

KUSHESHWAR STHAN CHAUR (North Bihar)

Status and prospects for fisheries development



CENTRAL INLAND CAPTURE FISHERIES RESEARCH INSTITUTE
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KUSHESHWAR STHAN CHAUR **(North Bihar)**

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fisheries development**

B. C. Jha & K. Chandra



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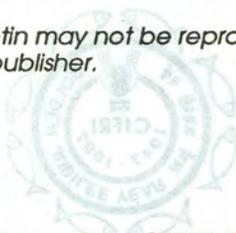
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FOREWORD

The entire North Bihar plain which lies north of the river Ganga is an alluvial plain with minor slope southward and lowland in the north eastern part. The levee deposits, sand bars along the river banks and marshy depressions, called chaur, are the significant features of this area. The chaur of north Bihar are highly sensitive biologically, being one of the rich resource of floral and faunistic biodiversity. Besides, they benefit hundreds of people in their day-to-day economic activities. It is essential, therefore, that these fragile ecosystems are preserved. However, with the increasing demand for multiple use of land and water, management has taken precedence over preservation. The management of north Bihar wetlands is generally ill-planned and uncoordinated devoid of holistic approach. Cross-purpose pursuits of individuals, groups or different government agencies, to serve their own objectives, are detrimental to over all development of this resource. It is time when diversities and resultant conflicts are reconciled for human welfare in order to promote its rational and proper utilization.

Kusheshwar sthan Chaur area under Kosi-Gandak basin has been highly significant from fisheries and biodiversity point of view since time immemorial. All the economic activities of the region centre around these water bodies and thus these waters are very important for upliftment of rural economy of the area. Development of fisheries has to be the integral component of any poverty eradication programme by generating more wage-paid employment. The present effort based on empirical survey of Kusheshwar sthan Chaur area by CIFRI is a modest effort for identifying constraints which are influencing the fisheries development of this resource.

M. Sinha
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INTRODUCTION

The geographical location (84°-88° E and 22°-27° N) of north Bihar is such that it receives adequate quantity of rainfall and surface waters from a net work of rivers. The north-eastern part of this area has a large chunk of depressed land mass where water logging is a permanent feature and it posses four distinct lake areas, locally known as chaur's. The lake areas are Kabar tal, Kusheshwar sthan, Goga beel and Simri-Baktiyarpur beel. Amongst these chaur areas, the Kusheshwar sthan is of special significance being the largest in area (map- I).

Kusheshwar sthan, though considered as one chaur, has as many as sixteen well established perennial lakes of various size and shape. Mahisath chaur is the smallest (40 ha) whereas Larail is the largest (more than 600 ha). The chaur of Kusheshwar sthan have mutiple use of which fisheries and agriculture activities top the table. The fishery of the Kusheshwar ashtan chaur is managed by "Kusheshwar Fishermen Cooperative Society, having 2000 active members, spread over 109 surrounding fisherman villages. The chaur in the area are generally shallow in nature with high proliferation of aquatic vegetation covering 50% to 90% surface area. *Eichhornia crassipes*, a floating macrophyte, has been found to be highly dominant, specially in those chaur which receive relatively less riverine waters and are located nearer to the human settlements. Present fishery is generally restricted to carnivores of various species and size with greater dominance of *Wallago attu* and *Channa punctatus*. However, smaller group of fishes dominate the overall fishery. Indian major carp percentage is poor, except in Larail chaur, where the ingress of riverine stock is more pronounced. The lakes of Kusheshwar sthan hold much promise for fisheries development if managed properly.

PROFILE OF KUSHESHWAR STHAN CHAURS

Kusheshwar sthan is one of the best wetlands available in the country and has been a traditional wintering refuge of thousands of migratory birds, besides plenty of resident species. It is a valuable repository of biodiversity, both plants and animals. Large scale fishing activities and bird trapping is the hallmark of these waterbodies.

Location

Kusheshwar sthan chaur is located at a distance of about 65 km. from Darbhanga town and falls under Kusheshwar sthan block. However, the entire chaur area of Kusheshwar sthan is spread over in two blocks viz. Kusheshwar sthan and Birol. The place is no doubt connected with the district headquarters Darbhanga by a metallic road and some public transport facilities are available, but the condition of roads and age old

bridges are deplorable. The fact that it takes more than four hours by jeep to travel a distance of 65 km is a testimony in itself to the deplorable condition of the basic infrastructure for development, the road in particular. The place has added significance, being a pilgrimage of repute in this part of the State.

Size/Hydrology

The Kusheshwar chaur area in general and the Kusheshwar chaur (Larail chaur) in particular exhibit lot of variations in its size, subject to the quantum and intensity of inflow of water from riverine source. It is found from the records available with the local authorities that the water spread area extends as large as 100 sq. km. during the monsoon months (June to October). The actual chaur area becomes discernible only after October and an area of 20 sqkm remains under water till the next ingress of riverine waters in June. During the winter months, the chours, in and around Kusheshwar sthan, provide lucrative capture fishery resource, besides offering good habitat for large number of resident and migratory birds. Fishing and bird trapping are rampant in the area. Large scale killing of birds gets impetus from the local land holders, who own 21% of the total water area. They engage bird trappers either for own consumption or for marketing in the nearby areas. Monsoon run off and over flow from rivers like Kamala, