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Assessment of sustainability of Pangasius (*Pangasius hypophthalmus*) farming at Jhikargachha upazila in Jessore district, Bangladesh

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Abstract
The present study focused on existing status and assessment of sustainability of Pangasius (*Pangasius hypophthalmus*) farming at Jhikargacha upazila in Jessore district. The research was carried out through questionnaire interview with randomly selected 80 farmers during December 2014 to May 2015. Most of farms (96%) are under polyculture, while only 4% is under monoculture practice. The source of pangasiid fingerlings were fry traders, nearby nursery, local hatchery and large hatchery from Jessore. Fingerlings size varied from 1 to 2 inch with price of TK. 0.5-1/fingerling. Majority of the farmers stocked fingerlings in March to April with average stocking density was 18,700 fingerlings/ha. About 46% of Pangasius farmers have leased ponds and lease value varied from Tk. 1,12,200-1,49,600/ha/yr. The leased ponds were solely used for Pangasius farming. Over 19% of farmers exchanged water one time per year, while 81% never exchanged. Almost all of the Pangasius farmers used supplementary feeds in their farms. Among the farmers, 37% of farmers received general aquaculture training from Bangladesh Fisheries Research Institute (BFRI) and Department of Fisheries (DoF) and some non-government organizations (NGO's). Average pond size was 0.17 ha of which 85% was perennial and 15% was seasonal. Various constraints such as, lack of capital and proper technological knowledge, lack of continuous supply of quality fry, high price of the inputs especially feed, adulteration of feed, inbreeding, improper marketing and management problems were prominent. Some farmers use some unethical feeds in their farms. The highest proportion (41%) of the people was involved in Pangasius farming as main occupation and their age was between 31-40 years. The main reason of converting their ponds and lands for Pangasius farmimg was to get more profit. Large farmers always got higher profit over 2.03 Lac Tk./ha. However, small and medium farmers also got over 1.9 lac Tk. profit per hectare from Pangasius farming. Though the potential of fish farming in Jhikargacha region is mentioned-worthy, it is currently facing a number of problems such as, lack of capital, proper technological knowledge, lack of regular supply of quality fingerlings, improper proportion of protein and supply of adulterate feed, high price of feed, inbreeding, marketing and management problems. If the suggested constraints could be solved, the fish production in Jhikargacha region would possibly be increased tremendously and the pangasius farming would be progressed towards sustainability.

Keywords: Sustainability, Pangasius farming, Aquaculture, Constraints, Bangladesh

1. Introduction
The fisheries sector contributes 4.43 percent to the national GDP and 22.21 percent to the total agricultural GDP (DoF, 2012) [22]. Currently, fisheries are the second largest export sector in Bangladesh (Chowdhury *et al.*, 2010 and Wahab *et al.*, 2012) [19, 71]. In our daily food menu fish supplies about 60% consumed protein. Fisheries contributes 4.39% to the national GDP and 22.76% (almost one forth) to the agricultural GDP. Around 16.5 million (11% of total population)'s livelihood is associated with this sub-sector. Country's 2.46% export earning comes from fisheries (DoF, 2013) [23]. Bangladesh ranked 5th position in leading aquaculture producing countries in the world just after China, India, Vietnam and Indonesia (FAO, 2015) [26]. It's total fish production shows a consistently increasing trend from the fiscal year 1983-1984 to 2011-2012 and the production increased more than four times (754,000 MT in 1983-1984 to 3,262,000 MT in 2011-2012) (DoF, 2013) [23]. Fisheries in Bangladesh are diverse; there are about 795 species of fish and shrimp in the fresh and marine waters of Bangladesh and 12 exotic species that have been introduced (FAO, 2015) [26]. In the fiscal year of 2010–2011, the total of the country's export earnings from this sector was 2.73 percent (DoF, 2011)

[21]. An estimated 1.4 Million people are engaged fulltime and 12 million people as part time in the fisheries sector (Ahmed *et al.,* 2012) [4, 71]. In the last 30 years, aquaculture has experienced an unprecedented development in global animal production with an average yearly growth rate of over 10% between 1980 and 2000 (FAO, 2010) [25]. By 2050, the world's population will rise from its current level of 6.8 billion and plateau ~9 billion, with nearly all population growth occurring in economically developing countries (Godfray, 2010) [28]. The World Bank (2008) has estimated that the world will need 70-100% more food by 2050, and will need to feed 2.3 billion poor, requiring food production to increase by at approximately 70% from its current levels (FAO, 2009) [24]. The growth of aquaculture, despite its benefits and the fact that it is the only way to meet the increase in demand for sea products evaluated at 192–270 Mt in 2050 (Wijkstrom, 2003) [72], raises a certain number of issues directly related to its sustainable development. Because of its introduction from Thailand the fish is popularly known as Thai pangus (Roberts and Vidthayanon, 1991) [59]. *P. hypophthalmus* is well accepted by a wide range of people and therefore, it has been a good source of protein and calorie poor, medium and better-off people in rural as well as urban areas (David, 1962) [20]. Amongst exotic fish species Thai pangus (*Pangasius hypophthalmus*) is the best due to its easy culture system, favorable weather condition for culture and high market demand (Sarker, 2000) [65] The pond culture of native pangus (*P. pangasius*) was started in 1945 at Khulna region of Bangladesh. But due to the lack of specific technical know-how as well as proper culture management it was neither successful nor so popular to the local people Sarder *et al.* (1994) [64]. Although necessary steps for native pangus culture in closed water condition were taken in 1987 at Chandpur, but the initiative did not face any notable success (Sarker, 2000) [65]. After the failure of native pangus culture the government of Bangladesh imported 100 numbers fry (0.18 g weighted) of Thai pangus (*P. hypophthalmus*) from Thailand in 1990 (Sarker, 2000) [65]. Outside Bangladesh, three important species viz. *P. hypophthalmus, P. larnaudi and P. sanirwangsei* are cultured extensively in Thailand, Combodia and Vietnam both in earthen ponds (Bardach *et al.*, 1972) [14] and in floating net cages (Aguru, 1970) [2] where it reaches up to 3 kg in two years. The survival rate of *P. hypophthalmus* is satisfactory, 85%, stated by Rahman *et al.*, 1992. High density and semi-intensive culture of *P. hypophthalmus* in ponds have been established and are very popular in Bangladesh. Such culture can produce at a rate of as high as 25-30 tons/ha/yr. with protein rich diets (BFRI and BARC, 2001) [16]. Two types of culture systems have been practiced in Bangladesh for *P. hypophthalmus* farming: monoculture (following intensive culture strategy) and polyculture (following semi-intensive culture strategy). The polyculture of carps account about 80% of the total freshwater aquaculture production in extensive and semi-intensive system of Bangladesh (ADB, 2005 and Ahmed, 2005) [1, 3]. The remaining 20% are mainly from pangasius, tilapia, small indigenous species (SIS) of fish and rice-fish farming (Muir, 2003) [46]. In the polyculture systems the production of *P. hypophthalmus* is about 10-12 tons/ha. In the case of the intensive commercial culture, production is about 25-30 tons/ha with animal protein rich diets and water exchange (BFRI, 2001) [16]. Recent survey shows that most of ponds in Bangladesh are not cultured in planned and scientific way, which hampers the pond fish farmers to improve their production and socio-economic status. Over the last two decades spectacular development has taken place in farming of this species in Bangladesh. However in the recent years, economic benefit from this farming is being depleted partly due to increasing feed cost, lack of proper management, unavailability of low cost supplementary feeds and some socio-economic constraints (Akter, 2001) [6]. As a result, it was reported that pangasius farmers are gradually losing their interest to invest in pangasius farming in the study area (Wahab *et al.,* 2008) [70]. To improve the overall conditions of the pangasius farmers, it is necessary to think about the sustainability of Pangus (*Pangasius hypophthalmus*) farming and upgrade the existing pangasius management practices through institutional initiatives (Monir *et al.,* 2011) [45]. Over the last 10 years, pangus farming was accelerating; recently it has been affected negatively by many factors. The pangus farming has been started declining and farmers have identified various issues especially high input cost and low market price, lack of proper management, unavailability of low cost supplementary feeds, unavailability of quality feed ingredients, availability of adulterated ingredients, complex value chain of fish marketing, unethical uses of inputs, socioeconomic constraints etc. The main objectives of the study were, to know the present scenario of Pangus (*Pangasius hypophthalmus*) farming systems and to address the causes affecting the production trend in pangus farming and formulate remedial measures and guidelines for sustainable pangus farming.

