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Diversified fish farming for sustainable livelihood: A case-based study on small and marginal fish farmers in Cachar district of Assam, India

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ABSTRACT

Freshwater aquaculture is one of the fastest-growing sectors in India and has the potential for large scale employment. However, this sector is dominated by small and marginal fish farmers adopting traditional technologies resulting in low productivity and nominal impact on their livelihood. The success of fish farming as a business depends mostly on its scientific culture practice and efficient farming strategy, which will assist not only in individual socio-economic development but also the economic growth of the country as a whole. Through a case-based research method an economic analysis has been made on species diversification strategy of fish farming. It is found that, by adopting an effective and most economical diversification strategy consisting of the culture of *Gudusia chapra* along with *Carps* in small-scale composite culture ponds will resulted in more than 100% return on investment. Therefore, the outcome of this research has propounded for a novel farming practice of small indigenous high valued species having negligible investment will enhance the income of fish farmers.

1. Introduction

The inland water bodies of a country play a significant role in supporting the livelihood of many people through fish farming and other allied activities. The term Inland Water consists of water bodies available in the form of ponds, lakes, rivers, streams, inland canals, dams etc. From time immemorial, these water bodies provide a significant source of food in the form of fisheries to the humankind. However, due to largescale wetland reclamation for agriculture, waste disposal, urbanization etc. their importance has been declining during the last decades and the negative impact of such activities has been felt in recent times in the form of drinking water scarcity due to waning of the ground water table as well as on freshwater aquaculture. The multipurpose usage pattern of these natural water bodies will not only help in maintaining the water table but also provide a distinct natural environment for the development and management of fisheries. As per the FAO (2016) report, "sixty million people are directly engaged, part-time or full time, in primary production of fish, either by fishing or in aquaculture, supporting the livelihoods of 10-12% of world population". Subasinghe et al. (2009) stated that aquaculture accounts for over 50% of the global food fish consumption. In the developing countries perspective, a study was conducted under BNP (2008) of FAO and World Fish Center and, it was found that in small-scale fisheries of developing countries during 2008 an estimated 93–97 million people were directly involved in the fishing, processing, and marketing, out of which 51 million were associated with inland fisheriesFAO Food and Agriculture Organization of the United Nations, 2009. On the other hand, Panayotou (1982), found in his research that small-scale fishing is "livelihood of last resort" in developing countries and was further supported in the works of Nguyen-Khoa and Smith (2004); Smith et al. (2005); Ellender et al. (2009). However, Martin et al. (2013), suggested that fishing is a supplementary activity that will strengthen the livelihood of small-scale fish farmers and plays a significant role in poverty eradication through an increase in income, employment, and food security among the households having limited and poor quality of farmland.

In the pursuit of eradicating poverty in all its forms and dimensions, the United Nations (2018) resolution on transforming the world in 2030 has emphasized 17 (seventeen) Sustainable Development Goals (SDGs), out of which three have significant relevance in Fishery Sector viz. Goal-1 (No Poverty); Goal-2 (Zero Hunger) and Goal-12 (Sustainable Consumption and Production). Therefore, keeping in view the potential of the aquaculture sector, it is possible to achieve the above goals that will undoubtedly impact positively on the health, happiness, prosperity and well-being of every citizen of a country. The aquaculture sector consisting of large-scale fish catch generally directed for export purposes, while small-scale inland fishing goes for local consumption directly supporting food security. In addition to it the freshwater

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environment not only assist in poverty alleviation through fishing and contribute effectively towards food security but also provide an ecosystem service that stimulates human well-being. Moreover, as per the FAO report "the economic value of inland freshwater fisheries catches is estimated at USD 26 billion" and major contribution will come from Asia (66%). This sector has the potential to employ between 16.8 million and 20.7 million people with a further 8 million to 38 million in the post-harvest sector.

In aquaculture, India stands second next to China globally, and India's freshwater aquaculture has around 95% contribution of the total production, since the aquaculture production in India is shifting from the marine dominated fisheries to the inland fisheries. During the year 2017–18, the fisheries production of the country is estimated to be 12.60 million metric tons, out of which 65% is from the inland sector, and about 50% is from the culture fisheries. The growth from the fisheries and aquaculture sector is faster than the growth from the crop and livestock sector. Being the fastest-growing sectors in India, and over the years, this sector has witnessed tremendous changes in the farming practice, advancement in technologies, policy support, emerging markets and consumption pattern. This has resulted in establishing the sector as a main source of livelihood for diverse stakeholders along the value chain. Due to its large potential, this sector is receiving considerable patronage from the federal as well as state governments to sustainably achieve the production, productivity and profitability.

2. Present status of fresh water aquaculture

India's rich natural resources of freshwater bodies provide a unique opportunity for a prosperous aquaculture industry. As reported in Table 1, India is blessed with 1.95 lakh kms of rivers and canals; 29.26 lakh ha of reservoirs; 24.33 lakh ha of ponds and tanks; 11.55 lakh ha of brackish water; 7.98 lakh ha of floodplain lakes and wetlands. On the other hand, the inland resources in particular to Assam consists of 4820 kms of rivers and canals; 0.02 lakh ha of reservoirs; 0.23 lakh ha of ponds and tanks and 1.10 lakh ha of floodplain lakes and wetlands. Despite this enormous potential only 35% of ponds and tanks were used for aquaculture in India (Katiha et al., 2005), leaving aside a large portion of natural resources underutilised.

The study of aquaculture productivity data extracted from Department of Animal Husbandry, dairying and fisheries, Governemnt of India, tells that the average yield from aquaculture ponds was estimated at 2.67 tons/ha (Fig. 1). Upon comparing different regions of India, it is found that North eastern region reported 2nd highest productivity and the yield gap (t/ha). The highest yield gap in western region is evident because of states like Rajastan and Gujarat being dry states, on the contrary the north eastern region although blessed with rivers, wetland lakes and beels, the potential utility is not up to the mark. However, Barik (2016), observed that to increase the fish production in future, ponds and tanks resources will play a vital role.

In response to the current status of fresh water aquaculture production trends, FAO (2016) report highlighted on the contribution of aquaculture at 44% in the global fish production and is growing at 07% annually becoming one of the fastest growing animal food producing sector. According to Jayasankar (2018), "global capture fishery is presently at crossroads with over 70% of the resources exploited and therefore aquaculture is the only option to fill up the gap of much of the future demand for fish". In this respect, Tidwell and Allan (2001); Sugiyama et al. (2004) had also discussed on the role of aquaculture in the "supply of much needed animal protein to the world population". The average annual aquaculture production in particular to North-east India vis-à-vis all India production as presented in Fig. 2 exhibits a dismal performance of North-eastern states. On the contrary, the per capita consumption per month in all 07 north eastern states amounts to 8.32 kgs, which is 25% of per capita monthly consumption from rest of India (24.51 kgs). These results has been in consonance with Barik (2016) where he found a strong correlation in between production and consumption of fish at the state level, while in case of eastern and north-eastern India the consumption was higher than the production.

Table 1
Inland fisheries resources of India and Assam.

Sl No.	Resources	Area (All India)	Area (Assam)
1	Rivers and Canals	1,95,095 kms	4820 kms
2	Reservoirs	29.26 lakh ha	0.02 lakh ha
3	Ponds and Tanks	24.33 lakh ha	0.23 lakh ha
4	Brackish Water	11.55 lakh ha	0.00 lakh ha
5	Floodplain Lakes and Wetlands	7.98 lakh ha	1.10 lakh ha
	Total Water bodies	*73.12 lakh ha*	*1.35 lakh ha*

Source: Fisheries Division, D/o Animal Husbandry, Dairying & Fisheries, 2017.

The state of Assam has the immense potential for fresh water fisheries because of its excellent sub-tropical climate highly conducive for fish culture development in different aquatic bodies (Das, 2006). Despite its enormous aquatic resources and congenial environment for fish development, the state of Assam is not producing sufficient quantity of fish to cater the requirements of its ever-increasing population. Thus, the state is highly dependent on import of substantial quantity of fish from other states like- West Bengal, Andhra Pradesh, Bihar and Uttar Pradesh. On the present status of fish culture practised in rural areas of Assam, Das and Goswami (2002), found a very poor mean production of fish in the study area. They also proposed for development of small-scale enterprise on fish culture by utilising small ponds.

Although, fish and fish seed farming and marketing are a source of livelihood for many of the rural folks in the state, yet lack of technological intervention and proper support resulted in higher yield gap in the state. This production and consumption gap may be taken as an opportunity to set up fish-based enterprises in the state of Assam. It is expected that the fishery sector will play a vital role in the development of the socio-economic scenario and will prove to be a driving factor in the economic growth of the state as well as the country. Petersen (2003)) emphasized on the implication of revenue generated from fishery on GDP of Pacific Island countries. While Gillett and Lightfoot (2002) had documented the fishing and fisheries importance to the Pacific island countries' economies. Jang and Chang (2014a, 2014b) applied panel error correction model and found a long run relationship between national income and fish consumption. However, from Indian context no such study has been found relating to causality between fish production and economic growth. In addition to this, the growing importance of aquaculture in the livelihood of rural people calls for the farmers to receive maximum value at least possible cost out of what they produce and sell. Despite adoption of various strategies intended to increase the productivity and output of the farm, it was felt that the past strategies failed to emphasize the need to raise the farmers income, and accordingly the government of India has set up goals to double the farmers income by the year 2022. The NITI Ayog, Govt. of India, has stated that the source for growth of farmers income can be from: Increase in Agriculture Productivity; Improvement in Total Productivity Factor; Diversification towards High Value Crops; Increase in Crop Intensity. From the aquaculture point, it requires the development of the value chain in fish farming and the marketing of the produces in a strategic way.

