

Roadmap for Fisheries Development in *Mauns and Chauris* of Bihar



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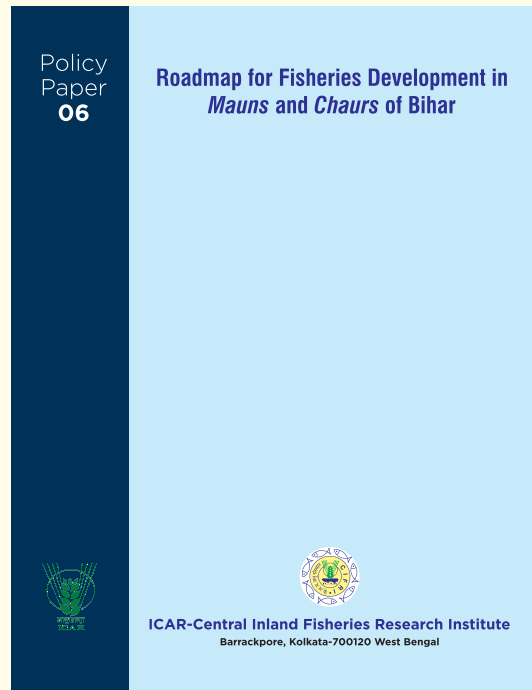
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Preface

The state of Bihar is the thirteenth largest state of India; the total area covered by the state of Bihar is 94,163 km². The state is located between 24°-20'-10" N ~ 27°-31'-15" N latitude and between 83°-19'-50" E ~ 88°-17'-40" E longitude. Bihar is situated along the Ganga river basin, includes 38 districts of which 21 districts in North Bihar and 17 districts in south Bihar. Bihar plains drained by the Ganges River, including its northern tributaries Gandak, Budhi Gandak and Koshi, originating in the Nepal Himalayas and the Bagmati originating in the Kathmandu Valley that regularly flood parts of the Bihar plains, the southern tributaries include Son, Punpun, Falgu etc. The state of Bihar is endowed with a variety of natural water resources viz. Rivers and associated water bodies like flood plain wetlands (Oxbow lake, meanders, seasonal flood plain), Reservoirs, Ponds and Tanks. Despite abundant aquatic resources in terms of about 3200 km of rivers, 200,000 hectares chauras and flood plain wetlands, 9,000 hectares of oxbow lakes or mauns, 26,303 hectares of reservoirs and 93,296 hectares of ponds and tanks, fish supply is short of demand in the state of Bihar. The annual fish production was 5.06 MT, while the present annual demand is 6.42 lakh MT, resulting in 1.36 lakh MT gap between demand and supply.

Therefore, formulation and implementation of effective strategies for fisheries and aquaculture development in the region are the need of the hour to bridge the existing gap between fish production and demand. Considering the huge untapped potential, it is expected that open water fisheries development should be one of the priority areas involving different organizations.

The policy document for "Roadmap on Fisheries Development in Mauns and Chauras of Bihar" is the outcome of concerted efforts of ICAR-Central Inland Fisheries Research Institute (ICAR-CIFRI) and state fisheries departments. Regional consultation on "Open water fisheries development in Eastern region" for 4 states was also organized by the Institute to formulate the roadmap. The document inter alia includes strategies suggested for open water fisheries development based on the available fisheries resources.

The publication of this roadmap will be of immense help to policy makers, planners, fisheries officials, researchers and all those concerned with fisheries development in Bihar. Further, this publication should facilitate evolution of suitable and relevant open water fisheries management programmes in the region.

B. K. Das
Director

Roadmap for Fisheries Development in Mauns and Chauras of Bihar

Background

Bihar is situated along the Ganga river basin, includes 38 districts of which 21 districts in North Bihar and 17 districts in south Bihar. The state of Bihar is endowed with a variety of natural water resources viz. Rivers and associated water bodies like floodplain wetlands (Oxbow lake, meanders, seasonal floodplain), Reservoirs, Ponds and Tanks. Despite abundant aquatic resources in terms of about 2800 km of rivers, 200,000 hectares chauras and floodplain wetlands, 9,000 hectares of oxbow lakes or mauns, 25,000 hectares of reservoirs and 90,000 hectares of ponds and tanks, fish supply is short of demand in the State of Bihar. Apart from Ganga river system, 15 rivers and rivulets such as Koshi, Gandak, Budhi Gandak, Kareh, Kamla, Bagmati etc. A total 88 species of fish have been reported from the state. The commercially important fishes such as *Catla catla*, *Labeo rohita*, *Cyprinus carpio*, *Cirrhinus mrigala*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, *Labeo bata*, *Labeo gonius*, *Mystus tengara*, *Tor tor*, *Notopterus notopterus*, *Notopterus chitala*, *Heteropneustis fossilis*, *Clarius magur* etc. are comprises major fisheries in the Bihar.

Fish production of Bihar was 0.43 million tons in 2013-14 where as demand (0.50 million tons), as reported only 86% of demand was satisfied. Development of the aquatic resources with the adoption of the available technologies can bridge this gap, by at least 35% increase in production from the present level of 4.3 lakh tons. The total fishermen population of Bihar is about 49.59 lakh of which 37.079 lakh are active fishermen. The natural location of Bihar is such that the depressed landmass between river Gandak and Koshi has the distinction of nurturing huge number of open-water fishery resources and among them the floodplain wetlands; the river meanders (oxbow lakes) and tectonic lakes (chauras) are highly productive, but lack proper management. Culture-based fisheries could be the viable option for enhancing the fish productivity in floodplain lakes (mauns & chauras) with visible results in short period of time. However, to pursue the culture-based fisheries development in floodplain wetlands, a number of issues need to be addressed on priority basis like availability of quality fish seed (advanced fingerlings), effective

management of weeds, restoration of connecting channels between the rivers and wetlands, restoration of marginal areas of floodplain lakes which have been silted up, adequate management of water level through the construction of inlets and outlets, especially in chours, mobilizing the community for their active participation in *chours* being multiple ownership water bodies.