2. Materials and Methods

2.1 Study area and periods

The study was carried out to analyze the sustainability of pangus (*Pangasius hypophthalmus*) farming at Jhikargacha region from November 2014- May 2015 (Figure 1). Pangus farmers from four unions of the upazila extensively practiced for pangus culture were studied. The study area is located between $23^0 12'$ to $22^0 56'$ north latitude and $88^0 58'$ to $89^0 08'$ east longitude.

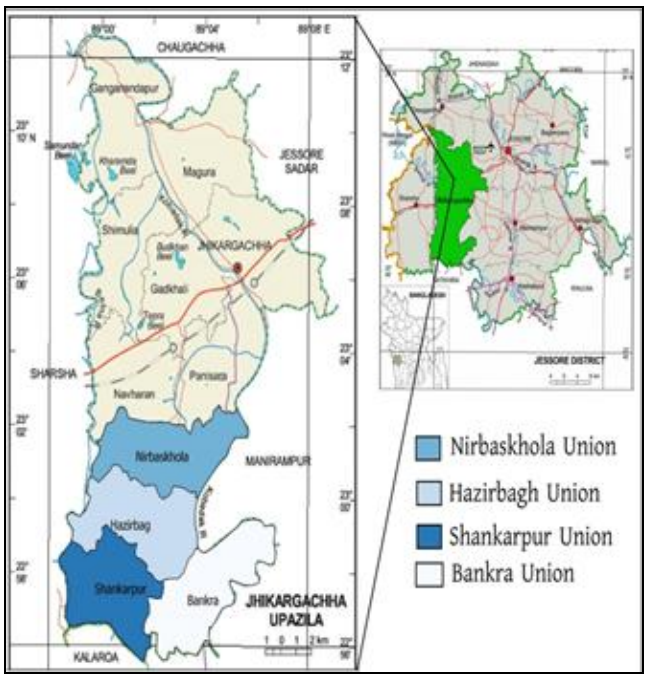

Fig 1. Location of the study area at Jhikargacha in Jessore district.

2.2 Sampling of farmer

The study was conducted through collecting necessary data from a total of 80 farmers from four unions at Jhikargachha upazila under Jessore district. The sampling was done randomly from the list of pangus farmers taken from the Upazila Fisheries Office in Jhikargacha. The details of the respondents are present in Table 1.

Table 1: Distribution of Pangasiid catfish farmers in the study area.

Target Group	Study Area	Sample Size
Pangus farmers	Bankra	20
	Hajirbagh	20
	Nirbashkhola	20
	Sankarpur	20
Total		80

2.3 Data collection methods

The data were collected through direct interviews with the randomly selected pangus farmers. Some information were collected through wider participation of the community is likely to be more accurate and it is an advantage of PRA over other methods. Crosscheck interviews were conducted with key informants such as Upazila Fisheries Officer (UFO), school and college teachers, local leaders and non-government organization (NGO) workers where information was contradictory. The interviews of respondents 20 were conducted in their offices and / or houses.

2.4 Collection of water samples

Water samples were collected from surface to a depth of 35-45 cm of each pond type. On each sampling day, 500 ml of water was collected in a clean black plastic from each pond type. Samples were collected very carefully without any agitation. Each bottle was then marked with respective pond number and replication number. The bottles were then brought to the Laboratory of Fresh water substation, Bangladesh Fisheries Research Institute (BFRI), Jessore to determine ammonia, nitrite, nitrate and phosphorus following the methods of Stirling (1985) [69].

2.5 Processing and analysis of data

The collected data were coded, converted into international units, summarized and processed for analysis. These data were verified to eliminate all possible errors and inconsistencies. Then the data were tabulated into a computer. After the entry of data, it was analyzed using Statistical Package for Social Science (SPSS) and Microsoft (MS) Excel.