In this context, the objective of this study was to identify the available scopes for species diversification strategies and propose a scheme to increase productivity and farmers income, that will induce more number of young entrepreneurs to venture into this sector. Finally, fish farmers at the grass root level can adopt an improvised species diversification strategy to satisfy consumer needs as well as increase their income from a limited farm resource.

3. Methodology

The field study was undertaken in two villages viz., Kanchanpur and

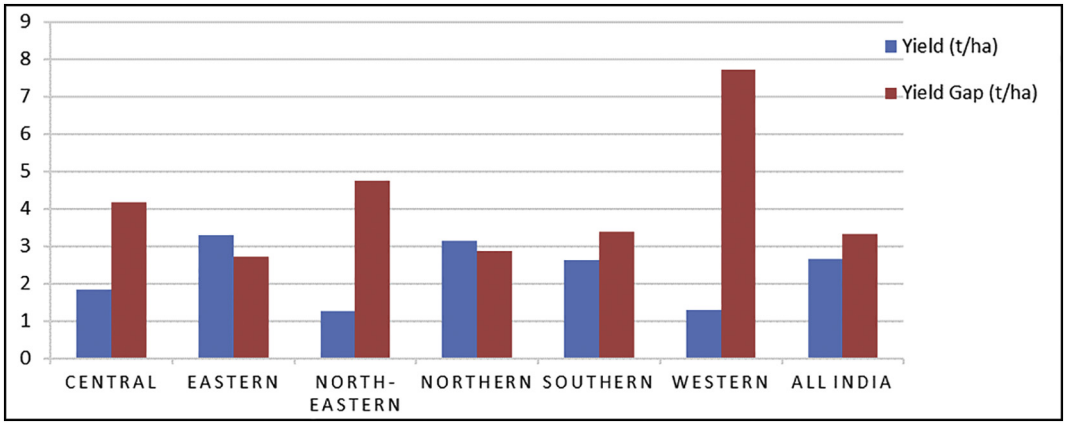

Fig. 1. Yield and yield gaps in freshwater aquaculture.
Source: Barik (2016).

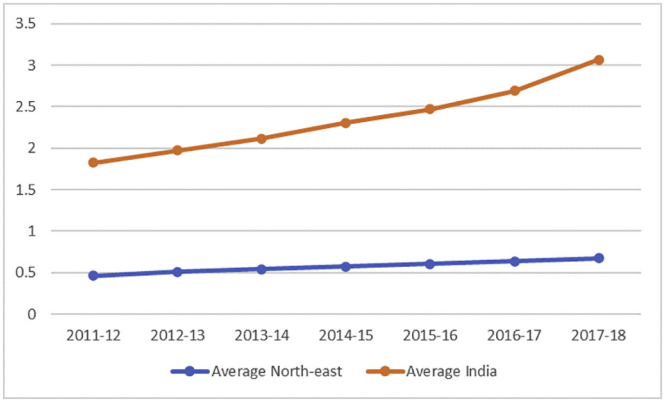

Fig. 2. Annual average inland fish production.

Shastrinagar of Cachar district in the state of Assam. The Cachar district is situated in the southern part of Assam in north-east India, between longitudes 92°24′ E and 93°15′ E and latitudes 24°22′N and 25°8′N East and 35 m above mean sea level (Figure 1). The reason for choosing these two villages for this study lies with the majority of the population of these villages constitutes scheduled caste low earning fish farmers (Census, 2011). The farmers of the district have, of late through the intervention of various agencies, including the Department of Fisheries Government of Assam, have started Semi-intensive fish farming.

The objectives of this study were addressed by adopting case-based research method, since it is a very popular method that comprises careful and detailed observation of a sampling unit. Convenience sampling technique was used to select 17 respondents involved in *Gudusia chapra* farming along with carps and data were collected through focus interview on a schedule (Anton and Curtis, 2017). The researcher has conducted the field assessment by composing focus groups made up of fishers. The participants of focus group were intended to be informal and to ensure their comfort, meetings were held in the participants villages. The socio-economic characteristics of the fish farmers in the study area is given in Table 2.

