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Prevailing aquaculture practices in a drought-prone landscape: A case of Purulia district of West Bengal, India

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Abstract
Historically Purulia district of West Bengal state in India is a water-poor landscape. In the present study, prevailing aquaculture practices in some drought-prone areas of Purulia district had been evaluated based on a multi-layered cross-sectional questionnaire-based survey. The findings of the study revealed that the majority of fish farmers belong to a low-income group (80.5%) and this is a male-dominated occupation (98.3%). Most of the aquaculture farmers have basic literacy (50.5%) and possess medium size family (60.82%). Majority farmers (44.2%) practice small-scale aquaculture having pond size less than 1 ha with single ownership mode. Farmers are practicing traditional extensive type farming (81.23%) and polyculture is prevalent. Aquaculture activity in Purulia district are dominated by Indian Major Carps (IMCs) in combination with other exotic varieties. Among the fish farmers of Purulia district, 75.32% do not use any kind of supplementary feed and perform multiple-stocking multiple-harvesting. Due to the non-adoption of scientific management practices, aquaculture productivity is very poor and the market chain is also not well equipped. Among the various problems, scarcity of water (78%), disease outbreaks (25%), poor quality of fish seeds (53%), lack of extension services and technical knowledge (65%), social issues like theft (39%) etc. are major issues. To cope up with these challenges, formulation of a local adaptation plan as well as strong technical, financial and extension services from government or non-government organizations and research institutions are required for sustainable development of aquaculture in Purulia district.

Keywords: Purulia, drought-prone landscape, aquaculture practice, local adaptation plan

1. Introduction
Rural communities living in drought-prone areas often belong to the underprivileged group as the obdurate climatic conditions enormously trim down the productivity of crops in both the manner of quantity and quality [1]. For the rural communities residing in such climatically challenging landscape, aquaculture-centric development may have some affirmative quantifiable impressions that can provide diversified pecuniary gain as well as vigorous nourishment. Since immemorial time, aquaculture and fisheries sector has been played a fundamental role in food security and acted as a source of quality protein [2]. Factually, aquaculture provides employment and offers a prospected reliable income for impecunious communities [3]. Although India is the second largest fish producer and contributed 7.1% in global aquaculture food fish production [4], nearly one-sixth of India is defined as drought-prone areas with recurring drought being the major challenge [5].

West Bengal is the second largest fish producing state among all the states of India and accounts for 20% of the total fish production of the country [6]. On a physiographic basis, West Bengal holds very contrasting landscape ranging from hill areas to coastal saline zone. The estimated annual fish production of West Bengal in 2015 is 1.61 million metric ton with a growth rate of 13.52% [7]. Purulia district of West Bengal is one of the water-poor territories and falls under red and laterite agro-climatic zone. The constraints such as unproductive land, extreme water stress and poor micro-irrigation facilities restrict the agricultural yield of the district beyond the subsistence level [8]. Extreme poverty situation, food and employment insecurity of the forest fringe dwellers especially belonging to the tribal communities in the district are the established facts [9].

During the past year, Purulia district produced 49977 ton of fishes from 18576 ha water spread areas and holds very lower rank (15th) among all districts of West Bengal [7].

The estimated annual demand of fishes in Purulia district is 54439 ton resulted in a deficit of 4462 ton. Low rank of Purulia in aquaculture is due to small and medium water bodies, which are suffering from water scarcity during drought situations as well as the season of rainfall deficit.

Ethnic people are very poor in this district and consequently, they are migrating to neighboring districts or states in search of alternative livelihood. Almost 70% of the working population is employed as a cultivator or as laborers and the participation ratio as labor is significantly high. In contrast, the average income of cultivator is very low which has great adverse impacts on the improvement of Purulia.

Rural aquaculture as a weapon to mitigate poverty, reduce inequality and provide employment has received attention in recent years. However, it is important to know the practical complexities and minimum workable knowledge involved in the farming to enkindle the sustainable production of a region [10]. Therefore, it is essential to impart proper knowledge-based scientific technologies and available opportunities of fish farming for the fish farmers to attain sustainability [11]. Considering the importance and potential of aquaculture in this region, this communication provides information on various insights on the aquaculture practices, production methods, constraint along with a socio-economic profile of the fish farmers of Purulia through a household survey. Finally, some local adaptation plans had been advocated for aquaculture to cope with climate change-induced water scarcity. The outcome of this research will serve as a baseline for formulating a management plan for sustainable aquaculture development in this region.