3. Results

3.1 General information of pangus farming

3.1.1 Starting of pangus farming

Among 80 surveyed farmers, 9% pangus farmers started farming in 1995-2000, 31% farmers started in 2001--2005, 47% started in 2006-2010, and another 13% farmers started in 2011-14. Almost all interviewed farmers agreed that the primary reason for converting their lands or ponds into pangus farms was to get more profit from pangus culture (Table 2).

Table 2: Starting year of pangus farming.

Starting Year	Bankra (n=20)	Hajirbagh (n=20)	Nirbashkhola (n=20)	Shankarpur (n=20)	Total (n=80)
1995-2000	2 (10)	2 (10)	2 (10)	1 (5)	7 (9)
2001-2005	5 (25)	6 (30)	7 (35)	7 (35)	25 (31)
2006-2010	10 (50)	9 (45)	9 (45)	10 (50)	38 (47)
2011-2014	3 (15)	3 (15)	2 (10)	2 (10)	10 (13)

n= Sample size; Figures in the parentheses indicate percentage

3.1.2 Category of pangus farmers on the basis of farm size

Among the pangas farmers, 21% was found small (<0.5 ha), 49% medium (0.5-1.0 ha) and 30% large (>1.0 ha) farmers. The average farm size of the medium farmers and large farmers were 2.49 and 3.80 times higher than the small farmers (Figure 2).

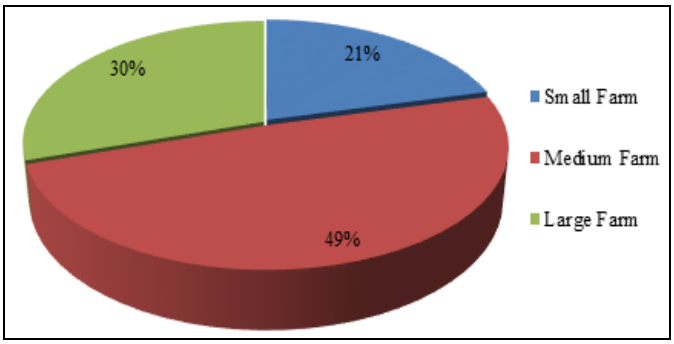

Fig 2: Category of pangus farmers in the study area.

3.1.3 Farmers perceptions and knowledge about pangus

In the study areas, a good number of farmers 90% made various comments on the advantages of pangus culture. Its fast growth was identified as an important advantage. It has an important role in meeting household consumption needs throughout the year. It's easy harvesting was appreciated by the farmers (Table 3).

Table 3: Farmers perceptions and knowledge about pangus.

Advantages of pangus farming	Total (n=80)
Fast growth	11
High yield	8
Ease of rearing and can be stocked at high density	9
Ease of seed production in the hatchery	5
High resistance to disease	2
Easy to harvest	25
Can be marketed in live condition	20

3.1.4 Age structure

Knowledge of the age structure of pangus farmers is important in estimating potential productive human resources. There was a very little difference between the zones, of the interviewed farmers, 14 % were up to 30 years old, 41% between 31-40, 30 % between 41-50 and 12 % were more than 50 years old. The highest percentages in four areas were in the range 31 to 40 age group. Bankra having the highest percentage in this group (50%), Hajirbagh was 45%, Shankarpur and Nirbashkhola were 40 % (Table 4.).

Table 4: Distribution of pangus farmers according to their age groups.

Age Distribution	Bankra (n=20)	Hajirbagh (n=20)	Nirbashkhola (n=20)	Total (n=80)
Up to 30	3(15)	2(10)	2(10)	11(14)
31-40	10(50)	9(45)	6(30)	33(41)
41-50	5(25)	6(30)	8(40)	24(30)
Above	2(10)	3(15)	4(20)	12(15)

n= Sample size; Figures in parentheses indicate percentage

3.1.5 Education level of pangus farmers

The interviewed pangus farmers were found literate with four levels of education; (I) No education (illiterate) (ii) Primary level i.e., 1 to 5 class, (iii) Secondary level i.e., up to S.S.C level, (iv) Higher secondary level i.e., up to xi and xii class (v) Bachelor i.e., up to degree. Result of the present investigation indicate that 10% of farmers was illiterate, 34% had primary level of education, 37% had secondary, 14% had higher secondary and only 5% had Bachelor degree (Figure 3).

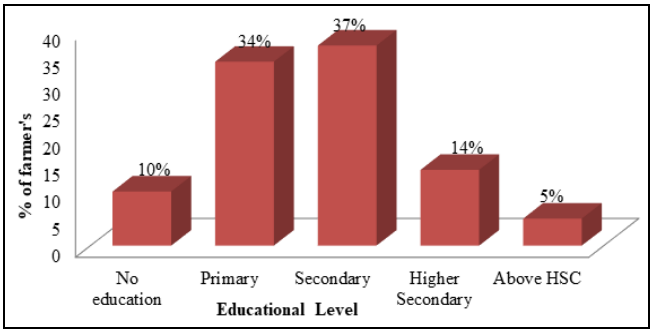

Fig 3: Distribution of pangus farmers according to their educational level

3.1.6 Family types

In rural Bangladesh, families are classified into two types: i) Nuclear family: married couple with children, and ii) Joint family: group of people related by blood and/or low. In the pangus farming community, it was found that 35% of farmers lived with nuclear families, and 65% lived with joint families. The highest percentage of pangus farmers with nuclear family structure was found in Hajirbagh (45%) and joint family in Nirbaskhola (75%) (Figure 4).

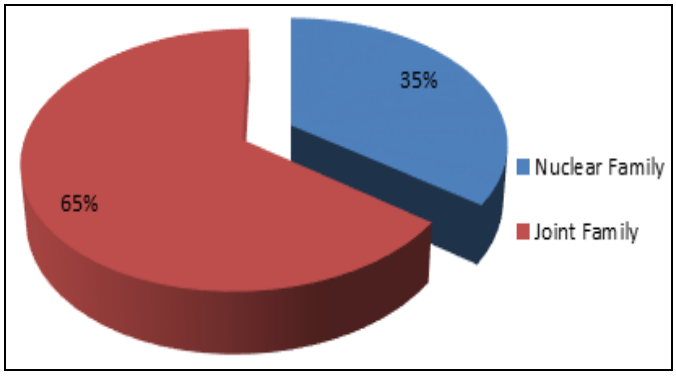

Fig 4: Family type of the farmer's

3.2 Land use of pangus farmers

Pond features of different categories farmers are shown in (Table 4.4). The average pond area of the medium and large farmers are 2.49 and 3.8 times higher than the small farmers, while the surface area of the medium and large farmers are 2.60 and 3.93 times higher than the small farmers and the dyke area of the medium and large farmers are 2.12 and 3.38 times higher than the small farmers (Table 7)

Table 7: Pond characteristics of different cat fish farmers in Jhikargacha upazila.

Farm Type	Total pond area (dec)	Surface (dec)	Dyke (dec)	Surface area (%)	Dyke area (%)
Small	$82.05^{\pm 17.30}$	62.64±13.95	19.29±204.35	76.34	23.51
Medium	204.35±26.94	163.30±19.87	41.05±7.38	79.91	20.08
Large	312±44.18	246.67±27.60	65.33±19.967	79.06	20.93

n= Sample size; Figures in parentheses indicate percentage

3.3 Pond ownership

In the study area, it was found that the percentage of pangus farms who have own pond without partnership is 28%. The maximum percentage of pangus farmers who have lease pond is 46 % and rest 26% have both leased and own ponds (Figure 5).

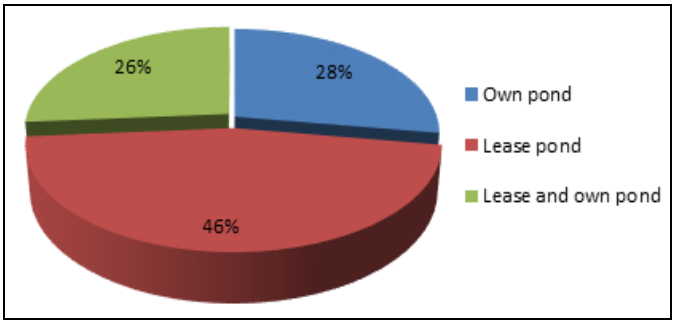

Fig 5: Pond ownership of pangus farmers

3.4 Soil types of ponds

Loamy soil is suitable for pangus farming and sandy, clay soils are not suitable. From the study, it was found that 66% pond had loamy soil, 24% had sandy loamy, and the rest 10% had silt loamy soil (Figure 6).

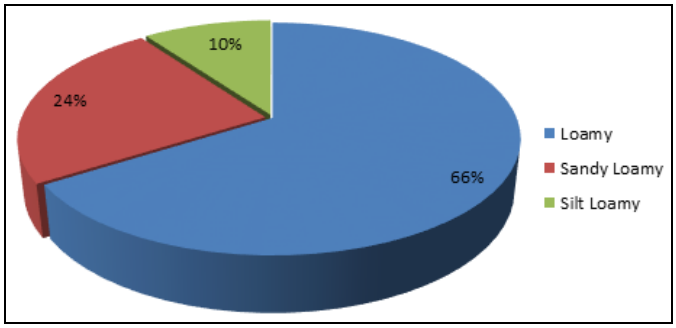

Fig 6: Soil types of pangus pond.

3.5 Water use and water exchange

In the study area all of the farmers generally use underground water in their Pangasius pond. Most of them have own water facility. The People who have no own water facility, they get underground water from nearby deep tube well by means of

payment. In the study area, there is very poor percentage of farmer who usually exchanges his pangasius pond water in a year. Only 19% of farmer exchanges water in their pond and 81% people don't exchanges water in the pangasius pond but very often they added extra underground water in their pond when they need. It was found that the cost of water use increased gradually from small farmers to medium farmers and then large farmers. The costs of water use in medium and large farmers were 1.01 times and 1.3 times higher than the small farmer (Figure 7).

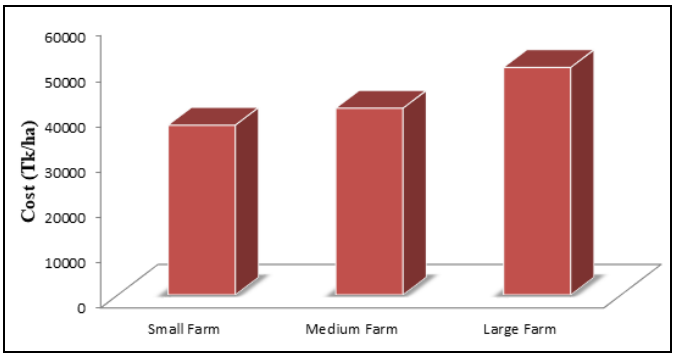

Fig 7: Cost (Tk/ha) of water use in different types of pangus farmers.

3.6 Use of chemicals and fertilizers

The chemicals and fertilizers use pattern in the study is presented below, where out of 80 farmers almost all the farmers use different types of chemicals. In the study area, the farmer use different type of chemicals and fertilizers like lime, geolite, matrix, salt and Triple Super Phosphate (TSP) in their pangus pond. Usually when they face any problem in their pond, they usually take suggestion from the nearby feed and aqua medicine trader, or representative of feed and medicine company. Among all the farmers about 56% farmer use lime, 20% use geolite, 1% use matrix, 4% use salt, 8% use and 11% use some other antibiotics or chemicals. Lime is used mainly to remove gas (e.g. ammonia) and improve health condition, geolite is used for pH control and to prevent disease, matrix is used to remove bad smell of sediment, salt is used to improve quality of soil as well as water, and TSP is used to control pH. Among the chemicals, lime is used by most of the farmers, and it is six times higher than the matrix user and two times higher than the matrix user. Salt and TSP are also used by pangas farmers but these are three times lower than lime (Figure 8).

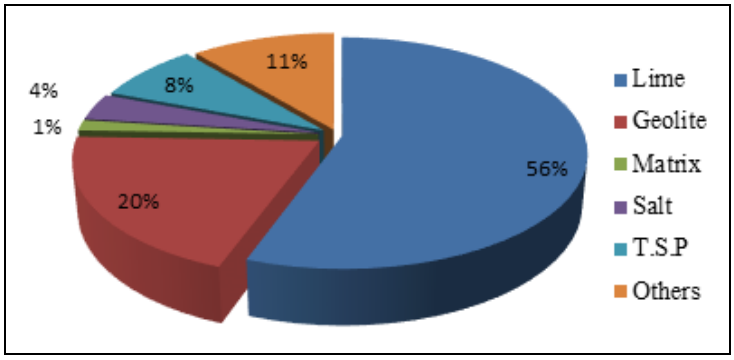

Fig 8: Use of Chemicals and Fertilizers in different types of pangus farmers.

3.7 Use of feed

Over 20 different feed companies supplied feed to the pangus farmer in the study area. Among them Mega Feed Co., City Group, Paragon Feed, Lucky Feed Co., Rupali Feed, CP Feed, ACI, Teer Feed, Afil Fish Feed, Khan Fish Feed, Fresh Fish Feed, National Feed, Saudi Bangla Fish Feed, Quality Feed and AIT are the major companies. But most of the farmers prefer mainly six feed companies. It was found that 17% farmers use Mega feed, 15% use Fresh feed, 14% use Rupali feed, 9% use Paragon feed, 23% use Teer feed, 11% use CP feed and 11% use other feed (Figure 9).

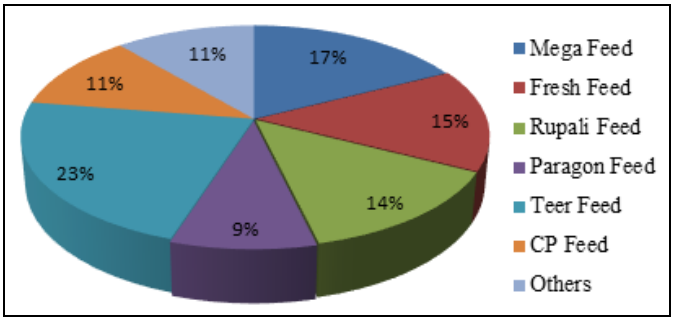

Fig 9: Use of different companies Feed in different types of pangus pond.

3.8 Culture season and methods

In the study area it was found that 96% farmers cultured pangus with other fish (poly culture), whereas only (4%) farmers cultured only pangus (monoculture). Highest percentage (100%) of polyculture farmers was found at Hajirbagh and Nirbaskhola. Maximum poly culture farmers used carps fish like rui, catla, silver, mrigal (Table 8).

Table 8: Pangas culture system

Culture methods	Bankra (n=20)	Hajirbagh (n=20)	Nirbaskhola (n=20)	Shankarpur (n=20)	Total (n=80)
Poly culture	18(90)	20(100)	20(100)	19(95)	77(96)
Mono culture	2(10)	-	-	1(5)	3(4)

n = Sample size; Figures in parentheses indicate percentage

3.9 Sources of pangus fries and fingerlings

About 46% of the farmers collected fingerlings from the nearby nursery, 43% of the farmers collected fries/fingerlings from the fry traders and 11% from the local private farms or Hatchery. Fingerlings size varies from 1 to 2 inch with price of TK. 0.8-1/fingerling. The fry traders transported pangasiid catfish in poly venyle chloride (PVC) drums on pickup vans (Table 9).

Table 9: Sources of pangus fries/ fingerlings

Sources of fries / fingerlings	Number of farmers				
	Bankra (n=20)	Hajirbagh (n=20)	Nirbaskhola (n=20)	Shankarpur (n=20)	Total (n=80)
Fry Trader	7 (35)	9 (45)	10 (50)	8 (40)	34 (43)
Nearby nursery	10 (50)	8 (40)	9 (45)	10 (50)	37 (46)
Hatchery	3 (15)	13 (15)	1 (5)	2 (10)	9 (11)

n = Sample size; Figures in parentheses indicate percentage

3.10 Stocking density of pngus farming with other species

In the study area, all of the farmers maintain stocking density for pangus culture with other species. The farmers mainly stocked pangus with some other fish species like Monosex Tilapia, Silver carp, Grass carp, common carp, Bata, Mrigal, Rui and Catla. It was found that maximum stocking density were pangus and monosex tilapia (Figure 10).

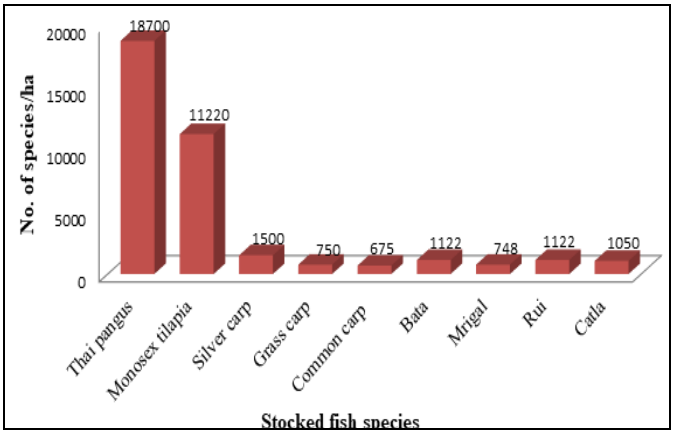

Fig 10: Stocking density of pangus farming.

3.11 Total sale of pangus

The production of larger farmers is 1.02 (29022 kg/ha) times higher than the small farmers and 1.01 times higher than the medium farmers. The returns of the large and medium farmers are comparatively stable; that of the small farmers are not so stable. Sometimes they are looser can not sale their products (Figure 11).

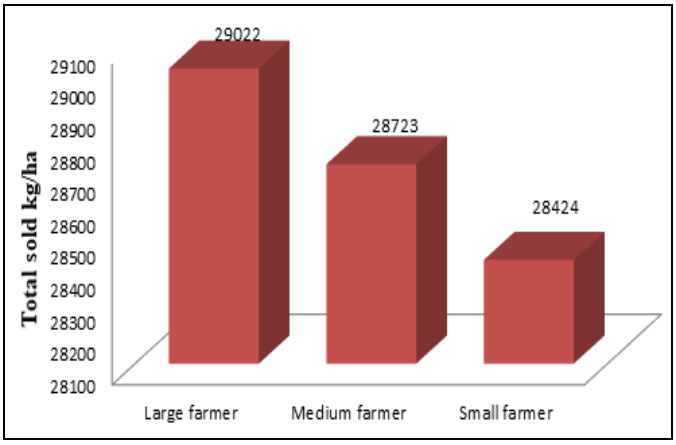

Fig 11: Total sale of pangus in different types farmers

3.12 Total income of pangus farmers

The income of large farmers is 1.02 (Tk. 3192420) times higher than the small farmers and 1.01 times higher than the medium farmers. Large farmers always get higher profit. However, small and medium farmers also get some profit, but sometimes they loss drastically and where the small farmers face the highest loss (Figure 12).