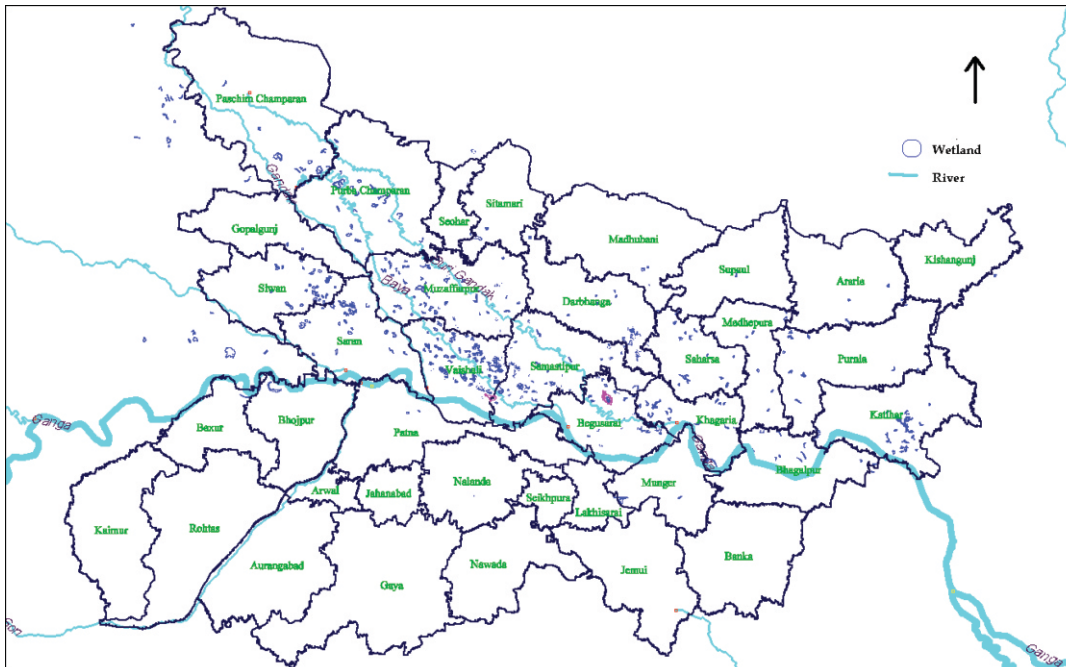


Fig.1: Water resources of Bihar

Introduction of new enclosure system, pen culture would also be essential, not only to produce table fish for ready marketing, but also for raising the stocking materials of desired species and of desired size in situ to support the stocking programme. Presently, as per the Bihar Jalkar act 2006, the oxbow lakes are being leased out to fisher cooperatives, or the fisher SHG group for 7-10 years, where the lessee harvest fish without adopting responsible fisheries methods. It would be prudent, therefore, to develop a mechanism for capacity building for bringing the floodplain wetlands under culture-based fisheries development to bridge the gap between demand (5 mt) and supply (4.3 mt). The resources of Bihar are as follows.

Table 1: Fisheries Resources of Bihar

Sl.No.	Resource	Water area
1.	Ponds and tanks	90,050 ha
2.	Ox-bow lakes(<i>mauns</i>)	9,000 ha
3.	Chaur	2,00,000 ha
4.	Reservoirs	25,000 ha
5.	Rivers	2,800 km

Present Fishery Resource Status of the State

The district-wise availability of floodplain wetland resources (chaur and mauns) of Bihar are given in tables 3&4. Bihar has an estimated chaur area of more than 2, 00, 000 ha (Table 3) while the area under oxbow lake (maun) has been estimated at around 9,000 ha (Table 4).

Table 2: Chaur resources of Bihar

Districts	Seasonal water body <i>Chaur</i> area (ha)	Districts	Seasonal water body <i>Chaur</i> area (ha)
Purnia	2680	Vaishali	13550
Katihar	9192	West Champaran	882
Saharsha	5433	East Champaran	3164
Madhepura	9975	Muzaffarpur	4000
Supaul	7777	Begusarai	10,000
Araria	2796	Darbhanga	12141
Gopalganj	9118	Samastipur	6300
Siwan	11,911	Sitamarhi	1486
Saran	86941	Madhubani	200
Total			1,97,546

Table 3: Maun resources of Bihar

Districts	Area (ha)
East Champaran, West Champaran, Muzaffarpur, Samastipur, Begusarai, Darbhanga	9000

Ecological Profile of Floodplain Wetlands

Bihar has the distinction of two types of floodplain wetlands, the ox-bow lakes (mauns) and tectonic lakes (chaur). Accordingly, the floodplain lakes have two distinct sets of ecological profiles. The origin of the lakes determines the hydrological regimes, which in turn influence the biota and production functions. The

levels of human interventions also play a significant role in determining the ecological profiles at a given time. Comparatively, however, the ox-bow lakes (mauns) indicate relatively better ecological status than the chours.