2. Methodology

2.1 Study areas and sample size

The study was conducted in 15 community development blocks out of 20 blocks of Purulia district where the aquaculture practice is quite prevalent. These selected blocks are Jhalda-II, Arsha, Barabazar, Bundwan, Purulia-II, Puncha, Manbazar-I, Manbazar-II, Neturia, Para, Raghunathpur-I, Raghunathpur-II, Kashipur, Santuri and Purulia-I. Blocks namely Jhalda-II, Arsha, Barabazar, Bundwan, and Manbazar-II contain higher numbers of backward tribal villages. In this study, 300 fish farming households distributed over 65 villages under 45 Gram Panchayats [1] were surveyed during 2016-17. The target samples for this survey was predominantly the households pertaining to the fisheries and aquaculture activities.

2.2 Data collection framework

A cross-sectional multi-layered interview-based questionnaire was designed for the survey that covered all aquaculture related activities. The questionnaire was developed to collect the information in a well-structured format with closed questions wherever possible and also modified according to a range of available literature [11-14]. Special care was taken to make the language simple and easy. The non-technical vernacular languages were used as far as possible to conduct the interview process easy. At the basic stage, the questionnaire was prepared in English language and later it was translated to Bengali (local language) for easy communication with the farmers. The survey questionnaire consisted of five major categories, i.e., (i) socio-economic profile of farmer, (ii) information regarding aquaculture activities (iii) pond and fish health management practices (iv) harvest and market chain (v) challenges faced by farmers. Finally, in some group discussions, farmers provided various insights regarding adaptation strategies in relation to climate change, based on their local knowledge and experience. These discussions provided the broad outlines for developing local adaptation plans.

2.3 Analysis of data

Both qualitative and quantitative techniques were utilized for analysis of data. The analyses of entire data were done through Microsoft Excel ™ 2007 after exclusion of the erroneous data. Basic descriptive statistics combined with qualitative information collected through qualitative techniques were used to describe the patterns in the data and their interpretations.

3. Results and discussions

3.1 Socio-economic profile of the fish farmers

Based on the caste distribution [2], the local fish farmers of the Purulia district can be classified into four major categories. The dominant farming groups belong to general caste (56.7%) followed by Scheduled Castes (SC) with a share of 27.6%. The other two categories are Other Backward Classes (OBC) and Scheduled Tribe (ST). The aquaculture operations are dominated by Hindu religious groups (97.6%) and a small fractions of Muslim communities was also involved in aquaculture (Table 1).

Table 1: Socio-economic profiles of aquaculture farmers in Purulia District

Variables	Description	Value (%) (N=300)	Variables	Description	Value (%) (N=300)
Caste	General	56.7	Marital Status	Married	95.8
	SC	27.6		Single	4.2
	ST	14.1	Secondary Occupation	Agriculture	75.6
	OBC	1.6		Livestock	15.7
Gender	Male	98.3		Mason	5.4
	Female	1.7		Fish vending	1.3
House hold size	≤4 members	23.8		Small Business	1.1
	5-8 members	60.82		Daily Wage	0.9
	> 8 members	15.38	Annual Income	≤ Rs. 50,000	80.5
Educational Qualification	Illiterate	9		Rs. 50,000-1,00,000	16
	Primary	22.6		Rs. 1,00,000-1,50,000	2.3
	8th Standard	50.5		Rs. 1,50,000-2,00,000	1.2
	Secondary	13.6	Age Group	18-30	2.3
	Higher Secondary	2.5		31-45	29.8
	Graduate	1.8		46-60	58.7
	Post-Graduate	0		Above 60	9.2
Religion	Hindu	97.6			
	Muslim	2.4			

Male dominated the aquaculture operations (98.3%) in the Purulia district and women involvements in aquaculture are very poor. Majority of the respondents belonged to the upper age group (46-60 years) (58.7%) followed by middle age group (31-45 years) (29.8%). Only 9.2% people over 60 years aged are engaged in aquaculture activities. Participation of young age group (18-30 years) in aquaculture was found to be very less (2.3%). These indicate that young generations are not interested to carry out aquaculture activities as an occupation, even the young people from traditional fisherman family is not willing to take the aquaculture activities as a livelihood option. There may so many reasons behind this phenomenon e.g., lack of profit, lack of good marketing chain, the effect of modern social trends of being service holders, lack of awareness etc. Climate change such as irregular rainfall, an unexpectedly high temperature in summer season also leads to uncertainty in aquaculture production also play a major role and make it dispassionate to the young generations.