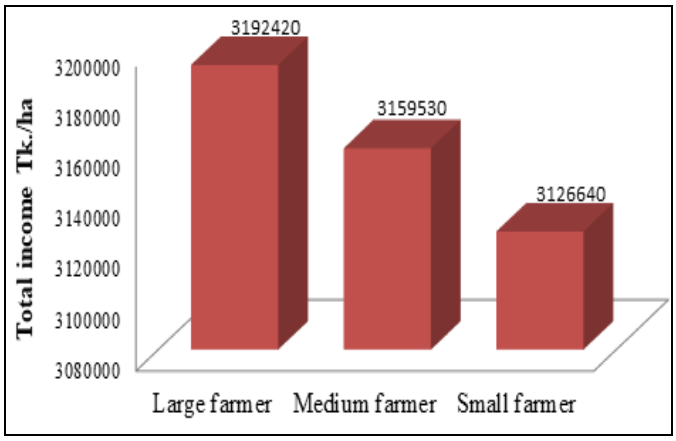

Fig 12: Total income of different types of pangus farmers

3.13 Cost and benefit of pangus farming

The pangus farming is very expensive as it is feed dependent culture system. The cost items are fingerling, feed and fertilizers, chemicals, labor costs, water use and others. Head wise cost and returns are mentioned clearly in different farm types (Table 10).

Table 10: Cost and benefit (ha-1 crop-1) pangas farms in the study area.

Particulars	Cost and income in different farm types		
	Small farm	Medium farm	Large farm
A. Cost items			
1. Lease value	112200	112200	108460
2. Pond preparation	80760	74800	71060
3. Fry/fingerling	308550	299200	284240
4. Feed	2334096	2350200	2341240
5. Chemicals and fertilizers	12342	11968	11500
6. Harvesting cost	123420	119680	115940
7. Others	62500	58550	56100
Total	3033868	3026598	2988540
Total production (kg)	28424	28723	29022
B. Total income	3126640	3159530	3192420
Benefit	92772	132932	203880

3.14 Experience and training of pangus farming

It was found that 15% farmers learned the pangus culture technology themselves through learning by doing. About 48% gained experience from friend and neighbors, 16% farmers acquired experience from NGO and remaining 21% obtained experience from GO's (DoF, BFRI etc.). The highest percentage (48%) of farmers learned the farming of pangus from friend and neighbors and then from GO's (DoF, BFRI etc.) (Figure 13).

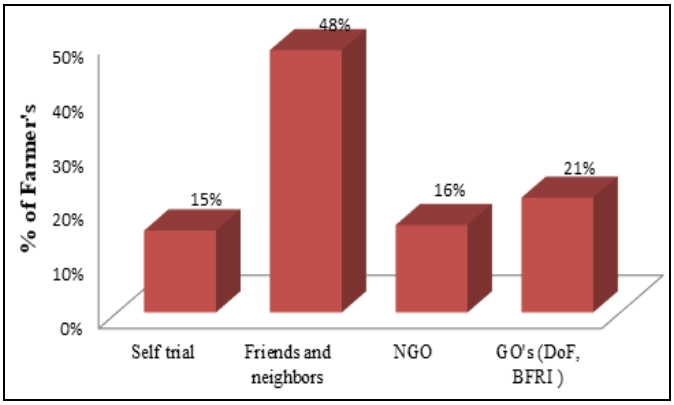

Fig 13: Experience of Pangus farming in Jhikargacha area

3.15 Credit facilities for pangus farmers

Institutional credit facility for pangus farmers was found to be very limited. Only 20% pangus farmers were found to have access to institutional credit. Two banks, the Bangladesh Krishi Bank (BKB) and Grameen Bank was found as the major sources of institutional credit for pangus farmers in the studied areas (Figure 14).

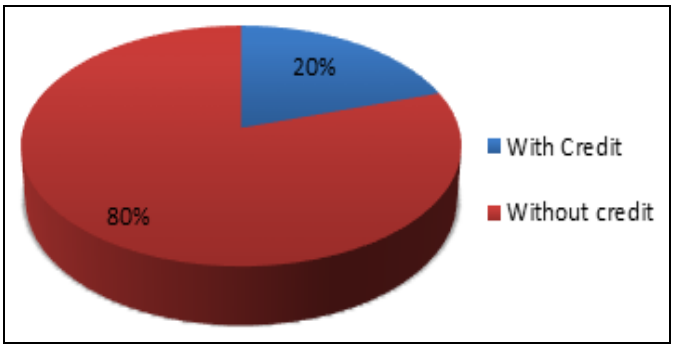

Fig 14: Credit facilities for pangus farmers.

3.16 Impacts of pangas farming on water quality

It was found that the highest ammonia, nitrate, phosphorus was respectively 0.89±0.16 ppm, 0.30±0.06 ppm, 5.03±0.21 ppm in three different categories of pangus farm (Table 11).

Table 11: Impacts of pangus farms on water quality.

Sample No.	NH3-N (ppm)	NO3-N (ppm)	PO4-P (ppm)
Large (>1.0 ha)	0.89±0.16	0.07±0.01	2.27±0.04
Medium (0.5-1.0 ha)	0.32±0.06	0.21±0.03	5.03±0.21
Small (<0.5 ha)	0.65±0.11	0.30±0.06	2.12±0.03

3.17 Socio-economic condition of pangus farmers

Though farmers living condition are poor the survey suggests that they have improved their socio-economic condition through pangas, as narrated by 69% of pangas farmers. In the table shows the highest percentage of positive response was found in Bankra (80%) (Table 12).

Table 12: Opinion of pangas farmers about their socio-economic status in the surveyed areas.

