low level of income reflects their poor economic condition, which was not sufficient to maintain their normal livelihood. At the same time they cannot afford much for fish culture activities. Rahman (2016) [27] observed that highest annual income was above Tk. 400,000, moderate income about Tk. 100,000-400,000 and lowest income range was Tk. 1,000-100,000. Ali (2013) [4] reported that the highest annual income ranged from Tk. 61,000-90,000 and the lowest annual income ranged from Tk. 30,000-40,000 which is very similar to the present study.

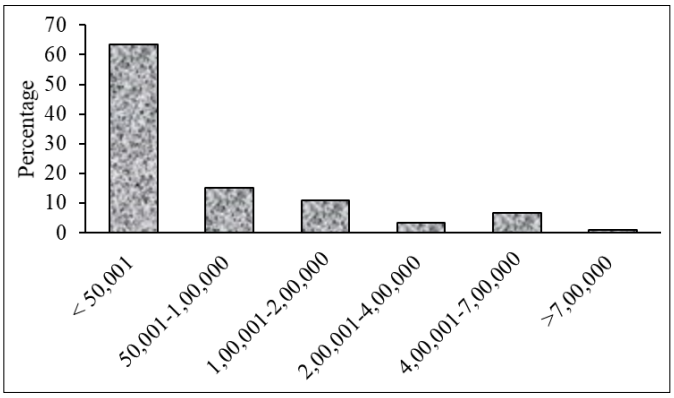

Fig 6: Annual income (Tk.) of the respondents in the selected areas.

3.2. Present Aquaculture Practices

3.2.1. Pond Size and Depth

In the present study, size of most ponds (85.8%) was below 0.50 ha, where minimum pond size was 0.15 ha. However, a few ponds were large in size ranging 1-3 ha (Table 2). On the other hand, average depth of the ponds was 1.5 m, which is close to findings of Saha (2003, 2004) [30, 31] Kundu (2012) [20].

Table 2: Farm size of the fish farmers in the selected areas

Farm size (ha)	Respondents (Number)	Respondents (%)
<0.50	103	85.8
0.51-1.0	8	6.7
1.01-2.0	6	5
2.01-3.0	2	1.7
>3.0	1	0.8
Total	120	100

3.2.2. Water Sources

The study revealed that 55% of the fish farmers used ground water, 35.80% farmers mainly depended on the rain water and only 9.20% farmers used surface water (Fig. 7). The provision of clean and safe water is considered to be the most valued element in the pond fish culture. For fish growth and their survival good water source is undoubtedly becomes a prerequisite. Water quality also plays a significant role in culture of fish and other aquatic organisms. Soil quality of the study areas posses sandy properties and its water retention capacity is very poor especially in dry season. Therefore, water was supplied to the fish ponds with water pumps. Islam (2010) [16] stated that 40% of the ponds were seasonal, and the farmers depended on both surface and underground water, and 60% were perennial. Kabir (2009) [17] observed that 34% of the ponds were seasonal and 66% were perennial and the farm owners used both surface and underground water in the ponds.

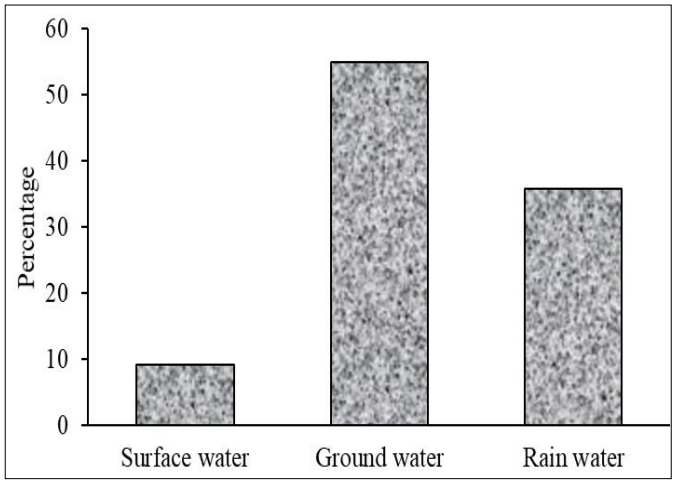

Fig 7: Sources of water for aquaculture in the study areas.

3.2.3. Culture Systems

There are different types of culture systems depending on the species compositions such as monoculture, polyculture, mixed culture etc. It was found that all the farmers (100%) in the selected areas practiced polyculture systems. The species cultured in the study areas were rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus mrigala*) and Chinese carps such as silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), common carp (*Cyprinus carpio*), shing (*Heteropneustes fossilis*), magur (*Clarias batrachus*), pangas (*Pangasius sutchi*), koi (*Anabus testudineus*), sarputi (*Puntius sarana*), bighead carp (*Hypophthalmichthys nobilis)*, tilapia (*Oreochromis niloticus*) etc. and only one farmer cultured Vietnamese koi in polyculture. Most of the farmers did not follow any scientific combination of the species. Rahman (2014) [28] reported that almost all the farmers carried out polyculture system, where 60-70% farmers cultured rohu, catla, mrigal with tilapia, 50% farmers cultured koi, *shing*, *magur*, and the rest 3.33% cultured tilapia with catfish. Generally, 14-17 fish species are cultured in polyculture systems in different combinations in Bangladesh, although all are not stocked together at a time, which resemble the findings of the present study (Biswas 2003; Ahmed *et al.* 2010; Tanjina 2011) [5, 2, 34].

3.2.4. Problems in Fish Culture

According to the present study, social problems were the single most important problem in aquaculture in the selected areas reported by 35.80% of the respondents. Financial problems (30%), technical problems (26.70%), physical problems (1.70%) were also identified as important problems in the study area. On the contrary, 5.80% farmers faced no problems (Fig. 8). The different problems observed were: social problems - theft, poisoning and multiple ownership of ponds; technical problems - lack of technical knowledge, lack of awareness on fish production technology; and financial problems - lack of money, higher production cost, lower market price etc. Similar problems and constraints to aquaculture were reported by Robbani (2002) [29], Islam (2010) [16] and Rahman *et al.* (2011) [24].

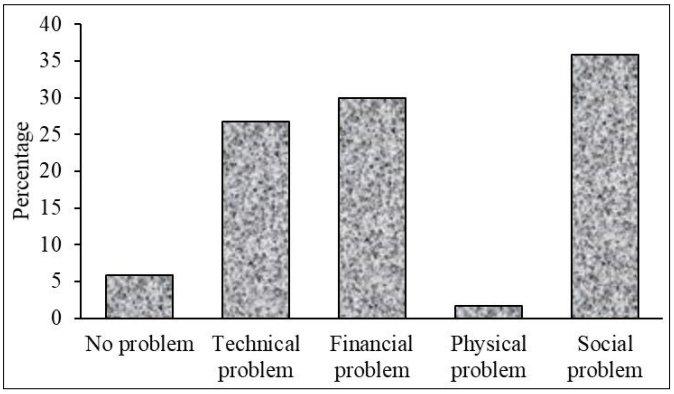

Fig 8: Problems and constraints to aquaculture observed in the study areas.

3.3. Feeds and Feed Ingredients

3.3.1. Feed Types

The collected data revealed that 40% farmers applied commercial feeds, 30% used farm made feed prepared with rice bran, wheat bran, fish meal, maize flour and mustard oil cake, and 30% farmers used both farm made and commercial feeds in the ponds (Fig. 9). Rahman (2007) [25] observed that 80% fish farmers applied supplementary feed prepared with rice bran and mustard oil cake, and Rahman (2014) [28] stated that farmer used fish feed consisting of mustard oil cake, rice bran, wheat bran, fish meal, soy bean meal etc. in their farms. Similar findings were reported by Islam (2010) and Ahmed *et al.* (2010) [2].

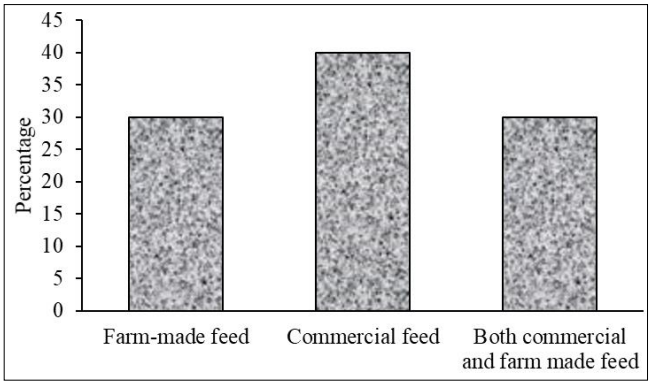

Fig 9: Feeds applied by the farmers for the aquaculture species.

3.3.2. Types and Forms of Commercial Feeds

The present study showed that majority of the farmers (60%) used pellet feeds, and 10% used powder feeds. On the other hand, 30% farmers did not use any commercial feeds (Table 3). Among them 67.5% fish farmers used floating feeds, 1.7% used sinking feeds and only 0.8% used both floating and sinking feed. A study conducted by Rahman (2014) [28] revealed that 90% farmers used commercial pelleted feeds for rearing fishes. Different forms of commercial feeds are produced by different feed manufactures. The commercial fish feeds contain comparatively higher amounts of essentials nutrients such as proteins, lipids, carbohydrates, vitamins and minerals compared with farm-made feeds (Hasan and New, 2013).