Majority of the fish farmers has the basic literacy i.e., up to eighth standard (50.5%) followed by primary education (22.6%). Negligible (1.8%) fish farmers are educated up to graduate level. Das *et al*. [15] observed that education and training played an important role in the adoption of new scientifically improved aquaculture technologies and education has a positive role in production and income. Education is not directly related to improving small-scale aquaculture but related to the adoption of advance aquaculture practice, hatchery maintenance, availing of innovative schemes offered by government etc. [16]. The survey reveals that besides aquaculture practice, fish farmers are engaged in agriculture activities (75.6%), followed by animal husbandry practice (15.7%) and fish vending. As far as the income of the farmers was concerned, 80.5% of the respondents had an annual income is less than Rs. 50,000 followed by 16% of the respondents had an income range of Rs. 50,000-100000.

3.2 Farming types and farm holdings

Most of the ponds in surveyed area were seasonal (77.69%) and majorities of them depend upon rainwater (97%) as prime water source of aquaculture. It is evident from Table 2 that, the fish farmers of the Purulia district are solely accustomed with finfish culture. Most of the farmer practice traditional extensive type farming system (81.23%) followed by modified extensive farming practice (17.54%). Very few farmers (1.23%) practice semi-intensive aquaculture practice using supplementary feed with high stocking density. Most of the farmers (94.6%) practice polyculture, followed by monoculture (5.2%). A negligible portion of farmers (0.2%) only performs integrated fish farming with duck rearing and horticulture activities. It was observed that the majority of West Bengal farmers ventured into integrated farming without knowing the actual benefit [11]. None of the aquaculture ponds in Purulia district has an inlet-outlet system. In Purulia district, most of the aquaculture ponds (45.25%) are used as multipurpose water bodies like agriculture irrigation, bathing, and other household activities.

Generally, the owner of the fish ponds practice aquaculture (56.7%) in his own pond. Some progressive fish farmers (43.3%) also practice fish farming by taking a lease from other pond owners for augmenting the production. Most of the aquaculture ponds (44.2%) are small in nature (<1 ha) followed by 29.9% (1-2 ha) and 25.9% ponds are >2 ha.

3.3 Pond preparation and seed stocking

As Purulia is a drought-prone area, most of the ponds become dry in the summer season. However, some fish farmers (13.23%) have only followed dewatering and drying process as a part of pond preparation. Only 1.6% surveyed fish farmer used to tilt the pond bottom and remove bottom sediment as a part of the pond management process. A fraction of fish farmer (12.19%) uses lime, raw cow dung and other chemical fertilizers as a part of pond preparation. The proper quantity of lime is mainly applied to stabilize pH and acid-base buffering capacity, inverse available phosphates, accelerate decomposition of organic matter in pond soil; improve pond water quality through one or more chemical processes and control fish parasites or occurrence of diseases [17]. The major portion of the fish farmer (68.72%) collects the fish seed from the Ramsagar (a hatchery hub) of the adjacent Bankura district. However, 30.18% fish farmer buy the fish seed from the local vendors or seed selling agents. The local fish seed vendors purchase bulk amount fish seed from the adjacent Bankura district and sell to the local fish farmers in retail mode. Only 1.1% fish farmer collect the fish seed from the hatchery within the district. As there is only one accredited hatchery in Purulia district, it becomes unable to meet the demand of the district. The demand of the fish seed in this district mostly is meeting up by the adjacent Bankura district. Majority of farmers (65.31%) stock hatchling (spawn) followed by combinations of hatchling, fry and fingerling (20.44%) into their grow-out pond. About 10.24% of farmer stocks fry, but a negligible portion of farmers (4.01%) only stock fingerling in their grow-out pond. Due to the high initial investment, most of the farmers are unwilling to stock fingerling in their grow-out pond. The similar trend of stocking practice is also noticed in South 24 Parganas district [11] and also in Andhra Pradesh [14]. Most of the farmer (40.21%) preferred to stock hatchling at the rate of 50,000-1, 00,000 nos. per bigha [3] followed by stocking of fry at the rate of 10,000-50,000 nos. per bigha. Only less number of farmers (1.1%) stock fingerling up to 1000 nos per bigha, which is an ideal stocking rate. Only 2.5% farmers acclimatize the fish seed before stocking and 1.83% disinfect with potassium permanganate ($KMnO_4$) (Table 2).