Improved condition	Name of Union				
	Bankra (n=20)	Hajirbagh (n=20)	Nirbaskhola (n=20)	Shankarpur (n=20)	Total (n=80)
Yes	16(80)	13(65)	14(70)	12(60)	55(69)
No	4(20)	7(35)	6(30)	8(40)	25(31)

n = Sample size; Figures in parentheses indicate percentage

3.18 Constraints of pangus farming

It was found that the pangus farmers at Jhikargacha upazila of Jessore area were facing a number of technical and social constraints during pangus farming. The major problems were lack of capital, high price of quality feed, highest price of fingerlings of pangus, inbreeding fry produced in hatcheries, adulterated feed, transportation problem, marketing problem, poor technical knowledge etc. (Table 13).

Table 13: Key constraints of pangasius farming in the study area.

Constraints	Number of farmers				
	Bankra (n=20)	Hajirbagh (n=20)	Nirbaskhola (n=20)	Shankarpur (n=20)	Total (n=80)
1. Lack of scientific knowledge	3 (15)	2 (10)	2 (10)	1 (5)	8 (10)
2. High price and low quality of feed	4 (20)	3 (15)	2 (10)	2 (50	10 (12)
3. Poor quality of fries	5 (25)	6 (30)	8 (40)	5 (25)	24 (30)
4. Lower growth	4 (20)	5 (25)	6 (30)	8 (40)	23 (29)
5. Low market price	2 (10)	3 (15)	1 (5)	3 (15)	9 (11)
6. Financial problem	2 (10)	1 (5)	1 (5)	2 (10)	6 (8)

n = Sample size; Figures in parentheses indicate percentage

4. Discussions

It was observed that the highest portion of the farmers 48% acquired their fish farming experience from friends and neighbors, 15% of the farmers learned the pangus culture technology themselves through learning by doing. Asif *et al.* (2014) [12, 34] stated that,only 33% of the fish fry and fingerling traders attained training and the rest had no training knowledge Sharif and Asif (2015) [35, 49, 67, 68] reported that, only 15% of the nursery operators attained training and the other had no training knowledge. Islam (2009) [36] observed that 43% farmers acquired their fish farming experience from friends and neighbors, the highest portion of the farmers (47%) gathered their knowledge from different institutions (e.g. DoF, BFRI). found in his study that about 49% farmer's fish farming experience from friends and neighbors in observed that about 45.56% pangus farmers gained experience from friends and neighbors, Mymensingh Aquaculture Extension Project (MAEP) and DoF. In the present study it was found that most of the farmers (41%) belong to the age group 31-40 and this was their main occupation. Kaiya *et al.* (1987) [39] stated that fish culture efficiency varied with the age and number of owners of pond which shows the similarity with the age group only. Rana (1996) [57] found in his study in Sirajgonj district that 70% ponds farmers were in 18-45 age groups. Asif *et al.* (2014) [12, 34]; Islam *et al.* (2014) [34]; Asif *et al.* (2015) [35, 49, 67, 68]; Sharif *et al.* (2015) [35, 49, 67, 68]; Islam *et al.* (2015) [30] and Razeim *et al.* (2017) [58] did more or less similar study compare with the present study. It was found that the average pond size was 0.17 ha, and production from the large farms the highest 34%. Size of pond is an important variable for the production of fish as analyzed by Islam and Dewan (1987) [39]. Return on