Ox-bow lakes (Mauns)

- Most of the lakes are in a critical phase of ecological transition with an indication of the advanced stage of eutrophication.
- Massive stands of aquatic weeds (5-20 kg/m²) have been the hall mark in these lakes affecting the fish and fisheries adversely.
- The concentration of dissolved oxygen fluctuates from suboptimal to super saturation level (16 mg/l and above), a manifestation of excessive growth of macrophytes
- The amplitude of seasonal variation of pH (7-10) and alkalinity (150-300 mg/l) are high, so is the case with specific conductance (200-450 u Mohs).
- The carp fishery, the mainstay of revenue to the fishers, has substantially declined (4-10%) in the face of lopsided growth of biotic communities.
- The contribution of forage fish in the total catch has increased menacingly to the tune of more than 60%.
- Increased availability of forage fish species has paved ways for greater dominance of predators, which again affected the carp fishery adversely.
- The auto-stocking of quality fish seed has diminished to almost negligible level owing to the loss of connectivity between rivers and wetlands
- Data available at CIFRI indicates that on an average the per-day catch per fisherman is as low as 300 g of low priced smaller varieties with less market acceptability.
- It has been observed that reckless fishing practices are common and rampant.
- Wanton killing of brooders and juveniles are very common in almost all the lakes
- Irrational fishing gear like fine meshed mosquito clothing nets, locally known as "Chattijal" is used rampantly, making these ecosystems almost an ecological desert.

Tectonic lakes (Chours)

- Ecologically the chours are highly degraded ecosystems owing to excessive human intervention.

- Massive infestation of macrophytes has been the most visible impact of excessive human intervention and indicative of highly shallow nature, which paved ways for greater colonization of macrophytes. In general the connectivity with the rivers/water sources has been lost.
- The fishery is largely dominated by smaller variety of fish species and predators
- Most of the chauras are in advanced stage of eutrophication, leading to swampification at a faster pace, as such colossal loss of effective water area to support fisheries and biodiversity.
- A definite shift in fish diversity at the species as well as population levels has been observed, from economically important species to unwanted species.
- The natural biodiversity of chauras has received a beating in recent times due to increased human interferences, which has triggered massive proliferation of unwanted biota like Macrophytes
- The overall ecological integrity of these lakes has nosedived, affecting the production functions and fisheries adversely.

Productivity, Present Production, Projected Production and Gap in Production

Despite of the huge water resources, the present fish productivity from chauras and mauns is very low. The present status of fish present fish productivity, production potentials and projected productions, are highlighted in following table.

Table 4: Productivity, present production, projected production and gap in production (*mauns and chauras*)

Resource	Area (ha)	Present yield(kg/ha)	Projected yield (kg/ha)	Present production (t)	Projected production (t)	Gap (t)	Projected increase (times)
Mauns	9000	220	1500	1980	13500	11520	6.82
Chauras	200,00	50	750	10000	1,50,000	1,50,000	150

Management Options for Fisheries Enhancement in Open Water Resources

Fish production from floodplain wetlands can be increased, following the scientifically developed management strategies by CIFRI. There could be many options for fisheries enhancement in wetlands, depending upon the objectivity and prevailing ecological conditions in a particular system. Eco-friendly options before us in augmenting fish production from the water bodies are various enhancement

measures. FAO (1997) defines enhancements as technical interventions in existing aquatic resource systems, which can substantially alter the environment, institutional and economic attributes of the system. Enhancement is a process by which qualitative and quantitative improvement is achieved from water bodies through exercising specific management options.

Management Option

Culture-based fishery is the most common mode of enhancement being followed in inland water bodies in India. The main areas of interventions are as following.

- Stock enhancement,
- Species enhancement,
- Management enhancement,
- Culture-based fisheries including pen culture

Stock Enhancement

In open water bodies, which have lost riverine connection due to construction of embankments and siltation, natural fish stocks of commercially important fish species have been depleted due to disruption of the auto-stocking process from the Parent Rivers and also due to the low number breeding population to sustain recruitment. In such cases stocking with fingerlings of required fish species is found to be effective for developing self-recruiting populations to augment recruitment and there by production. The main aspects of stock enhancement are selection of species for stocking, determination of stocking rate and the size at stocking. Stock enhancement can be either to create culture-based fisheries based predominantly on the recapture of stocked fish or to enhance/supplement the self-recruiting populations, where recruitment is poor.

Species Enhancement

Species enhancement is planting economically important and fast growing fish species from outside with the aim of colonizing all the diverse niches of the water body for getting enhanced fish biomass. While doing this all the possible consequences of introductions have to be taken into account. Commercially important fish species can be transplanted to utilize unused food resources.

Management Enhancement

Altering the pattern of management can substantially improve the economic attributes of a water body. This include adopting culture fishery along with capture, developing sports fishery and opening to managed tourism, declaring protected

areas and natural reserves etc., deciding whether private management, management by cooperative societies, co-management, etc. can also alter the economic attributes of the water bodies.

Technological Interventions

Pen culture for raising advance fingerlings

Pen is an enclosure that can be utilized to hold fishes as captive stock within a beel/wetland. The pen culture technology is useful in shallow, derelict and weed choked water bodies, where aquaculture is not possible and fishing is difficult. Recommended area of a pen unit is 0.1-0.2ha; battery of such units can be installed as required. The technology can also be used for raising fingerlings for stocking. A production of 500kg carp fingerlings of 10g/100mm size can be achieved in pens of same size in three months by stocking 50000 to 75000 fry of 15-30mm size with a survival of 80%. The technology is eco-friendly and involves low input cost including supplementary feeding and fish health management. The number of pen units to be put up depends on the size of water body and production requirement.

Balancing between native and stocked fish species

Enhancing production through stocking should not endanger the sustainability of indigenous species. Stocked species should not exceed 60-70% of the fish population, with indigenous species accounting for the remainder. The number of seed required is estimated on the basis of the proposed stocking density, targeted production amount, area of the waterbody, species combination, fingerlings availability and cost including transportation to reservoir site, and budget.

Culture Based Fisheries with Stocking Strategies

Culture-based fishery

As a general guideline, the fish species options being advocated for culture based fisheries in wetlands are stocking of Catlacatla (surface feeder), Labeorohita (column feeder) and Cirrhinus mrigala (bottom feeder) at 100-120mm/10-15g size. The stocking density will depend on the carrying capacity of the water body in question. However this might vary according to local situations and the existing species spectrum of the water body. In general, however, a stocking density in the range of 1500-2000 advanced fingerlings for wetlands is recommended to increase production and productivity of wetlands on a sustainable basis.

In the backdrop of stocking of advanced fingerlings (100-120 mm), it would be expected that the survival is more than 60%. The wetlands being the highly productive ecosystems and generally have higher predator pressure; the stocking density should vary between 1500-2000 fingerlings.

Type of water body	Species	Stocking rate (%)
Weed-free system	Surface feeder + column feeder	70
	Bottom (detritus) feeder	30
Moderately weed-infested	Surface feeder + column feeder	60
	Bottom (detritus) feeder	40
Highly weed-infested	Surface feeder + column feeder	30
	Bottom (detritus) feeder	70

Infrastructure Support Required

Requirement of Brood-stock

In order to produce 32 Crore fingerlings an estimated 36000 kg of female and 36000 kg of male brooders would be required, considering one lakh spawn/kg female, taking into account (spawn to fry 25%; fry to fingerling 50 % and fingerling to advance fingerling 95% survival respectively). Assuming market price for one kg of brooder a sum of Rs. 1.44 Crore @ Rs. 200/kg will be required towards the cost of brooders.

Infrastructure required

Hatcheries: To produce 2.7 billion spawn 45 hatcheries will be exclusively required. To breed 1 kg of female water area of about 3 m³ is necessary. The optimum dimension of the spawning pool will be of 6 m X 2.5 m (Diameter x Depth) with total volume of about 75m³. Hence, about 25 kg to 30 kg of female can be taken for spawning in one cycle. Considering 30 kg of female and 30 kg of male, a total of 30 lakh spawn can be produced per cycle. If total operational period is 90-100 days with 3-4 days of each cycle followed by 1-2 days for sanitation, a total of 20 cycles could be possible to produce 6 crore spawn. Therefore, at least 45 hatcheries having a production capacity of 6 crore spawn each need to be established to produce 270 crore spawn. This 270 crore spawn will give rise to 75 crore of fry followed by 37.5 crore fingerlings and followed the targeted production of 32 crore advance fingerlings.

The hatcheries may be built in Muzaffarpur, Saran, Vaishali, Samastipur, Darbhanga, Begusarai, Khagaria, Saharsa, Purnea, Araria.

Table 5 Feed Requirement for or seed raising

Initial stage	Final stage	Ration level (%)	Quantity of feed (in tons)	Duration (days)
Spawn	Fry	10	8	21
Fry	Fingerling	4	3600	90
Fingerling	Advanced fingerling	3	2400	30
Broodstock		2	560	360
Total			6568	

Feed mill: To cater the need of 6568 t of feed, there will need to install 8 feed mills with average production of 12 t feed / day. The feed mill may be set up in four commissionaires.

a. Two tier rearing facility:

- i. A nursery rearing pond area of 1360 ha will be required to produce fry from 270crore spawns
- ii. A pen rearing area of 1360 hais needed for 67.5 crore fry (if each pen area is 0.4 ha and two cycles of fry to fingerling rearing is carried out)

b. Aqua shops cum clinic: Each administrative block must have a one-stop Aqua shop for therapeutic medicines, basic chemicals, probiotics, water testing kit etc.

c. Soil & water testing Lab: At each district level, one soil and water testing laboratory may be set up.

d. Cold chain: planning may be done to insure refrigerated van, trucks at district level to transport fish to the distant cities.

e. Fish Market: One model and one small fish market may be set up in each district for efficient marketing and auction center.

Proposed Model for the Development of 100 ha of Wetlands

A proposed model for developing 100 ha of floodplain lakes (mauns&chaurs) is furnished below in Table 6 and also the cost of raising fingerlings in 0.4 ha size pen under pen culture is shown in Table 7.

Table 6: Development cost of 100 ha of wetland

Items	Cost per ha (Rs.)	Total cost (Rs.)
A. Initial Expenditure		
Weed clearance 30% of the surface area)	35,000	10,50,000
Sub Total A		10,50,000
B. Recurring		
Lease rent	4000	400,000
Stocking of fingerlings @ 2000, raising <i>in situ</i> in pens of 0.1 ha each (04 pens)	4000 x 4	1, 60,000
Sub-Total B		5,60,000
C. Fixed cost		
Sluice gate (inlet & outlet)	5,00,000	10, 00,000
Pens 04 nos.	1,02,000 each pen	4,08,000
Boat, 2 nos. (15' OAL) for monitoring	35,000 per boat	70,000
Nets, 20 units	20,000 per unit	400,000
Sub-Total C		18,78,000
Grand Total (A + B + C)		34,88,000
Returns: Fish Harvest @ 80% survival with an average weight of 600 g		1000 kg/ha/year; 100 t from 100 ha; @ 1,00,000 per t =Rs. 1,00,00000

Table 7: Cost of raising fingerlings in pens

Items	Unit Cost (Rs.)	Total Cost (Rs.)
A. Initial expenditure		
0.1 ha CIFRI Pen HDPE	47,675	47,675
Sub-Total A		47,675
B. Recurring		
Seed, 100,000 fry	80/thousand	8,000
Feed @ 1% body weight		4,000
Miscellaneous (lime, medicine etc.)		1000
Sub-Total B		13,000
Grand Total		60,675

Each pen would produce 50,000 fingerlings, as such 2,000,00 fingerlings can be produced from 04 pens in one cycle, which would be adequate for stocking a wetland of 100 ha. The life of a pen-structure is three years; the fixed cost on pens would not be there for second and third years of operations.