Table 2: Farming type, water used, pond types, pond management, details of fish seed, information on stocking type and stocking rate by the fish farmers in Purulia District

Variables	Description	Value (%) (N=300)	Variables	Description	Value (%) (N=300)
Size of pond area	< 1 ha	44.2	Pond preparation	No preparation	72.98
	1-2 ha	29.9		De-watering and drying	13.23
	>2 ha	25.9		Use of cow dung, liming and other fertilizers	12.19
Ownership of the pond	Own pond	56.7		Sediment removal and tilting	1.6
	Leased pond	43.3	Fish Seed Type	Hatchling	65.31
Pond Type	Seasonal	77.69		Fry	10.24
	Perennial	22.31		Fingerling	4.01
Source of water	Rainfall	97		Mixed	20.44
	Others	3	Stocking type	Multiple	89.78
Inlet-Outlet in pond	Absent	100		Single	10.22
	Present	0	Culture Type	Polyculture	94.6
Water Color	Transparent	55.87		Monoculture	5.2
	Muddy	25.32		Integrated	0.2
	Brownish	8.36	Source of seed	Hatchery outside district	68.72
	Light Green	7.24		Local seed vendors	30.18
	Deep Green	3.21		Hatchery within district	1.1
Use of aerator in pond	No	100	Seed acclimatization	No	97.5
	Yes	0		Yes	2.5
Distance of pond from locality	< 1 km	36.2	Seed disinfection	No	98.17
	1-5 km	48		Yes	1.83
	> 5 km	15.8	Stocking rate/ Bigha	Hatchling: 50,000-1,00,000	40.21
Use of pond water other than aquaculture	Multi-purpose	45.25		>1,00,000	10.85
	Household use	26.38		Fry: 5,000-10,000	15.71
	Irrigation	18.65		10,000-50,000	24.33
	Household use and agricultural irrigation	9.72		Fingerling: up to 1000	1.1
Farming type	Extensive	81.23		1001-3000	3.7
	Modified extensive	17.54		3001-5000	4.1
	Semi-intensive	1.23	Use of nursery pond	No	100

3.4 Cultured species, stocking combination and supplementary feeding

It can be seen from the Table 3 that, the aquaculture in Purulia district is dominated by Indian Major Carps (IMCs) culture. Most of the fish farmer (60.47%) only stock IMCs in their culture ponds followed by (15.32%) exotic carps along with IMCs. *Labeo rohita*, *Catla catla*, *Chirrhinus mrigala* are the main three dominant species which gained popularity among the fish farmers of Purulia district. Besides that, some exotic carps species like, *Hypophthalmichthys molitrix*, *Ctenopharyngodon idella*, *Cyprinus carpio* are also stocked in the grow-out pond. The similar stocking combination trend is followed all over West Bengal, Andhra Pradesh and other states of India [10-11; 14] as well as in neighboring country Bangladesh [18-19]. Monoculture of Tilapia (mono-sex) is one of the popular options to a small group of farmers in the surveyed region.

Most of the farmers (75.32%) do not use any kind of supplementary feed in their culture pond. Dubey *et al.* [11] narrated that the farmer prefer to follow the myths for higher stocking density of fish seedlings and the belief is "fishes grow themselves", without external feeds. Some farmers (22.58%) use farm-made feed, these include rice bran and mustard oil cake mixture. A negligible portion of progressive fish farmer (2.1%) only buys commercial fish feed from the market and use regularly in their grow-out culture pond. Although natural food contributes to the nutrition of the cultured fish, the exogenous supply of artificial food is essential for supplying nutrients, which may be deficient in natural food. However, the application of artificial feed affects water quality more than any other management factors. Almost all the surveyed farmers of Purulia district adopt broadcasting feeding method (95.5%) whereas only 4.5% of farmers follow bag-feeding method. The bag feeding technique is a unique technique for the feeding of carps and probably it has come from Andhra Pradesh. In this method, empty polythene bags are usually trimmed to hold nearly 15-20 kg feed. At the lower portion of these bags, 2-3 rows of perforations are made [20]. The feed mixtures are placed into these bags and suspended from bamboo poles erected in various locations of the pond. Through this feeding method, the farmers were able to avoid feed wastage as well as know the quantum of feed consumed by fish [11]. However, the fact is that the fish farmers of Purulia district are unwilling to invest towards fish feed in their aquaculture activities.

Table 3: Details of fish species stocked, stocking combination and feed management practiced by the fish farmers in Purulia District

Variables	Description	Value (%) (N=300)	Variables	Description	Value (%) (N=300)
Species Cultured	*Labeo rohita*	63.9	Stocking Combination	*Only IMC	60.47
	Cirrhinus mrigala	41.1		*IMC + exotic carp	15.32
	Catla catla	31.8		*IMC+ major and minor carps	12.36
	Labeo calbasu	26.1		*Carp + Tilapia	10.05
	Ctenopharyngodon idella	24.9		*Carp + Catfish	1.8
	Cyprinus carpio	24.3	Supplementary fish feed	Not used	75.32
	Hypophthalmychthys molitrix	23.4		Farm-made feed	22.58
	Labeo bata	22.2		Commercial fish feed from market	2.1
	Barbonymus gonionotus	18.9	Frequency of feeding	Irregular	88.75
	Chitala chitala	9.3		Once in a day	11.25
	Oreochromis spp.	7.2	Nature of feeding	Broadcasting	95.5
	Clarius Batrachus	6.9		Bag feeding	4.5

*IMC= *Catla catla, Labeo rohita, Cirrhinus mrigala*

*IMC + Exotic carps = *Catla catla, Labeo rohita, Cirrhinus mrigala, + Labeo bata, Hypophthalmychthys molitrix, Ctenopharyngodon idella, Cyprinus carpio*

* IMC + Major and minor carps = *Catla catla, Labeo rohita, Cirrhinus mrigala + Clarius Batrachus*

*Carps + Tilapia = *Catla catla, Labeo rohita, Cirrhinus mrigala, + Labeo bata, Hypophthalmychthys molitrix, Ctenopharyngodon idella, Cyprinus carpio + Oreochromis spp.*

*Carps + catfish = *Catla catla, Labeo rohita, Cirrhinus mrigala, + Labeo bata, Hypophthalmychthys molitrix, Ctenopharyngodon idella, Cyprinus carpio + Clarius batrachus*

3.5 Health and water quality management

Based on the survey result, it has been revealed that maximum disease manifestation occurred in fish weighed less than 500g (70.2%). About 7.4% surveyed farm were free from any kind of diseases. Disease outbreak generally happens due to overstocking, poor water quality and regular maintenance of the culture pond. The most common diseases are the ulcer in the body (35.6%) followed by fin and tail rot diseases (28.1%). Besides that, gill disease (18.4%) and fish lice are also a prevalent problems to the fish farmers of the Purulia district. Retard growth and slender body due to lack of proper nutrition is also found in case 15.8% fish farmers. Maximum diseases occurred in the winter season (82.6%) and the middle of the culture period (68.3%) (Table 4). Various methods of preventive measures were reported during the survey. Liming (56.3%) is the most popular way to the farmers. A major portion of farmer (38.1%) does not follow any treatment method. During the preliminary stage of the disease, they harvest the fishes and sell it to the market. Very few farmers (5.6%) perform regular netting operations as a part of pond maintenance or as a way of preventive measures against diseases. However, very recently application of $KMnO_4$ is increasing day by day, although there is very little evidence of recovery from disease after treatment [11]. Complete draining of pond water, pond bottom drying, removal of bottom mud and liming during pond preparation were found to be effective in lowering disease risks in some aquaculture farms in Bangladesh [13]. Farmers of Purulia also reported that disease did not seem to huge losses to them. Majority of farmers learned the treatment methods from other farmers as well as from local chemical suppliers. However, farmers are not willing to consult with NGO's and government extension services regarding disease diagnosis. These phenomena in other parts of West Bengal [14] and in Bangladesh were also very common [21].

It is very clear from the survey result that, almost all the farmers (97.8%) are not aware of the measurement the water pH of the culture pond and its routine maintenance. Among the monitored aquaculture ponds, 80.1% ponds water ranges pH from 6.5 to 7.5. Only 18.4% ponds are acidic in nature (< 6.5).