Data presented in the above table shows that, majority of the respondents falls between the age group of 30–40 years (70.58%). This age group indicates that the farming of carps along with small indigenous fish species like G. Chapara has good potential to sustain as a farming practice, and scientific intervention and capacity building will further develop the productivity. 100% of the respondent fish farmers are males. This indicates that fish farming activities is largely dominated by males in the study area. 94.12% of the respondents were married, only one respondent is unmarried. It was found that 70.58% of the respondents were having education up to primary level; 11.76%

Table 2
Socio-economic characteristics of fish farmers in the study area.

Variable	Freq.	%	Variable	Freq.	%
Age			Experience		
20–30 Years	0	0	1–5 Years	0	0
30–40 Years	12	70.58	6–10 Years	4	23.53
40–50 Years	3	17.65	11–15 Years	8	47.06
Above 50 Years	2	11.76	More than 16 Years	5	29.41
Gender			Mode of Land acquisition		
Male	17	100	Purchase	0	0
Female	0	0	Lease/Rent	0	0
Marital Status			Inheritance	17	100
Married	16	94.12	Gift	0	0
Unmarried	1	5.88	Type of Pond/Structure		
Education Level			Earth/Concrete Pond	0	0
No Formal Education	0	0	Concrete Pond only	0	0
Adult Education	0	0	Earthen Pond Only	17	100
Primary School	12	70.58	Types of Culture		
Secondary School	2	11.76	Monoculture	0	0
Undergraduate or Above	3	17.65	Polyculture	17	100
Household Size			Integrated	0	0
1–5 Members	13	76.47	Type of Culture Species		
6–10 Members	4	23.53	Only Carps	0	0
More than 10 Members	0	0	Carps and Gudisa Chapra	17	100

were having secondary level education, while 17.65% were graduates. This means that the fish farming of carps and small fish species is largely done by the persons with lower education qualification. However, educated person are also engaged in farming of carps and *G. chapra*. The house hold size in the range of 1 to 5 members constitute 76.47% and that of 6–10 members constitute 23.53%. Experience in fish farming along with *G. chapra* was seen to be 6 to 10 years (23.53%), 11–15 years (47.06%) and above 16 years (29.41%). 100% of the respondents have acquired land through inheritance. 100% were involved in polyculture of carps along with G chapra. These all indicates that the household are nuclear in most case and the experience in farming is also quite large. The land holding is through inheritance which signifies that the respondents were quite comfortably doing the farming practice without much investment in land purchase. The income generated is also supporting their livelihood as the number of family members are less.

Apart from this, to determine the demand and supply of *Gudusia chapra*, as well as other common species, data were collected from the retailers (45nos.), vendors (12nos.), and wholesalers (06 nos.) operating in the study area. The market demand for various fish species cultured were estimated through a rating scale by allocating score *(Very High demand = 4 points; Moderate demand = 3 pts.; Low demand = 2*

Table 3
Estimation of species wise demand in the market.

Species	Mean Score				Total mean score	Rank
	Very High Demand	Moderate Demand	Low Demand	Very Low Demand		
L. rohita	2.2	0.75	0.2	0.1	3.25	II
C. catla	2.15	0.6375	0.325	0.0875	3.2	III
C. mrigala	0.6	0.7875	0.6	0.2875	2.275	VII
C. carpio	1.4	1.5375	0.2	0.0375	3.175	IV
Puntius spp.	0.95	1.3875	0.375	0.1125	2.825	VI
A. mola	1.3	1.125	0.35	0.125	2.9	V
G. chapra	2.75	0.6	0.125	0.05	3.525	I

pts.; Very Low demand = 1 pts.). The total mean scores representing the demand of each species in the market were evaluated, ranked and presented in the Table 3. The mean score derived were classified into Class Interval and shown in Table 4.

On the basis of demand and price of various species available in the study area a demand-price decision matrix presented in Fig. 4, to correctly understand the profitability in producing a particular fish species.

Finally, data from the actual procedure and practice of culture in an experimental setup at one of the farmer's pond was recorded. The data collected were analysed by means of an economic model to understand the economic benefits and cost from species diversification.

4. Economic model

This study has employed Gross Margin Analysis (GMA) tool to measure the profitability from the practice of *G. chapra* farming along with *Carps* in small composite ponds. In the contemporary farming and economic enivironment GMA is a vital tool in measuring the level of farm profitability. A Gross margin (GM) is the difference between Gross income (Total Revenue) earned by the fish farm and the total variable costs required to produce the output (Firth, 2002). The total revenue is the total output multiplied by price per unit of fish. The variable costs are those costs that vary in direct proportion to the level of production. The total variable cost includes costs on inputs such as: fertilizers, transportation, labour input, feeding cost and cost of other inputs like fingerlings etc. The above discussion can be represented in the following equation as follows:

$$\textit{Gross Margin} = \textit{Total Revenue} - \textit{Total Variable Cost}$$

Let us suppose, GM = Gross Margin; TR = Total Revenue; TVC = Total Variable Cost; TFC = Total Fixed Cost; S = Selling Price per unit; Q = Quantity Produced & Sold; V = Variable cost/unit

$$GM = TR - TVC = (Q * S) - (Q * V)$$

The rate of return on total investment can also be calculated to know the profitability of the proposed scheme as follows:

$$ROI = \frac{\textit{Net Margin}}{\textit{Total Cost}} * 100, \textit{ where } [\textit{Net Margin} = \textit{Gross Margin} - \textit{Nonoperting Expenses}]$$

In the above formula Net margin is determined after paying non operating expenses like interest on loan etc.