Fisheries Regime and Management Status

Management status of water resources

Based on the property rights and access the management regimes of the open water fisheries of Bihar can be categorized into four types i.e. Private management (individuals and groups), Fishers' cooperative management, SHG based management and Open access with no management. The ownership of water bodies comes under the department of fisheries. The management rights of wetlands were given on lease to the highest bidder (Fishermen Cooperative society/ Fishers SHG).

Private Management

Private management relates with the management of beelsde facto by lessee. The lease period which was earlier one to five years has been amended up to ten years for providing incentives to lessee for adopting stock enhancement measures. The management of mauns including the fishing operation is done by the lessee. Wetland fisheries management includes stock enhancement measures, weed management, fishing in the maun done by the lessee. Access of other fishermen operates in the beel on paying some amount to the lessee or coming under the sharing arrangement, where a share of the fish catch is taken by the lessee as fee.

Cooperative Management

In Cooperative management of floodplain wetlands, the management of fisheries operations is done by the members of the cooperative society as per the rules prescribed by the society. Here the access of property is governed by the membership of the cooperative society. Two types sharing arrangement of cooperative society and individual members are prevalent. In some societies, the fish catch is pooled together and sold in the market and a part of income shared among the members of the communities. In other societies, fishers give fifty percent of their catch to the society as share of revenue.

Open Access

Rivers, rivulets, streams are open access in nature means there is no control of access. But in fact the access of these water bodies is also based on local rights i.e

the fisherman operating in these rivers must be from the adjoining locality or same community etc. Only capture fisheries are practiced in these water bodies based on the automatic recruitment during the flood period.

Fishers Community and Status

The importance of fishing to local communities, both in terms of nutrition as well as livelihood, is rarely noted in India, but in Bihar the fishing rights in open water is exclusively given to the fishing community, fisherman cooperative society and self-help groups of fisherwomen and fishers. The Jalkar Management Act of Bihar (2008) gives priority to women of the fishing community to practice fish culture in the ponds and tanks. In the case of Bihar, fishermen were defined as 'professional fishers' in the 2006 Jalkar Act. This was amended to 'traditional fishermen'.

The fisher population in Bihar was 26.58 lakh in 2011. There are 410007 fishers registered with the primary fisheries cooperative societies. The budget for fisheries remains low. In 2012-13, the State spent Rs 786.2 million for fisheries, in 2013-14 it dropped to Rs 280 million. The budget outlay jumped to Rs 650 million in 2014-15. Fisheries have got the lowest allocation within agriculture sub sectors. The state however has the largest number of fishers in the country.

Institutional Mechanism

Stakeholders in fisheries of Bihar

A large number of stakeholders involved in open water fisheries management in Bihar. These are State departments like Fisheries, Cooperative and Environment & forest. Others include Fisheries Cooperative societies, and Local bodies. Fishers, end users and water users given as under.

- Local user communities - People live in the vicinity and directly use the resources, i.e. the fishers, lessees
- Local communities having an indirect interest in the management of the resource; i.e., local communities which rely on some function of the wetland, i.e. flood control, but no direct use the resources e.g. villagers in adjoining areas.
- Remote user communities i.e. share fishers and laborers.
- Commercial direct users i.e. lessees, middleman and fish traders
- Suppliers and marketers associated with fisheries

- Government agencies with responsibility for management of some aspect of fisheries resources, eg, department of fisheries, panchayat, dept. of Forest for Bihar
- NGOs, development assistance organizations and concerned individuals, and
- Research institutions
- End consumers of fish products.

Each of the stakeholders operates at different level of management. Therefore, a number of management domains exist with different components and output (Table 8). Thus, interventions in the management process which focus solely on a particular user community, or even on a user community and the relevant government agency, are often undermined by parts of the wider community that have not been included in project design considerations. Among different stakeholders the fishers constitute the most important stakeholders as the life and livelihoods of them are dependent on the resources.

Laws and regulations governing fisheries in Pre Independence Era:

- By Regulation XXVII of the Permanent Settlement of 1793 in Bengal, (the rights over fisheries were included as a part of the rights over estates held by the zamindars or the landlords. The zamindars leased out these rights over fisheries to farmers, moneylenders, and occasionally to the fisher)
- *Canal and Drainage Act 1873*
- *Indian fisheries act 1897*
- *The Government of India Act, 1935*
- *Bihar Cooperative society act 1935*

Laws and regulations governing fisheries in Bihar after 1947

- Directive Principles and fundamental duties under the Constitution of India
- Constitution of India Schedule 7, List 1 entry 21, 56
- Bihar Fish Jalkar Management Act 2006(amendments in 2007, 2008 & 2010)
- Bihar Cooperative societies amendment Act

Table 8: Management Domains in Floodplain Wetlands of Bihar

Sl. No.	Domains of Analysis	Components	Outcomes
1.	Natural Process	<ul style="list-style-type: none"> • Nutrient assemblage • Auto stocking • Connectivity to River • Biodiversity • Flooding 	<ul style="list-style-type: none"> ■ Productivity potential ■ Technological and Management options ■ Production enhancement possibilities ■ In-situ conservation ■ Sustaining assemblage and ecosystem ■ Ecosystem integrity
2.	Human Intervention	<ul style="list-style-type: none"> • Management regime • Fishing practices • Fishing efforts • Weed control 	<ul style="list-style-type: none"> ■ Sustainable production ■ Productivity enhancement ■ Resource use ■ Sustainability
3.	Agencies of Intervention	<ul style="list-style-type: none"> • Individuals • Formal & informal groups • Community • Govt. Departments • Scientific organization • Traders & Commission agents • Financial institutions 	<ul style="list-style-type: none"> ■ Efficient resource use ■ Community participation ■ Employment opportunity ■ Livelihood & nutritional security ■ Fishing ban & holidays ■ Credit availability ■ Technological improvement ■ Improved resource monitoring
4.	Institutions	<ul style="list-style-type: none"> • Social Interaction & process • Property relationship • Social Institutions • Market agencies 	<ul style="list-style-type: none"> ■ Rules and Norms ■ Negotiated understanding ■ Conflict resolution ■ Increased participation ■ Access to resources ■ Community based management ■ Information sharing and exchange ■ Capacity utilization
5.	Policies	<ul style="list-style-type: none"> • Leasing policy • Infrastructure development • Control of effort • Resource Conservation • Institution Building • Security mechanism • Welfare measures 	<ul style="list-style-type: none"> ■ Resource allocation, user access right, ■ Sustainability ■ Long term welfare ■ Input support ■ Improved decision making ■ Conservation of endangered species ■ Participative and precautionary measures ■ Improved enforcements measures ■ Awareness among fishers ■ Biodiversity conservation