Table 4: Details of fish health, water quality management, harvesting and marketing practiced by the fish farmers in Purulia District

Variables	Description	Value (%) (N=300)	Variables	Description	Value (%) (N=300)
Occurrence of disease at size	< 500 g	70.2	Commonly occurred diseases	Ulcer in body	35.6
	500g-1kg	17.3		Fin and tail rot disease	28.1
	>1 kg	3.1		Gill diseases	18.4
	Does not occur	7.4		Mal-nutrition	15.8
Occurrence of disease at season	Winter	82.6		Fish lice	2.1
	Summer	15.3	Preventive Measures taken	Liming	56.3
	Monsoon	2.1		No treatment	38.1
Occurrence of disease at phase	Middle of the culture period	68.3		Netting at regular interval	5.6
	After stocking	23.8		Water exchange	0
	At the end of the culture period	7.9	Water pH range	< 6.5	18.4
Water quality measurement	Water pH not measured	97.8		6.5-7.5	80.1
	Water pH measured	2.2		>7.5	1.5
Stocking pattern	Multiple	87.4	Mode of marketing	Local market	56.9
	Single	12.6		Via middle man	37.4
Mode of harvesting	Multiple	85.8		Auction centre	3.6
	Single	14.2		At pond side	2.1

3.6 Harvesting and marketing

Aquaculture farmers of Purulia district preferred to follow multiple-stocking and multiple-harvesting processes. About 85.8% farmers follow multiple harvesting throughout the year. In Purulia, farmers do not extend the culture period too much (maximum 6 months) and initiate harvesting process from advanced fingerling stage due to several reasons such as i) early drying of ponds ii) high market demand of advanced fingerlings iii) slow growth due to malnutrition and non-use of supplementary food and iv) risk of theft. Most of the fish farmers (56.9%) directly sell their fish at the local market. About 37.4% of fish farmer sell their farmed fish through intermediary and only 3.6% farmer sell directly at auction market (Table 4). The marginal farmers (2.1%) sell their production also on the pond side. The prevalent established market chains are thus three types. These are i) producer-retailer-consumer ii) producer-wholesaler-retailer-consumer and iii) producer-consumer.

3.7 Extension service and knowledge gaps

As the fish farming activity is an age-old practice in West Bengal, the maximum farmer (65.2%) gained their farming knowledge through their sharing experience with other farmers followed by knowledge level through own farming experience (20.6%) (Table 5). Very few numbers of surveyed farmers (9.9%) have undergone different types of training and capacity building programmes conducted by the government department. The government aided training programme can be classified into four categories based on area covered under training i.e. i) Gram Panchayat level ii) block level iii) district level iv) State level. Maximum numbers of farmer (58.25%) have attended block level training programme, followed by district level training programme (19.1%). Very few farmers (9.6%) have got the chance to attend the State level training programme. Only 3.2% fish farmer use mass media as source knowledge for aquaculture activities.

From the present piece of survey, it can be depicted that, most of the aquaculture farmers do not follow the scientific methods of fish farming though many of them are trained and awarded different type of exposure visit conducted by the government. About 85.6% fish farmer do not possess concrete knowledge about best management practices (BMP) and 93.7% farmer do not have any concept about organic farming. Despite several extension activities, government, educational institutions and NGOs are unsuccessful to develop sustainable aquaculture practice and methods in that area and coordination and communication between government stakeholders and fish farmers to implement the scientific advancements in aquaculture are lacking. These trends were also noticed in other parts of India as well as in other Asian Countries also [11-12; 14].

Table 5: Details about extension services, environmental variability and production by fish farmers in Purulia District

Variables	Description	Value (%) (N=300)	Variables	Description	Value (%) (N=300)
Source of knowledge gain for fish farming	Experience sharing	65.2	Govt. aided Training programmes attended	Block level training	58.25
	Own experience	20.6		District level training	19.1
	Govt. aided training programme	9.9		Gram Panchayet level training	13.05
	From mass media	3.2		State level training	9.6
	Training programme arranged by NGO	1.1	Concept about organic farming	No	93.7
Knowledge on BMP	No	85.6		Yes	6.3
Climatic events	Draught	88.1	Production per bigha	1-3 quintal	70.1
	Heat wave	8.3		3-5 quintal	24.6
	Flooding	3.6		>5 quintal	5.3

3.8 Problems and constrains

The aquaculture farmer faced various types of problems and challenges in this district. Farmers opined that climatic phenomenon like the drought is the major hindrance in aquaculture activities (88.1%). Apart from that, water scarcity (78%), disease outbreak (25%), poor seed quality (53%), lack of extension service and technical knowledge (65%), theft (39%) and irregular nature of monsoon (23%) are major issues (Table 6). The scarcity of water during the summer month is a major challenge. Most of the small ponds dried up during the summer month due to scorching heat. Therefore, culture period becomes shorten from 12 months to 8-9 months resulting farmers to harvest small fishes. Besides these, improper financial assistance and lack of sufficient credit facilities, poor market price and quality of feeds also play major setback role in the development of freshwater aquaculture. To mitigate these negative impacts, farmers are often reluctant to take any adaptation strategies except some autonomous one. Low education, small land holdings size and low incomes were major constraints that significantly influence farmers to adopt any suitable adaptation strategies [22]. Therefore, special attention should be given to these constraints while designing and formulating policies for increasing community resilience against recurring drought events.