5. Practice of G. Chapra farming

The *G. chapra* is mostly found in inundated paddy fields, flood plain wetlands, and flooded low-lying areas locally known as 'hoars' (Ahmed et al., 2007). It is reported that this fish mainly feed on plankton during their early stage and gradually consuming bigger particles as well. They usually feed on surface inhibiting plankton and gradually switch over to feeding on marginal and bottom-dwelling planktonic crustacean. Active feeding was observed in pre- and post-spawning phase in their life cycle (Jhingran, 1972). However, it is also reported that this fish feed primarily on detritus as well as planktons (Mondal and Kaviraj, 2010). The *species* is considered to be an important source of micronutrient for women and children in the rural areas (Ahmed et al., 2007).

In Assam, the farming of *G. chapra* mainly depends on the successful catching of the brooders from natural habitat and subsequent release in carp pond in live condition. The farmers first collect the fish from its natural habitats like wetlands Fig. 5. For a collection of brooders, they use seine nets with tiny mesh size like mosquito nets are preferred. As reported by the farmers, the fish species being sensitive to light need to be caught by netting in early morning hours before sunrise or in the evening after sunset. The fishes so caught in the net are then kept in aluminium containers, with water filled up to the desired level. The water in the container is churned to form water current without delay as soon as the fishes are kept, which enables aeration of the water to avoid mortality. Approximately 15 to 20 numbers of fishes are carried from its natural habitat to the farmer's pond where the composite culture of carp is already going on. The selection of stock is based on size, i.e., larger fishes are transferred from its natural habitat to the pond. The sex ratio depends on mere chance. The farmers then carry out the normal composite carp culture practice. The supplementary feeding for carps is done with Rice Polish and Mustard Oil Cake at 1:1 ratio, and no extra feed for *G. chapra* is supplemented. The *fish* mainly depend on the natural food available in the pond and reproduces in the pond environment. From a mere 15 to 20 numbers, the harvest achieved to approximately 70–100 Kg. The harvesting is sometimes done along with the carps partially 3–4 times in a season.

6. Economic analysis of G. Chapra farming along with carps

The economic analysis generally consists of a cost-revenue framework. In this study the estimated cost of inputs borne by the respondents in the farming practice of carps along with G. Chapra is provided in Table 5. The cost estimated is for 0.50-ha pond area, where experiment had been conducted. The estimated cost involved Fixed Cost and Variable Cost.

The analysis of cost and return from carps and G Chapra farming by using fixed and variable cost and yield is presented in Table 6. The total revenue is determined by multiplying the price per kilogram with the yield. It is found that with the increase in production the variable cost per unit has decreased from ₹80.85 to ₹77.25, since in the same pond with existing input a farmer can able to produce two species i.e. Carps and G. Chapra. The decrease in cost is assisted with increase in gross margin by ₹28,844, which is 22% rise from only Carps farming. To calculate net margin, interest expenses @12% p.a. was assumed (implicit cost) if the farmer will take a loan to cover the total cost of production. Under such circumstances, the net margin has shown an

Table 4
Classification of demand by allotting class interval.

Score	Demand Pattern	Species (Scientific name)	Species (Local name)
1.50–2.00	Very Low Demand	*H. molitrix*	Silver
2.01–2.50	Low Demand	*C. idella*, C. mrigala	Grass carp, mirika/japani
2.51–3.00	Moderate Demand	Puntius spp. A. mola,	Putha, moka
3.01 and above	High Demand	L. rohita, C. catla. G. chapra, C.carpio	Rui, Baus, Chabilla, Common