Table 3: Forms of commercial feeds used by the farmers in the study areas

Form of Feed	Respondents (Number)	Respondents (%)
No commercial feed	36	30
Pellet	72	60
Powder	12	10
Total	120	100

3.3.3. Forms of Farm-Made Feeds

Among the respondents, 64.20% were found to use feeds of ball form; only 0.80% farmers used mash form of feeds in case of farm-made feed types, no respondents was found to report of preparing pelleted feed in the farms, whereas 35.00% farmers did not use on-farm feeds (Table 4). Commonly used feed ingredients in the selected areas were rice bran, wheat bran, mustard oil cake, maize flour, fish meal etc. Rahman (2007) [25] found that 80% of the farmers applied supplementary feed prepared using rice bran and mustard oil cake. On the other hand, Rahman (2014) [28] reported on using of farm-made aquafeeds by 10% farmers, which consisted of mustard oil cake, rice bran, wheat bran, fish meal, soyabean meal etc.

Table 4: Forms of farm-made feeds used in the selected areas

Forms of Feed	Respondents (Number)	Respondents (%)
No farm-made feed	42	35.0
Pellet	0	0
Ball	77	64.2
Mash	1	0.8
Cake	-	-
Total	120	100

3.3.4. Feeding Methods

It was found from the survey that 100% of the fish farmers supplied feeds to the cultured species manually. It indicated that traditional fish culture methods were being practiced in the study area. Manual or hand feeding is the most common form of feeding practice in the semi-intensive aquaculture in developing countries. The method is very simple and have some advantages including no additional capital equipment needed, provides an opportunity for regular direct observation of the cultured organisms, any unexpected condition, for example, oxygen deficiency, disease occurrence etc. can immediately be identified.

3.3.5. Feed Storage

It was found that 97% fish farmers had feed storage facility. Over half of the respondents (52.50%) had '*kacha*' rooms for feed storage; followed by 25.50% had '*paka*' room, 18.30% had 'semi-*paka*' room and 3.30% did not have any feed storage facility. This reflects the poor storage condition of the feed in the study area because '*kacha*' rooms may cause different problems that deteriorate the quality of fish feed during storage (Fig. 10).

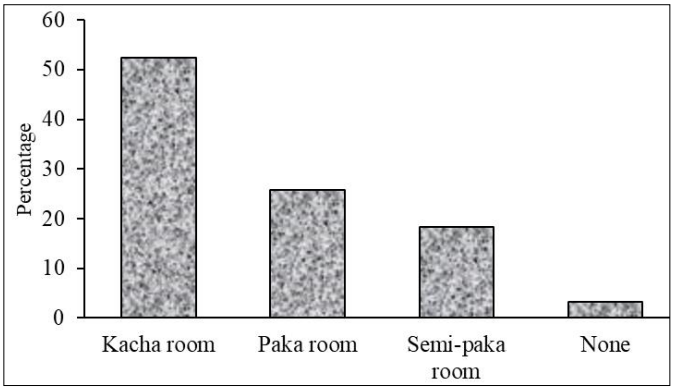

Fig 10: Feed storage facilities prevailing in the selected areas.

3.3.6. Feed Manufacturers

In extensive aquaculture practices no input or supplementary feeds are used. However, uses of commercial feeds have widely been adopted in semi-intensive aquaculture to get more production recently. Therefore, it was found that fish farmers used Mega feeds (35% respondents); Quality feeds (19%), Nourish feeds (8%), Aftab feeds (3%), Eon feeds (3%) and Provita feeds (3%) in the selected areas (Fig. 11). Application of commercial fish feeds in aquaculture of same manufacturers observed in the present study also reported by Alam *et al.* (2012) [3] and Rahman (2014) [28] in different regions of the country.

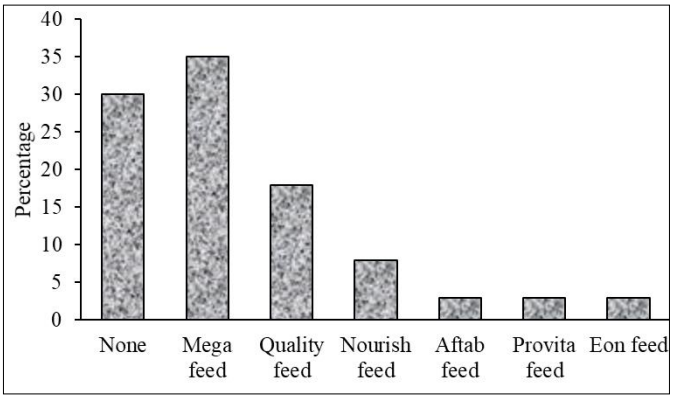

Fig 11: Commercial fish feeds available in the study areas.

It can be concluded that considerable development in aquaculture has been achieved in many regions of Bangladesh, whereas it is still at the preliminary stages in the study areas. On-farm feeds may not contain sufficient amount of nutrients, as the farmers do not have proper knowledge on quality of feed ingredients, formulation, manufacturing process and quality evaluation of the prepared feeds. On the other hand,

the nutritive values of commercial feeds are inconsistent, often of low quality. Therefore, further quality assessment of fish feeds is very important. The Government should establish and implement policy on aquafeed for maintaining the required nutritional quality of fish feeds for the sustainable aquaculture production.

4. Acknowledgment

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