- Bihar Chaur evum Maun vikash yojana
- Other Govt orders
- Rules of management
- Village community
- Informal institutions

Formation and Transfers of Fishing Rights in Bihar

As per Bihar fisheries Jalkar management act, department of fisheries, Government of Bihar has ownership over the open water bodies of Bihar. Fishers have got access to these waterbodies subject to the conditions and reasonable restrictions. Some of the chaur in Bihar are private registered property and hence under the control of private persons. Fisheries management rights of government owned mauns and chaur are given to fishers, fishermen cooperative societies and fishers' self-help groups. The Maun/Chaur are leased to the highest bidder from traditional fishermen community, fishermen cooperative societies and self-help group for a period of 7/10 years on lease. Traditional fishermen or fishermen cooperative societies have access to fishing in rivers. Ponds and tanks are leased to traditional fishermen or fishermen cooperative society, trained fishers for 3-5 years. Figure 2 shows the formation and transfers of fishing right in Bihar.

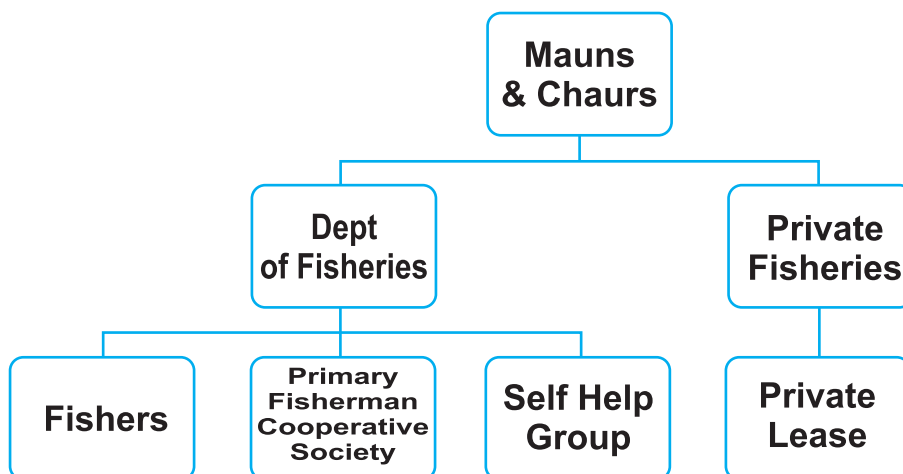


Figure 2: Formation and Transfer of fishing right in open waters of Bihar

Enhancement Strategies in Small Reservoirs

Stocking policy is specific to a reservoir and decided by its biogenic capacity, the growth rate of stocked species, natural mortality, and losses to escape and predator pressure. Fish species that feed low on the food chain are preferred, but they should also offer good eating, economic value and potential for marketing, either locally or in remote markets. CIFRI studies suggest that fish fingerlings 125 millimeters (mm) and longer achieve better survival rate and good growth. Small reservoirs can be stocked at the rate of 800-1000 fingerlings/ha. Out of the 25000 ha reservoir area at FRL, average water area during pre-monsoon is around 4000 ha. The stocking of 1000 ha reservoirs needs 8-10 lakhs advance fingerlings.

Human Resource Development (HRD) Requirement

- A requirement of 10000 trained farmers (1 trained farmer/20 ha) for culture based fisheries in Chours and Mauns.
- Additional 500 Innovative farmers may be trained by ICAR-CIFRI.
- At present one training centre of department of fisheries is operational at Patna. An additional farmers training center may be opened in north Bihar with a capacity of 100 trainees/Batch for capacity building of farmers.
- Fisheries subject may be strengthened at Krishi Vigyan Kendra through creating a post of Subject Matter Specialist at KVK indistricts having fisheries potential.
- Matsya mitra scheme may be launched in Bihar to augment the para fisheries workers at village level to disseminate scientific technical knowledge at village level.
- One Fisheries collage is operating under Rajendra Prasad CAU, Pusa at Dholi in Muzaffarpur. The intake of students at graduate level may be increased.
- Primary fishermen cooperative society may be strengthened at block level to adopt scientific fisheries management at maun and chaur level.

CIFRI Intervention in Bihar

Wetland Fisheries Development Project in East Champaran under CSS

The DAHD&F has approved 5 projects for 3 years (2017-18 to 2020-21), under Central Sector Scheme on blue revolution for pilot demonstrations of technologies

for fish yield enhancement and livelihood improvement in 5 wetlands of Bihar namely Majharia, 120ha; Kararia, 120ha; Sirsa, 70ha, Rulhi, 80ha and Kothia 60 ha. These projects are

1. Fisheries development in Rulhi wetland of Bihar through stakeholders' participatory fisheries management model (Co-management) in a sustainable manner-An Innovative project
2. Fisheries development in Sirsa wetland of Bihar through in-situ fish seed rearing and fisheries enhancement techniques for tapping fish production potential-An Innovative project
3. Fisheries development in Kararia wetland of Bihar through empowerment of communities and stakeholders participation for capacity building and improved livelihood -An Innovative project
4. Fisheries development in Majharia maun of Bihar through refinement of site specific fisheries enhancement technology-An Innovative project
5. Fisheries development in Kothia Maun of Bihar -A Pilot Project