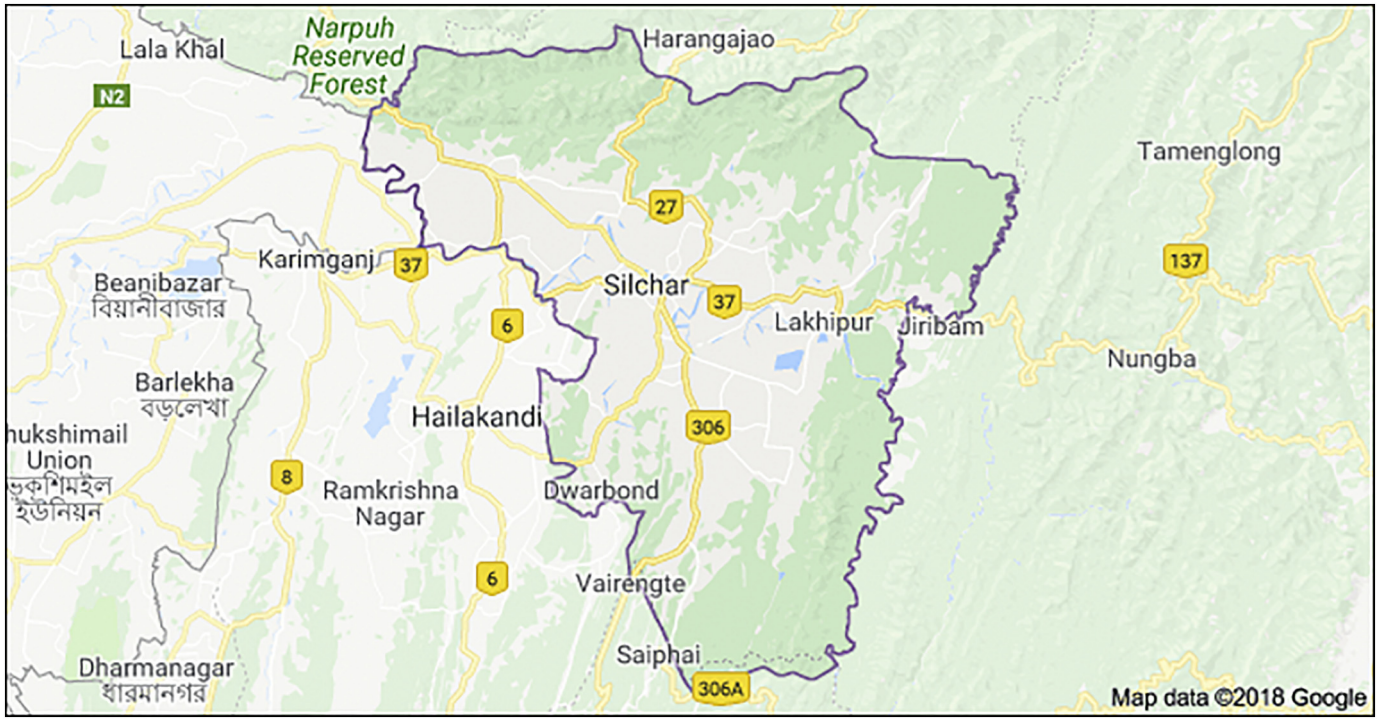

Fig. 3. Map of Cachar District of Assam (Source: Google Maps).

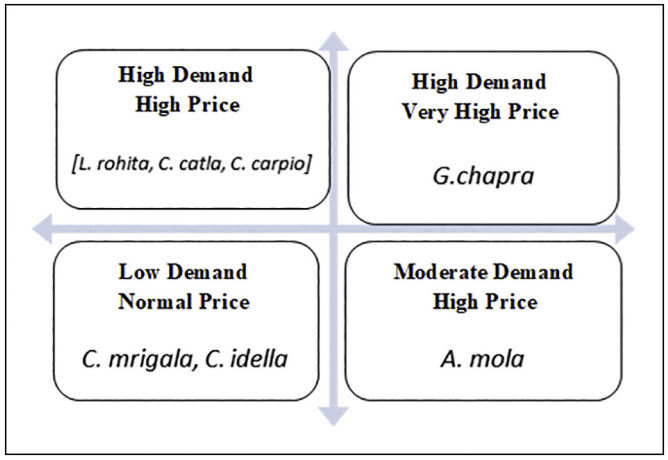

Fig. 4. Demand-price decision matrix.

increase of 24.5% and return on investment has jumped from 86.13% to 107%.

7. Findings of the study

From the study it is found that farmers in the study area are involved in farming of carps along with small indigenous fish species like *Gudusia chapra*. The working capital requirement in a 0.50-ha pond area was ₹1,21,275.00. This working capital is required for farming of carps excluding the amount of Rs 756.00 which is the cost of labour incurred in catching of mature G. Chapra species. The incremental net income of ₹28,753 by introduction of small species with carps while the extra cost involved is just ₹756.00. No other additional working capital for inputs is required for farming of G. chapra along with carps like feed, fertilizers etc. Hence from economic point of view the practice of carp farming along with small indigenous high valued fish species like *Gudusia chapra* is a viable option for small and marginal fish farmers for sustainable livelihood.

