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Impact of technology on fish production in north east region of Bangladesh

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Abstract
A quest was conducted to assess the existing technologies used by the fish farmers and its impact on the fish production in north east region of Bangladesh (Sylhet district) from July, 2015 to June 2016. Three upazilas were selected as experimental sites viz. Sylhet sadar, South surma and Golapganj under Sylhet district. There were highly significant differences ($P \leq 0.05$) in the uses of cow-dung, urea, triple superphosphate (TSP), lime, rice barn and mustard oil cake between semi-intensive to extensive culture technology in the farmer level. Cost item parameters such as fingerlings, feed, fertilizers, human laborers, harvesting and marketing and miscellaneous also revealed highly significant difference ($P \leq 0.05$) between semi-intensive and extensive culture technology except for land use cost ($P \geq 0.05$) and production output also expressed similar result. The mean values of the parameter net profit for extensive and semi-intensive culture were 78330.00±19223.85 tk/ha/yr and 419470.00±368024.69 tk/ha/yr respectively. In epilogue, semi-intensive technology had a highly positive impact on fish production as well as it was more profitable for aquaculture in north east region of Bangladesh (Sylhet district).

Keywords: aquaculture, technology, semi-intensive, extensive and cost item

1. Introduction
Bangladesh is an agro-based country and is striving hard for rapid development of its economy [6]. It is often argued that the future development of the country depends particularly on the agricultural sectors and plays a vital role in the socio-economic development of rural area, fulfilling the animal protein demand, creating employment opportunity, alleviating poverty and earning foreign exchange for the country [20]. About 18.2 million people directly or indirectly earn their livelihood by fisheries related activities [8]. Fish and fisheries are indispensable part in the life and livelihoods of the people of Bangladesh [5]. Freshwater fish farming plays primal role in the livelihoods of rural people in Bangladesh [18, 19]. It creates diverse livelihood opportunities for the people who are living below the poverty level [3, 16]. Pond fish farming is more profitable business than rice cultivation so that many farmers in rural areas are converting their rice field into aquaculture pond [12]. In rural areas pond fish farmers have taken fish farming activities as a secondary occupation and most of the farmers improved their socioeconomic condition through pond fish farming activities [16].
Most of the freshwater pond fish farming in Bangladesh is dominated by either extensive or semi-intensive and in very few cases intensive [22]. In semi intensive culture system fertilizer (mainly cow dung, Urea and TSP) is used irregularly and supplementary feed such as rice-bran and oil cakes are given on the contrary, fishes are grown on natural feeds and fertilizer in extensive method [22]. Most of the farmers carried out monoculture of fishes and cultured mainly Tilapia and Pangus. The development of aquaculture can only be enhanced by the introducing modern technologies. While there have been instances of successful introduction of technologies to boost up production in Bangladesh [28]. The major problem has been the lack of appropriate technology [9, 10, and 29]. Aquaculture technologies have been developed and disseminated to farmers while some scholars have stated that what is needed is to develop the technologies and make them available [10, 13], others insist that the transfer of technology would be more effective when there is a greater interaction among the developers, transfer agencies and the farmers [10].

However, the crucial point for the farmers is to be able to afford any technology extended to them [10]. But, the inability of farmers to afford the technologies extended to them that made farmers abandons the ponds [10]. Rogers [23] has added another dimension by stating that the adoption of technology can be affected by the way it is named and positioned.

There are different types of water bodies are available in study area so fishermen are used different type of culture techniques to achieve more production. Therefore, the aim of the quest was undertaken to explore the types of technologies are used for fish production, the changing trend of livelihood of fish farmers, the opportunities and constrains of fish farming and the effects of technology on fish production at local level in Sylhet district.

2. Materials and Method

2.1 Study area, Target group and Period of the study

The research was accomplished in Sylhet district covering three Upazilas namely Sylhet sadar, South Surma and Golapgonj (Fig. 1) considering farming areas, livelihoods dependency on farming, communication and activities of GOs and NOGs on fish farming. Majorities of targeted fish farmers were small and marginal farmers, who are generally poor but had some rich farmers from solvent families. The data were collected from July 2015 to June2016.