The objectives of the project are

- To develop wetland fisheries through institutionalizing stakeholders' participatory fisheries management model in a sustainable manner
- To disseminate in situ fish seed rearing and fisheries enhancement techniques (stocking enhancement, enclosure cultures) for tapping fish production potential of wetlands
- To empower communities and stakeholders through improved livelihood opportunity and capacity building
- To refine site specific fisheries enhancement technology for the development of wetland fisheries

The module of operation of the proposed project would be technological support and execution of the whole programme by CIFRI, Barrackpore with financial support from Union Ministry and administrative support from line departments of respective states with direct participation of local community. Basic infrastructure required for fisheries enhancement, such as nursery pond, cage culture, pen culture will be in place in the targeted wetlands along with confidence and motivation of stake holders

for adoption and sustainability. The project will require both fingerling and advanced fingerlings for stocking in cages, pens and open water.

Nursery pond facility (Kararia 3ha, Majharia 3ha, Rulhi 2ha, Kothia 2 ha), in the proximity of wetland has been created. CIFRI GI cages have been installed in Rulhi (6), Majharia (6) Kothia (6) and Sirsa (12) for production of advanced fingerlings and table fish of regionally preferred indigenous fishes. CIFRI Pen HDPE structure has been installed in Majharia 1.5ha, Kararia 1.5ha, Sirsa, 1.5ha, Kothia 1.5 ha for in-situ seed production. Fibre fishing boats were made available to the fishers of the five wetlands at the wetland sites.

Through the intervention of ICAR-CIFRI, the average productivity of these wetlands before the start of the projects were below optimal in the range of 150-300 kg/ha/year. The project was initiated with the aim of increasing the yield of from present 300 kg/ha/year to the tune of 800-1000 kg/ha/yr. 2000 fisher families are dependent on these five wetlands. The average income of fishers' family was Rs. 40000 per annum. The project was aimed at doubling the income of these 2000 fishermen families through doubling the production in next two years.

The increase in fish production in the selected wetland is being catalyzed through integrated approach of technological intervention such as, determination of seed requirement and stocking strategy thorough assessment of ecosystem structure, trophic state, fish species spectrum, production of quality seed through land based nurseries and pen culture. Basic infrastructure required for fisheries enhancement, such as nursery pond, cage culture, pen culture has been in place in wetlands along with confidence and motivation of stake holders for adoption and sustainability. With these interventions, the production and productivity of the wetlands have been increased significantly.

Through ICAR-CIFRI's technological interventions of culture-based fisheries management has resulted in increased double-triple fish yield of, viz., 180 kg/ha/yr to approximately 675 kg/ha/yr in Kararia Maun; 190 kg/ha/yr to 320 kg/ha/yr in Sirsa Maun; 70 kg/ha/yr to 140 kg/ha/yr in Rulhi Maun and 60 kg/ha/yr to 120 kg/ha/yr in Majharia Maun.

With sharing arrangement between lessee and fishers are in the ratio of 60:40 for stocked fishes and 30:70 for natural fishes, this increase in fish production helped in

augmenting the income of fishers' household and average household income has increased by almost 40% to approximately Rs. 60000 from fisheries. The technological intervention has received a favorable response from the local fishers as it has not only helped to eradicate the unemployment, but has also shown positive results in reversing the youth migration in search of jobs. On governance front, intervention of ICAR-CIFRI resulted in equitable benefitting sharing formula and effective Cooperative governance model.

Strength, Weakness, Opportunities and Threats

	Strength	Weakness	Opportunities	Threats
Natural Resources	Vast inland open water fisheries resources like 200000 ha of <i>Chauris</i> , 9000 ha of <i>Mauns</i> and 25000 ha of reservoirs	Anthropogenic factors and low rainfall causing depletion of resources towards non fisheries activities	Realizing untapped potential of resources	Siltation, loss of river connectivity, drying of water-bodies due to low rainfall
Human resources	Bihar having highest population of fishers. In last 8 years, Government has trained more than 5000 fishers	Poor socio-economic condition of fishers.	Unutilized youth manpower potential	Low income could refrain them away from fisheries
Fisheries access rights& Policy	Fishers, Fisheries cooperative societies, SHG have been given access rights for fishing in rivers, wetlands.	The well off people restricts fishers from fishing in several stretches	Formation of self-help group of fishers will provide opportunities for fishers. Strengthening of PFCS	Political patronage or support of well off will lead to more conflicts among fishers
Institutional Mechanism	Well established state government fisheries department with directorate	Inadequate lower fisheries extension functionaries	Quick enforcement of access rights of open water resources to fishers.	Pending works due to less man power

	Strength	Weakness	Opportunities	Threats
Technology for enhancement	Technology available for fisheries enhancement in Bihar	Inadequate technology transfer and extension system up to block and village level	Readily available technologies for production enhancement	Poor productivity of existing ponds and tanks and slow pace of utilization of riverine wetlands, <i>Chours</i> and <i>mauns</i> .
Availability of expertise	Fisheries training centre at Patna, ICAR research complex, Fisheries college at Dholi under RPCAU, Pusa. DFO at all district HQ	Less reach at farmers level	A chain of progressive fishers can be built by support of expertise	Inadequate share of fisheries knowledge. inadequate disease surveillance
Seed availability	4 govt hatcheries, 80 pvt hatcheries, 2 corporate hatcheries	Inadequate seed production. Requirement met from hatcheries of West Bengal	Development of new hatcheries in different districts, increase capacity of existing hatcheries. Government support for hatcheries construction	Availability of good quality brood stock.
Feed availability	Availability of rice bran, mustard, quality protein maize	Non availability of feed manufacturing and processing facility	Establishment of feed mill at zonal level	Cost of unit fish production is high