Constraints of Fish farming: It was discussed in the introduction section that despite presence of huge potential in fresh water aquaculture in the state of Assam, there exists a bigger gap between yield and consumption. The probable reasons for such gap might be existence of various constraints in fish farming. Therefore, in this study data were collected by employing a 04-point scale on this aspect and presented in Table 7.

The weighted mean score and rank of the responses on the questionnaires specific to the constraints faced in fish farming was calculated. It was observed from the table that “Poor credit linkage” and “Lack of scientific knowhow on G. Chapra farming” ranked first with a mean score of 4.00. Similarly, the constraint of collection of mature fish in live condition owing to its high mortality upon catching through nets from the wild source and Storage of the fishes ranked second and third with a mean total score of 3.88 and 3.82 respectively. This is followed by very low mean total score of 1.06 in case of the constraint lack of scientific knowhow on carp farming and marketing respectively. Poor demand of small fishes was ranked the at the bottom with a very low mean total score of 1.00.

8. Discussion

Although the carp fishes raised by farmers in their ponds are highly demanded in the market, still it faces some constraints from various aspects, like competition in terms of price from the imported fishes from other states and perceived value in terms of taste and nutrition from the carps and other fishes caught from the wild. The Fig. 6 illustrates the competition faced by farm-raised carps from imported stocks and wild caught carps, on the other hand, there exists no such competition in *G. chapra* because of the absence of imported stocks of this species and also the wild caught stocks are equally priced in the market because the taste and nutritious values are perceived to be same. Thus, the culture of *G. chapra* gives a competitive advantage in the fish farming business.

The key to success in small-scale aquaculture is skilful production through species diversification and marketing because too often farmers focus mainly on production without considering whether the

Fig. 5. *Scientific name: Gudusia chapra.*
Phylum: Chordata.
Higher Classification: Gudusia.
Order: Clupeiformes.
Local Name: Chabilla.

Table 5
Cost analysis of Fish farming.

Sl. No	Items of inputs[a]	Required Qty[a]	Rate[b] (₹)	Amount (₹)	Amount (₹)
1	Lime	400 kg.	20.00	8000.00	8000.00
2	Urea	120 kg.	12.00	1440.00	1440.00
3	SSP	150 kg.	12.00	1800.00	1800.00
4	Raw Cow Dung	7500 kg.	0.60	4500.00	4500.00
5	Fingerlings (5–6 in.) Carps	3000 nos.	8.00	24,000.00	24,000.00
	Fingerlings G. Chapra[c]	04 nos. of labourer @ ₹189 per man/day			756.00
6	Formulated feed (25% protein)	2000 kg.	39.00	78,000.00	78,000.00
7	Trial netting/ Harvesting	LS @ Rs.5000/ha		2500.00	2500.00
8	Prophylactic measures	LS @ Rs.2070/ha		1035.00	1035.00
Total Variable Cost				1,21,275.00	1,22,031.00
Fixed Cost per annum (Lease Rental)				15,000.00	15,000.00
Total Cost				1,36,275.00	1,37,031.00

[a] Estimated for Water Area 0.50 Ha.
[b] Price of inputs is based on the prevailing local market price.
[c] The fingerlings for *G. chapra* generally collected from wild. Thus, the labour cost for catching per man day is considered to be the cost of fingerlings.

Table 6
Profitability analysis of fish production.

Particulars	Carps	G. Chapra	Carps and G. Chapra
Quantity produced (0.50 Hector)	1500 kgs	80 kgs	1580 kgs
Price per kg	₹180.00	₹370.00	
Total Revenue (TR)	2,70,000.00	29,600.00	2,99,600.00
1. Fixed Costs[a]	15,000.00		15,000.00
2. Total Variable Cost	1,21,275.00		1,22,031.00
3. Variable Cost per unit	₹80.85		₹77.25
Total Cost (TC)	1,36,275.00		1,37,031.00
Gross Margin = TR - TC	1,33,725.00		1,62,569.00
Interest Expenses @12% p.a.	16,353.00		16,444.00
Net Margin	1,17,372.00		1,46,125.00
ROI	86.13%		107%
Percentage Increase in Net Margin			24.50%

[a] Fixed cost is the lease rental of pond (Assumed that the pond has been taken on lease not inherited).

existing market will pay a profitable price. The recipe for a successful small-scale aquaculture business is to identify marketing opportunities and then develop market-based production (Dasgupta and Durborow, 2009. In consonance with this observation the present study has highlighted the typical entrepreneurial characteristics of fish farmers as they viewed farming as a customer satisfying process but not as a goods-producing process. The farmers being a producer of the product have capitalised on the scope in playing a significant role in product mix based on market need and demand. It was seen that the increase in Product width of the farmer through a culture of high valued small fishes *(G. Chapra)* naturally increase the farmers' income at no additional cost of production. Unlike the farm raised carps which faces competition with interstate fish import and also from the carps caught from wild, the farm-raised *G. Chapra* faced no competition. A fish farmer may produce sufficiently, but to be successful in economic point of view, a proper strategy which usually consists of market research, target market identification and application of product mix is highly essential. The present study has revealed the typical entrepreneurial characteristics that have evolved among a certain fraction of fish

Table 7
Constraints of fish farming in the study area.