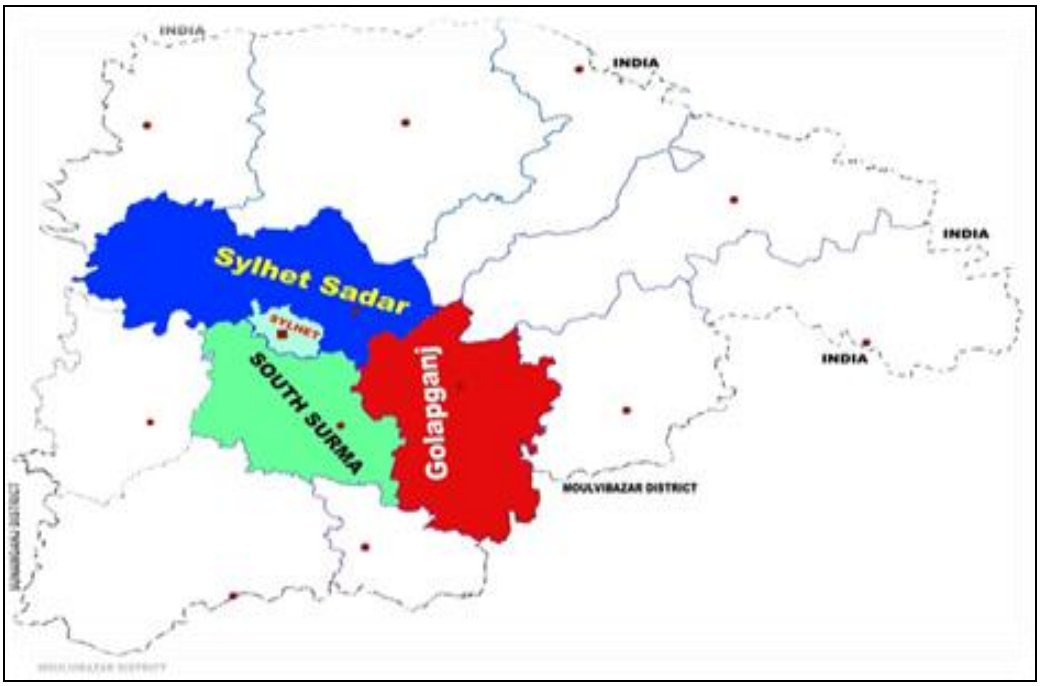

Fig 1: Map showing the study area in Sylhet district

2.2 Sample number and sampling procedure

For questionnaire interview, simple random sampling method was followed for fish farmers. Among 200 sample farmers, 65 were selected from Sylhet sadar Upazila and the other 65 from South Surma and rest samples from Golapgonj Upazila of Sylhet district. A total of 20 Focus Group Discussion (FGD) sessions was conducted where each group size of FGD was 5 to 7 farmers. For collecting data both individual and group interviews were also applied with different degree of effectiveness of the farmer's information.

2.3 Data collection, Data processing and analysis

The data were collected using pre-prepared face to face questionnaire interview and Focus Group Discussion (FGD) with fish farmers and crosschecked those data by various resource person and institution of that area. The collected data were scrutinized and summarized carefully before the actual tabulation. Some of the data were collected into local units and later converted into international units. After data entry, the data were analyzed with SPSS (Statistical Package for Social Science) version 11.5 and independent t-test was used to compare the mean value of the extensive and semi-intensive technologies.

3. Results and Discussion

3.1 Background of fish farming

Among the 200 respondents 17% fish farmers started fish farming in 1989 or before, 31% farmers started between 1990 and 1994, 34% between 1995 to 1999 and 18% after 1999. Islam [11] found that a large number of farmers (60%) started fish farming within 1991 to 2000, 20% were within 2001 to 2010, 15% within 1981 to 1990 and rest within 1970 to 1980 in the study area in Dumki upazila under Patuakhali district. Most of the interviewed farmers reported that the primary reason of fish farming was to get high income from the sale of production. The farmer's accentuated that fish farming is more profitable than agrarian farming.

3.2 General features of fish ponds

3.2.1 Pond ownership and size

In the study area 77% of the farmers have single ownership pond and 23% have ponds of multiple ownership. The average pond size in the study area was found to be 0.10ha. That's why the farmers can easily manage their pond during culture as well as harvesting. These results were matched with the findings of Rana [22] who observed that average pond size was 0.14 ha with 81% single and 19% multiple-ownership of the ponds in Golapgonj upazila under Sylhet district. Sarker and Ali [24] found that average pond size was 0.13 ha in Sreemangal upazila under Moulvibazar district. Ali [5] also found that average pond size was 0.13 ha with single ownership (64%) and multiple ownerships (36%) in Bagmara upazilla under Rajshahi district.

3.2.2 Pond type
The study revealed that ponds were of two categories: seasonal and perennial. The seasonal and perennial ponds were 60% and 40% respectively. Rana [22] observed that 45% of the ponds were seasonal and 55% ponds were perennial in Golapgonj upazila under Sylhet district. Ali [5] claimed that 46% of the ponds were seasonal and 54% ponds were perennial in Bagmara upazilla under Rajshahi district. The water levels of perennial ponds drop during dry season and become unsuitable for fish culture for that some farmers pump water to their ponds to increase water level. Seasonal ponds also become inappropriate for fish culture during dry season. The sandy soil properties are an important cause of drying during dry season. This finding is similar with the finding of Rana [22].

3.3 Fish production technology
3.3.1 Experience of fish farmers
According to the quest, 15% of the farmers gained experience by self-study, 67% obtained experience from Department of Fisheries (DoF), 5% from friends and neighbors, 4% from relatives and 9% from NGOs (Fig. 04). Islam [11] found that majority of farmers (65%) gained their experience from relatives, 2% friends and neighbors, 10% self-education, 5% DoF and 6% NGO's in Dumki upazila under Patuakhali district.

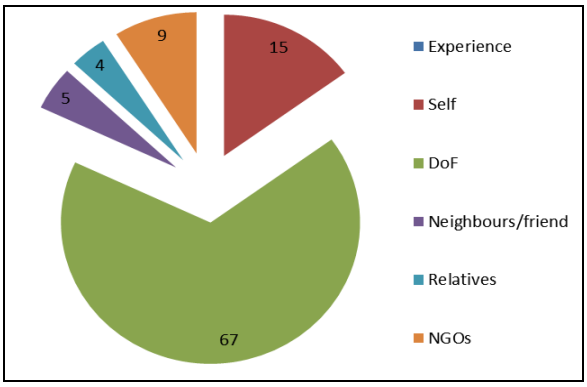

Fig 2: Source of fish farmer experience in the study areas

3.3.2 Culture season and method
The fish farming season of the study area is from February to December. During February to March ponds are prepared for the fish culture. Fish fries are stocked when they become available in April to June and the cultured fishes are harvested primarily during December to January. Most of the farmers (85%) carried out monoculture of fishes and cultured mainly Tilapia and Pangus. Among the surveyed ponds 1% was under integrated culture system. Rana [22] observed the season of fish farming is from April to December while fish fries were stocked April to July and harvested during December to January. Ahmed [1] observed that peak period of carp polyculture was from April to December whereas Rahman [21] reported that the season of carp farming was from March to December.

3.3.3 Pre-stocking management
Pre-stocking management of ponds in the study area comprises dike repairing, aquatic weed and undesirable species (predator and trash fish) control. About 96% of the farmers control aquatic weeds manually. For controlling undesirable species most of them (92%) used netting method. Some farmers used rotenone and phostoxin (2-5%) but did not follow any recommended dose. 15-20% farmers did not use any chemicals or other methods. The chemicals and other toxic substances used in pond farms to control aquatic weeds, pests, predators and undesirable species were rotenone, phostoxin, dipterex, bleaching powder, diseal, sumithion, endrin, copper sulphate, aldrin and DDT in 75.0, 65.0, 22.5, 10.0, 7.5, 5.0, 2.5 and 2.5 percent farms respectively [7].