Thrust Areas for Open-Water Fisheries Development in Bihar

- ❖ Conservation of precious fish germplasm in rivers
- ❖ Bringing floodplain wetlands under culture-based fisheries management to increase production and productivity
- ❖ Diversification of activities, such as adequate attention on shrimp and freshwater ornamental fish culture in pens
- ❖ Giving adequate attention on fish-based integrated management of wetlands
- ❖ Exploring the possibilities of fisheries development in canals

Broad Recommendations for Open-Water Fisheries Development in Bihar

- Bringing wetlands under culture-based fisheries regimes:
- Strengthening the delivery mechanism for the transfer of technologies
- Strengthening the cooperative societies and governance issues
- Ensuring need based adequate financial support to fishers
- Reviewing the existing leasing policy of the Govt. with greater emphasis on long term lease
- Developing adequate fish seed hatcheries to support culture-based fisheries in wetlands, with one model fish farm in each district.
- Immediate step to prevent irrational fishing practices in open waters (Ban on *Chattijal*, wanton killing of Brooders and Juveniles)
- Strengthening the marketing channel for better return
- Efforts to provide Insurance cover to open-water fisheries
- Conservation of physical as well as biological resources of floodplain wetlands
- Better linkage among Institutions, developmental agencies and fish farmers
- Training on latest technologies to officials and fishers on regular basis
- Diversification of fisheries activities like introduction of pen-culture and also diversification of culture candidates in floodplain lakes
- Restoring the connecting channels between rivers and wetlands
- Cluster approach for the development of wetlands, especially in terms of the production of stocking materials
- Greater emphasis on the production of high value table fish through enclosure based farming

Suggestions for Further Improvement in Fisheries Sector of the State

Diversification of Aquaculture: Aquaculture in Bihar is mainly dominated by major carp species which account for about 80% of total production. There are several other potential economically important species which could be gainfully brought under aquaculture practices. The availability of quality fish seed throughout the year and lack of appropriate technology are the main bottlenecks in the commercialization and industrialization of fish culture in the state. There is a need to develop the hatchery and the culture techniques of the species required for diversification.

Hatchery and culture techniques of cat fishes: Among these *Clarias batrachus* (Magur), *Heteropneustes fossilis* (Singhi), *Anabas testudineus* (Kevai) and *Pangassius pangassius* (Pangas) are the most popular and well adopted to the chours, pits, swamp areas and paddy field ecosystem.

Hatchery and culture techniques of ornamental fishes: Several important ornamental fishes like *Parambassis ranga*, *Chanda nama*, *Trichogaster fasciata*, *T. Lalius*, golden carps and other sand loaches, tiger barb, *Puntius* species including varieties of aquatic plants are found in natural bodies. This sector has not yet been covered in a technology driven manner and in an organised form. Keeping demand in view, culture and breeding technology of important ornamental fish species should be standardised in the state.

Hatchery and culture techniques of giant freshwater prawn: *Macrobrachium rosenbergii* is a suitable species for farming in ponds and tanks as well as shallow water areas. Effort should be made to make availability of seeds through establishment of hatcheries and standardisation of its culture technologies.

Fish feed and nutrition: To enhance the fish production beyond the natural food available in the water, supplementary feeding is essential. A balanced feed in the form of carbohydrate, protein, fat, vitamins, and minerals is required for quick growth of fishes. There is a need for the establishment of fish feed mills in the state to produce nutritionally balanced supplementary feed in adequate quantity at low cost.

Fish based integrated farming system: Fish based integrated farming would help in an ecofriendly and efficient use of water resources. The effort should be made to develop the resources and the location specific technology for integration of fish farming with one and more commodities. Some of these commodities are paddy, horticulture, cattle, poultry, duckery, piggery and goat. The need for a large multi-location trial is essential.

Creation/construction of ponds: The geometric progression of the human population is also posing pressure to create at least 2000 ha of new ponds per year to cope up with the demand. The state has to enhance the existing water resources by construction of new ponds in low lying fallow land. Beside good nursery and rearing ponds are also required for distribution of the quality fish seed.

Conservation and management of fish genetic resources and biodiversity: The loss of original breeding grounds accompanied with non-judicious/irrational fishing of broodstock and juveniles, sedimentation and pollution have negatively affected the natural recruitment in to fishery and the fish production. Many species which were abundant are now no more or on the verge of extinction. The development strategy for in-situ conservation of aquatic fauna and flora should be important threat area. It is necessary to develop breeding and culture techniques of endangered species for their rehabilitation.

Marketing and value addition: Fish being highly perishable, it has to be carefully handled once captured until it reaches consumers, so as to minimize the post-harvest losses. Though domestic fish marketing holds a lot of potential, it is still very unorganized and unregulated. Efforts should be made to create effective and reliable marketing network to return adequate return to the fishers and the farmers. The co-operative societies and self-help groups should be promoted to give their service in the field of marketing and transport of the fish. The value addition to the existing fishery is to be done in order to generate better revenues.

Establishment of fish pathology lab: Efforts should be made to establish fish pathology labs. Mobile vans with adequate facilities for soil and water testing should be promoted by the state government.

Training and extension: Major emphasis should be given to awareness and motivation coupled with training and exposure visits and demonstration with an aim to enhance the fish productivity from the existing water resources. Skill development

programme should be organized regularly in order to improve the productivity of the human resource involved in the fisheries sector.

Establishment of Aqua parks and aqua shops: The current technology developed for the improvement of the fisheries and to create mass awareness among the society should be done through establishing Aqua parks. The need of fish farmers can be met by establishment of Aqua shops.