Constraints	Very high (4)	High (3)	Less (2)	Very less (1)	N	Weighted Mean Score	Rank
Poor credit linkage	17	0	0	0	17	4.00	**1**
Lack of Scientific knowhow on G. chapra farming	17	0	0	0	17	4.00	
Matured/Brood fish Collection	15	1	1	0	17	3.88	**2**
Storage	14	3	0	0	17	3.82	**3**
Lack of Scientific knowhow on Carp farming	0	0	1	16	17	1.06	**4**
Marketing	0	0	1	16	17	1.06	
Poor demand for small fishes	0	0	0	17	17	1.00	**5**

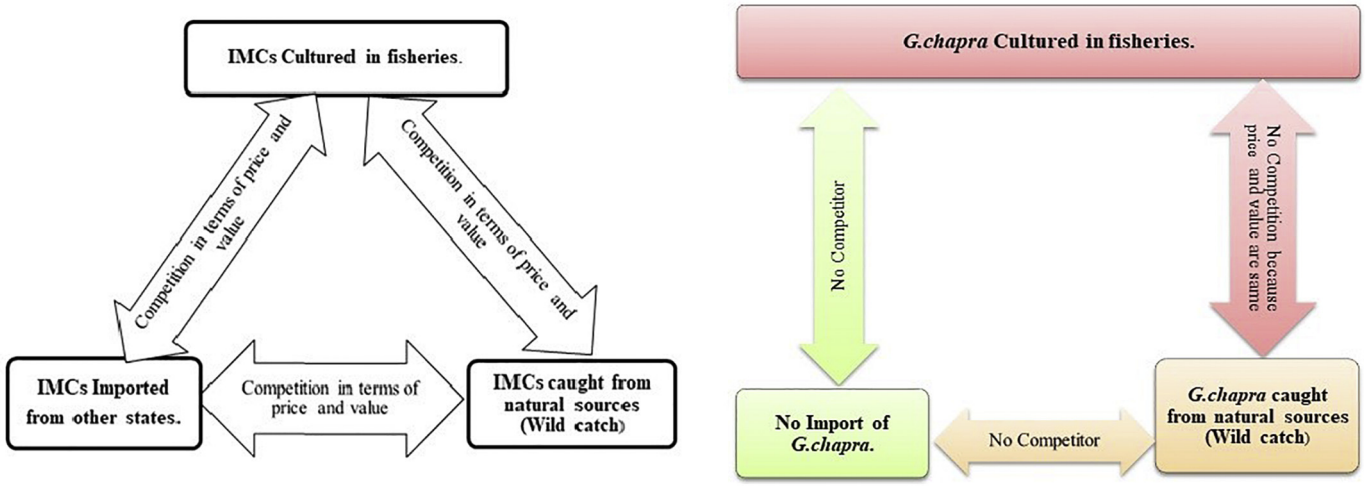

Fig. 6. Competition faced by farm raised carps and *G. chapra.*

farmer.

9. Conclusion and policy recommendation

The findings of this study reveal that farming of small indigenous fish species like *Gudusia chapra* along with composite culture of carps can be practiced in a profitable way by small and marginal fish farmers across the state. Scientific practice of culture of carps are practiced by the farmers but introduction of small fishes in carp pond is still being carried out in a traditional manner. The introduction of small high valued fish species in carp ponds do not incur extra operating cost but it has high potential of earning additional farm income. It is also found that the practice of carp farming along with high valued small indigenous fishes involves high economic viability. It may be recommended to encourage the fish farmers to culture such species along with carps.

Despite lack of scientific knowledge, breeding and transportation of brooders as well as storage constraints few farmers practice carps farming along with G. Chapra. Therefore, scientific package of practice should be developed by research institutions to farm indigenous high valued small fishes like G chapra. The brood fish or mature fish of such small fishes should be made available by the concerned agencies in the fish farming villages through trained up farmers as brood bank stockiest. The matured small fishes to the rural areas can be supplied from these stockiest. Owing to the healthy income potential and high return on investment (ROI) credit facility needs to be extended to the farmers by the financial institutions. Therefore, it is high time for the policy-makers to review the species diversification technique for the benefit of farmers that will improve their livelihood sustainably. The present study can be extended in determining optimum quantity to be produced depending on the demand in the market so that farmers can maximize their disposable income.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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