per pond basis under different pond size had a direct and positive relationship with input use; however, on the basis of per unit area pond efficiency was greater in medium size pond (Mollah, 1986) [44]. have reported that in Chandpur districts 82% pond were up to 0.20 ha. According to BBS (1984) 80% ponds in rural areas are less than 0.13 ha. Khan (1986) [41] stated that fish culture efficiency varied with the size of ponds. found that the average pond size was 0.12 ha. Saha (2003) [61] found that the average pond size was 0.21ha in Dinajpur sadar upazila and Saha (2006) [62] observed that the average pond size was 3.00 acre in Mymensingh region. Therefore, the pond size in the current study area was sustainable for pangus farming. Asif *et al.* (2014) [12, 34] reported that, the average size of the pond is 15 decimal to 30 decimal, which is similar with the present study. It was found that in small farm dyke area is the highest (23.51% of total pond area) and in large farm, dyke area is the lowest (20.93% of total pond area). In the present study, 28% of farmers have own pond without partnership, 46 % have leased pond and rest 26% have both leased and own ponds. Quddus and Moniruzzaman (2000) [48] observed that 34% ponds were under leased, and the rest 12% ponds were public or organizational property in Demra, Dhaka. Kundu (2006) [42] found that the leasing cost varied from Tk. 25,000-35,000/ha/yr. in Khulna district. Revealed, 32.50% ponds were owned by the respondents themselves. 67.50% culture ponds were leased ponds. It was found that 15% ponds were seasonal; remaining 85% ponds were perennial and also need to be filled during the dry season. Saha (2003) [61] observed that 17% ponds were seasonal and 83% ponds were perennial in Dinajur sadar upazil which supports the present study. It was observed that 66% ponds were with loamy soil, 24% with sandy loamy and rest 10% with silt loamy soil. Stated that 19% of the fish pond owners mentioned sandy soils of the ponds are a major problem in Rangpur district. Commercial fish feeds produced by different Industries (e.g. Mega feed, Fresh feed, Paragon feed, Teer feed, CP feed etc.) feeds used in the farming of the pangus in the studied areas. observed the growth performance of (P. Pangasius) in obtained at 40% protein level in feed containing cow viscera, mustard oil cake, wheat bran and rice bran. Akter (2001) [6] observed that the total dose of fish was 6,751kg/ha which were separately given as rice polish(1,598kg), wheat bran (870kg), oilcake (2,540kg), vitamin (41kg), fish meal (1,702kg) etc. Kausari (2001) [40] found the dose of feed was 38,916kg/ha. Found the dose of rice bran and oilcakes were 2731and 584kg/ha. Saha *et al.* (1997) [60] found the dose of rice bran and oilcakes were 2731and 584kg/ha respectively. Asif *et al.* (2014) [12, 34] reported that mustard oil cake, rice bran, wheat polish was used in fry rearing in Jessore. Reported that, in the case of rice bran, the daily mean application rate was found 444.23±236.41 kg/ha. The maximum and minimum daily application rate was found 1086.8 kg/ha and 148.20 kg/ha respectively. Fish meal, Rice polish, Mustard oil cake, Maize meal, Soyabean meal, ata and vitamin premix (Shabuj *et al.*, 2016) [10, 66]. Found the more or same results. The average FCR was 2 in all types of pond. Azimuddin *et al.* (1999) [13] found FCR of *P. hypophthalmus* from 1.73 to 2.04 in case of 40-50 and 60 fish 1m3 stocking density and reported FCR ranges from 2.10 to 6.86 in aquarium culture of *P. hypophthalmus*. Pathmasothy and Jin (1987) [47] found FCR was 2.27 to 3.66 when fed diet with 32% protein. The finding of the present study supports the above findings. Out of 80 farmers, most of them used chemicals and fertilizers. They used mainly lime, geolite, matrix, salt and TSP. Very poor number of farmers also used Vitamix F Aqua Premium, timsen, somethion, salt, provt-gel, oxytetracycline, oxy care, copper sulphate, bleaching powder, potash, etc. Shabuj *et al.* (2016) [10, 66] stated that urea, TSP and organic manure such as cowdung, mustard oil cake were used in pangus brood rearing. Application rate of various fertilizers during post stocking management were recorded as- cow dung, 155.12±79.10 kg/ha (49.4 to 358.15 kg/ha); urea, 158.27±79.85 kg/ha (46.93 to 370.50 kg/ha); TSP, 79.90±42.93 kg/ha (24.70 to 185.25 kg/ha). In the study area, the peak harvesting season were from June to July and November to December. Observed the peak period of harvesting from October to January. Ahmed (2003) [5] stated the peak harvesting season was April to July and found that 65%of farmers harvested their fish completely and only 35%of farmers harvested partially. Stated that the average price was TK.55. This difference was due to increasing price of feed and demand of pangus. It was found that the pangus was sold Tk. 50/Kg in the wholesale market. The present study is more or less similar with the study of Asif *et al.* (2014) [12, 34]; Islam *et al.* (2014) [34]; Asif *et al.* (2015) [35, 49, 67, 68]; Islam *et al.* (2015) [30]. In the study the average fish production was 28,723 kg/ha/yr., where the average pangus production was 16,156 kg/ha/yr. in the three types of farmers. It was found that all ponds were order polyculture system and farmers stocked mainly pangasius along with Indian major carps and some exotic carps. Bardach *et al.* (1972) [14] observed in Thailand *Pangasius larnandi* attained an average weight of 0.45 kg on the termination of one year and 1.0 kg in two years when stocked at 25 fish/m3. However, obtained 41.36 kg/decimal (9.97 ton/ha) fish in a poly culture experiment with pangus and carp species. Sarder (1992) [63] obtained a production of 588.72 to 1901.79 g/m3 of pangus (*P. pangasius Ham*) in six months when stocked at the rate of 3-6 fish/m3. Found 35.47 kg thai pangus per decimal in 120/decimal stocking density. Akter (2001) [6] conducted a survey in Trishal upazia under Mymensingh district and found that average production of pangus was 20,112 Kg/ha. Kausari (2001) [40] found that average production of pangus was 21,340 Kg/ha. Reported that, the overall production was found 6672.84 kg/ha. The previous study is more or less similar with the present study. The mean sell by large, medium and small farmers were 29022; 28723 and 28424 kg/ha/yr., respectively. The mean income of the large, medium and small farmers is 31,92,420; 31,59,530 and 31,26,640 Tk./ha /Yr. It was observed that, large farmer always earn the highest profit from pangus. Which is similar with the study of Asif *et al.* (2014) [12, 34]; Islam *et al.* (2014) [34]. Among 80 farmers, 65 the farmers never changes water from the pond, only 15 farmers changed water 1 time per year. John *et al.* (2004) [38] observed that some ingredients from this feed are settled down in the pond bottom that creates some nitrogenous compound, very often these compounds have toxic effects on water quality and ultimately on sound fish farming. Haque (2008) [70] stated it was already practiced in Vietnam and they produce in higher density and highest amount of pangus. So, water exchange was not satisfactory in the pangus farms in study area. In the study area it was found that the highest ammonia was 0.89±0.16 ppm. Boyd (1998) [17] observed that desired concentration of ammonia <0.1ppm in aquaculture pond water. Around 69%

farmers improved their social and economic status through pangus farming. Now they can afford better food, housing conditions and education. Miah (2001) [43] reported that 85% pangus farmers and related people were economically and socially benefited due to pangus farming. Gupta (1996) [29] reported more or less similar result and observed that 70% of the farmers were economically benefited and happy with the fish production technology. The result of the present study is comparatively lower than the above findings due to poor infrastructure, credit and marketing facilities in this region. Therefore, the socio-economic benefits of pangus farmers were not worthy. The major constraints mentioned by the farmers were lack of scientific knowledge, high price and low quality of feed, inbred fry produced in hatcheries, improper proportion of protein in feed, poor water quality, lack of credit facility, lower growth and lower market price. Stated farming constraints were lack of money and higher production cost. Stated that the non-availability of fish fingerlings: both indigenous and exotic species was the major problem in Rangpur district. Observed that the problem faced by the fish farmers is multiple ownership. Akter (2001) [6] stated that the major problems were also lack of credit, lack of scientific knowledge, high price of input and low price of fish etc. stated that the majors problem were lack of proper knowledge, poor market price of fish, lack of knowledge on water quality maintenance. The constraints study was conducted by, Asif *et al.* (2014) [12, 34]; Yeasmin *et al.* (2015) [11]; Sharif and Asif (2015) [35, 49, 67, 68]; Chowdhury *et al.* (2015) [18] and Razeim *et al.* (2017) [58], which is more or less similar with the present study.

5. Conclusion

Pangus farming has been practiced since 1998 in the study area. The pangus farmers faced a lot of constraints over time. But recently because of several critical constraints associated with pangus farming, they have been losing their interest in this popular enterprise. To improve the socio-economic conditions of the pangus farmers, it is necessary to upgrade the existing pangus farming management practices and overcome constraints they severely faced.

6. References

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