3.3.4 Stocking density
From the survey, it was revealed that majority farmer's stocked hatchery produced fry and some stocked wild fry. The standard stocking density for carp culture is 35 to 40 per decimal whereas the average stocking density in the study area was found 13,465/ha. Rana [22] found the average fish fries stocking density 19,147/ha in Golapgonj upazila under Sylhet district. Kundu [17] observed that average stocking density of carp fry (including Indian major carp) was 22,290 fry/ha for polyculture, tilapia 28,408 fingerlings/ha for monoculture and catfish (Pangus) 28,935/ha for monoculture in Gopalpur upazila under Tangail district. Rahman [21] found that the average stocking density was 25,250/ha in Gazipur.

3.4 Inputs and outputs of different farming technology
3.4.1 Use of lime and fertilizer
In the study area, there was highly significant difference ($P \leq 0.05$) for input parameters including cow dung, urea, TSP and lime in semi-intensive culture technology compare to extensive. Fish farmers used cow dung in extensive and semi-intensive farming at the rate of 489.00±230.13 and 1960.00±442 kg/ha/year respectively. The average dose of urea and triple super phosphate (TSP) in extensive and semi-intensive farming was 75.05±30.92 kg/ha/year, 283.75±54.24 kg/ha/year and 59.75±27.34 kg/ha/year, 239.30±49.99 kg/ha/year respectively. Most of the farmers used fertilizers irregularly. All the farmers used lime irregularly in variable doses. The average rate of liming in extensive and semi-intensive farming was found to be 82.95±36.90 kg/ha/year and 284.20±74.28 kg/ha/year respectively. The average dose of organic fertilizer was 1224.50±816.95 kg/ha/year and Urea and TSP was 179.40±113.50 kg/ha/year and 149.53±98.57 kg/ha/year respectively. Rana [22] observed the average dose of organic fertilizer 2,776 kg/ha/year and inorganic fertilizer such as Urea and TSP was 264 kg/ha/year and 177 kg/ha/year respectively in Golapgonj upazila under Sylhet district. Saha [25] found that the average dose of organic fertilizer was 8330 kg/ha/year and inorganic fertilizer was 387 kg/ha/year for urea and 176 kg/ha/year for TSP.

Table 1: Inputs and outputs of different farming technology in the study areas

Variables	Extensive	Semi-intensive	Level of significant
Cow dung (Kg/ha/year)	489.00±230.13	1960.00±442.45	*
Urea (Kg/ha/year)	75.05±30.92	283.75±54.24	*
TSP (Kg/ha/year)	59.75±27.34	239.30±49.99	*
Lime (Kg/ha/year)	82.95±36.90	284.20±74.28	*
Rice bran (Kg/ha/year)	756.00±252.29	1883.85±276.47	*
Mustard oil cake (Kg/ha/year)	126.10±41.12	410.90±87.31	*
Production cost (Tk/ha/year)	361370.00±76233.38	533490.00±92857.06	*
Production (Kg/ha/year)	4495.10±600.17	10420.90±1857.51	*
Profit (Tk/ha/year)	78330.00±19223.85	419470.00±368024.69	*

Note: *= P≤ 0.05 of significant;

3.4.2 Feed and feeding practices

Supply of feeds is important to increase fish production. It was found that 72% of the farmers applied supplementary feed such as both rice-bran and mustard oil-cake. Farmers normally do not use pellet feed because of its cost and availability. The average doses of rice-bran and mustard oil-cake in extensive and semi-intensive farming was 756.00±252.29 kg/ha/yr,1883.85±276.47 kg/ha/yr and 126.10±41.12 kg/ha/yr and 410.90±87.31 kg/ha/yr respectively. This study shows that, in terms of nutritional parameters including rice-bran and mustard-oil cake there is a highly significant difference (P≤0.05) between semi-intensive culture technology compare to extensive. Rahman [21] found that the dose of rice-bran and oil-cake was 2,730 and 580 kg/ha, respectively. Rana [22] observed the average dose of rice-bran and mustard-oil cake was 2215 kg/ha/yr and 489 kg/ha/yr respectively in Golapgonj upazila under Sylhet district.