Table 6: Details about major constrains faced by fish farmers in Purulia District

Description	Value (%) (N=300)
Scarcity of water	78
Lack of extension service and technical knowledge	65
Poor seed quality	53
Theft	39
Occurrence of disease	25
Irregular nature of rainfall	23

4. Conclusion and recommendation

From the survey, it is evident that the aquaculture production method in Purulia district is very poor and aquaculture has been threatened by several climatic phenomena, which severely limits the sustainability of freshwater aquaculture in this drought-prone landscape. In spite of several constraints factors, there is an ample scope of development of aquaculture and it could be a remarkable livelihood option to the rural forest fringe dwellers of Purulia district. Being a water-poor territory, the local adaptation strategies to cope with uncertainties and improve farmers' resilience could include:

- Prospect of alternative species should be examined where the existing species is misfit. Species like *Cyprinus carpio*, *Barbonymus gonionotus*, *Clarias* sp, *Pangasius* sp, Tilapia, Murrels, etc which is comparatively more adaptable to the enhanced temperature and less water and also have market demands.
- Importance should be given to fish species that require a short culture period. Smaller ponds that retain water for 4 months can be used for fish production with fast growing fish species like catfish, Tilapia, barb etc.
- The existing culture pattern and species combination for the affected regions should be modified. Over-dependence on specific species should be avoided and emphasis should be given on species diversification. Addition of high-value species like *Macrobrachium rosenbergii*, *Chitala chitala*, *Anabas testudineus* should also be examined.
- The supplementary feeding regime of the aquaculture sector should be changed. Incorporation of high-energy feed along with additives should be examined. Periphyton based farming should be encouraged.
- Using rainwater for fish culture and pond-dike cropping may increase water use efficiency. Community-based micro-irrigation facilities through rainwater harvesting may provide aquaculture opportunities in the dry season. Land shaping of ponds may increase the dike space utility.
- Planting fruit trees (banana, guava, sapodilla, coconut, lemon, papaya, blak peeper etc.) on pond dikes can provide food and income generation (better utilization of space). Pond slopes could also be utilized for seasonal vegetables that can be extended out onto the pond water with bamboo fences. Aquatic weeds such as Azolla, duckweed, water hyacinth and water spinach can be grown in ponds to provide economic benefits to farmers and shelter for fish during high water temperatures.
- Crops that consume less water and drought resistant varieties of crops should be explored as a way of increasing resilience against drought and to reduce crop failure in dry spells.
- Livestock-crop integration with aquaculture should be practiced.
- The market chain and post-harvest value chain is very week in this region and needs to be strengthened for a better return to the farmers.
- The farmer field school (FFS) approach, which is effective in developing participatory analyses of problems and identifying strategies in a wide range of livelihood interventions.

To attain livelihood constancy through aquaculture, appropriate legal and institutional frameworks, as well as the active cooperation of various stakeholders, are an important prerequisite. To implement local adaptation plans, strong technical, financial and extension services from government organizations and research institutions are urgently needed to enhance the adaptive capacity of fish farming communities in this water-poor landscape.