3.5 Harvesting and marketing

Although fish are harvested throughout the year, the peak harvesting period was found from December to January because during this period fish became marketable in size and market price was high. In this season, around 66% of the stocked fishes were reported to be harvested and rest of the fish (34%) was harvested during other season. The peak harvesting period was from December to January when 70% of farmer was harvested and rest of the fish (30%) was harvested other season in Golapgonj upazila under Sylhet district [22]. Saha [25] reported that, the peak-harvesting season was from November to January. However, Rahman [21] observed that the peak period of harvesting was from October to January. Ahmed [1] stated that the peak-harvesting season was from December to March. Farmers harvested their fish by using cast net and seine net in the study area.

3.6 Fish production

There was highly significant difference (P≤0.05) between semi-intensive system compare to extensive in terms of production output. The average annual yield of fish was 7458.00±3273.93 kg/ha. The average fish production per hectare pond was higher in semi-intensive farming (10420.90±1857.51 kg/ha) than in extensive (4495.10±600.17 kg/ha). Sheheli [27] observed that fish production was 6,752 kg/ha in Trishal upazila of Mymensingh district. Kamruzzaman [14] estimated average annual yield of carp production is 2,925kg/ha in Bhaluka.

3.7 Production cost

The average total annual fish production cost was Tk. 447430.00±120930.80/ha/yr (Table 2) in the study area. The average total cost of fish production was higher in semi-intensive (Tk. 533490.00±92857.06/ha/yr) than in extensive (Tk. 361370.00±76233.38/ha/yr). This study shows that, in terms of the parameter production cost, there is a highly significant difference (P≤0.05) between semi-intensive culture technology compare to extensive. Rana [22] observed the average fish production cost was Tk. 90,252/ha/yr in Golapgonj upazila under Sylhet district. Ahmed [1] found that the average fish production cost was Tk. 23,210 - Tk. 24,790/ha.

Table 2: Production cost of fish/ha in the study areas

Cost items	Extensive	Semi-intensive	Level of significant
Fingerlings	31745.00±3657.35	47060.00±4430.88	*
Feed	241950.00±27969.09	470900.00±26679.73	*
Fertilizers	10820.00±2106.41	14710.00±1542.63	*
Human laborers	21860.00±2537.67	33280.00±3012.03	*
Harvesting and Marketing	7870.00±1186.24	12060.00±11005.11	*
Land use	11790.00±7135.48	12460.00±2022.20	NS
Miscellaneous	4323.00±307.43	5729.00±336.14	*

Note: NS= Not significant, *= P≤ 0.05 of significant;

In the study area, feed cost appeared to be the highest which covered 76.94% of the total cost of pond fish production. While fingerlings, human labour, fertilizer, land use, harvesting and marketing and miscellaneous activities consumed 8.51%, 5.95%, 2.76%, 2.62%, 2.15% and 1.08% cost respectively.

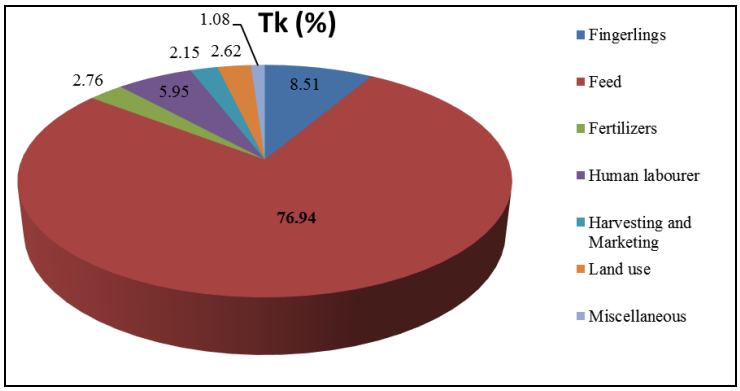

Fig 3: Production cost (%) of fish/ha in the study areas

Ahmed [4] claimed that feed costs generally constitute the highest single operational cost, accounting for 76%, 69% and 59% of total costs in intensive, semi-intensive and traditional feeding practices, respectively in Bangladesh. Saha [26] identified that the cost of feed appeared to be the highest (68.70%) in Mymensingh district and cost of fingerlings was highest (22.72%) in Jessore district of the total cost of production.

3.8 Net profit

From the survey, it was found that per hectare average profit from fish culture was 248900.00±311134.95tk/ha/yr. Per hectare average profit from fish culture was higher in semi-intensive (Tk. 419470.00±368024.69/ha/yr) than in extensive (Tk. 78330.00±19223.85 /ha/yr). This study shows that, in terms of the parameter net return, there is a highly significant difference ($P \leq 0.05$) between semi-intensive culture technology compare to extensive. Ahmed [4] claimed that the highest average gross margin per ha was found in intensive farms (US$3 649) compared with semi-intensive (US$2 235) and traditional (US$1 188) farms. Rana [22] found that the profit for fish culture Tk. 78,498/ha/yr in Golapgonj upazila of Sylhet district. From this study it was found that, semi-intensive culture was much more profitable than extensive culture. This is due to the use of modern technology in case of semi-intensive culture. So, we can say that, technology has a highly positive impact on fish production in Sylhet district.

3.9 Problems faced by the fish farmers

A huge number of problems were reported by farmers those are: poor technical knowledge, fish disease, non-availability of fish seed during stocking period, insufficient water during dry season, lack of money, lack of credit and natural disaster (flood, drought) etc. According to the survey, 37% of the farmers reported non-availability of fish fry during stocking period as the single most important problem for fish farming. While 21%, 12%, 7%, 18%, 5% respondents identified fish disease, poor technical knowledge, lack of money, insufficient water in dry season and low price of the product to be the most important problems respectively. Ahmed [2] conducted that lack of operating capital, low price of fish and high inputs prices were identified as major problems in Netrokona. Khan [15] found that lack of extension work for fisheries improvements caused the highest difficulty in pond fish culture.

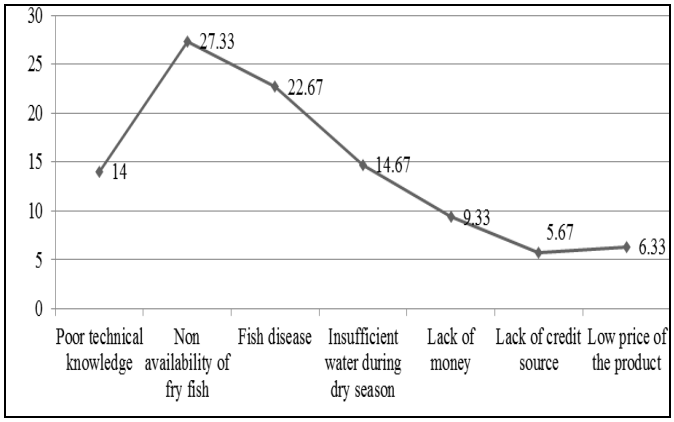

Fig 4: Problems faced by the fish farmers in the study areas

4. Conclusions and Recommendations

The fish farming sector plays an important economic role in Sylhet district through production of valuable cash crop, increasing food production, and increasing employment opportunities. From this quest, it is clear that semi-intensive culture technology is better than extensive culture. However, concerns have arisen about the long-term sustainability of fish farming due to lack of technical knowledge, poor supply of fish seed and marketing problems. The lack of technical knowledge in fish farm management may have huge effect on production. Adoption of semi-intensive culture technology with quality fish seed, feed, necessary training for scientific methods of fish farming and fingerling bank to the farmers by establishing more hatcheries by the help of Government and NGO should develop in each upazilas of the Sylhet district.

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