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6. References

1. Crespi V, Lovatelli A. Aquaculture in desert and arid lands: development constraints and opportunities. FAO Fisheries and Aquaculture Proceedings No. 20. FAO, Rome, 2011, 202.
2. Cunningham L. Assessing the contribution of aquaculture to food security: A survey of methodologies. FAO Fisheries Circular No. 1010. FAO, Rome, 2005, 25.
3. Pant J, Barman BK, Murshed-E-Jahan K, Belton B, Beveridge M. Can aquaculture benefit the extreme poor? A case study of landless and socially marginalized Adivasi (ethnic) communities in Bangladesh. Aquaculture. 2014; 418-419:1-10.
4. FAO. The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. FAO, Rome, 2018, 210.
5. Udmale P, Ichikawa Y, Manandhar S, Ishidaira H, Kiem AS. Farmers′ perception of drought impacts, local adaptation and administrative mitigation measures in Maharashtra State, India. International Journal of Disaster Risk Reduction. 2014; 10:250-269.
6. Government of India. Basic animal husbandry & Fisheries statistics. Ministry of Agriculture and Farmers Welfare, New Delhi, India, 2015.
7. Government of West Bengal. Handbook of Fisheries Statistics 2015-16. Department of Fisheries, Kolkata, India, 2015.
8. Mishra M, Chatterjee S. An effort of mapping the income inequality in the district of Purulia, West Bengal, India. Journal of Social and Economic Development. 2017; 19(1):111-142.
9. Dasgupta T, Chatterjee RN. Poverty Portrayal in the Context of Rural Bengal: A Case-Study of Purulia District of West Bengal. Studies of Tribes and Tribals. 2008; 6(1):1-11.
10. Murugannandam M, Pande RK, Sharda VN, Mishra PK, Raizada A. Myths, perceptions and knowledge of farmers on basics of fishes and fish farming in western Himalayas: A review of realities. Indian Journal of Traditional Knowledge. 2014; 13(1):70-86.
11. Dubey SK, Chand BK, Trivedi RK, Mondal B, Rout SK. Evaluation of the prevailing aquaculture practices in the Indian Sundarban delta: An insight analysis. Journal of Food, Agriculture and Environment. 2016; 14(2):133-141.
12. Arthur JR, Phillips MJ, Subasinghe RP, Reantaso, MB,

Macrae IH (Eds). Primary Aquatic Animal Health Care in Rural, Small-scale Aquaculture Development. Technical Proceedings of Asian Regional Scoping Workshop, Dhaka, Bangladesh, 27-30 September, 2002, 382.
13. Khan MH, Lilley JH. Risk factors and socio-economic impacts associated with epizootic ulcerative syndrome (EUS) in Bangladesh. In: Primary Aquatic Animal Health Care in Rural, Small-scale Aquaculture Development. Arthur JR, Phillips MJ, Subasinghe RP, Reantaso, MB, Macrae IH (Eds). FAO Fisheries Technical Paper No.406. FAO, 2002, 27-39.
14. Abraham TJ, Sil SK, Vineetha P. A comparative study of the aquaculture practices adopted by fish farmers in Andhra Pradesh and West Bengal. Indian Journal of Fisheries. 2010; 57:41-48.
15. Das A, Kumar NR, Krishnan M, Yadav VK, Immanuel S. Adoption of improved aquaculture technologies in Tripura, India. Fishery Technology. 2014; 51:58-63.
16. Syandri H, Elfiondri Junaidi, Azrita. Social status of the fish farmers of floating status of the fish farmers of floating –net cages in lake Maninjau, Indonesia. Journal of Aquaculture Research and Development. 2015; 7(1):1-5.
17. Wilkinson S. Aquaculture fundamentals: The use of lime, gypsum, alum and potassium permanganate in water quality management. Aquaculture Asia. 2002; 7(2):12-14.
18. Brown D, Brooks, A. A survey of disease impact and awareness in pond aquaculture in Bangladesh. In: Primary Aquatic Animal Health Care in Rural, Small-scale Aquaculture Development. Arthur JR, Phillips MJ, Subasinghe RP, Reantaso, MB, Macrae IH (Eds). FAO Fisheries Technical paper No.406. FAO, Rome, 2002, 85-93.
19. MacRae IH, Chapman G, Nabi SMN, Dhar GC. A survey of health issues in carp/ Macrobrachium culture in rice fields in Bangladesh. In: Primary Aquatic Animal Health Care in Rural, Small-scale Aquaculture Development. Arthur JR, Phillips MJ, Subasinghe RP, Reantaso, MB, Macrae IH (Eds). AO Fisheries Technical Paper No.406. FAO, 2002, 85-93.
20. Veerina SS, Nandeesha MC, Gopal Rao K. Status and Technology of Indian Major Carp Farming in Andhra Pradesh, India. Special Publication No.9, Asian Fisheries Society Indian Branch, Mangalore, India, 1993, 76.
21. Hasan MR, Ahmed GU. Issues in carp hatcheries and nurseries in Bangladesh, with special reference to health management. In: Primary Aquatic Animal Health Care in Rural, Small-scale Aquaculture Development. Arthur JR, Phillips MJ, Subasinghe RP, Reantaso, MB, Macrae IH (Eds). FAO Fisheries Technical Paper No.406. FAO, Rome, 2002, 147-164.
22. Pangapangaa PI, Jumbe CB, Kanyanda S, Thangalimodzi L. Strategic choices towards droughts and floods adaptation in Southern Malawi. International Journal of Disaster Risk Reduction. 2012; 2:57-66.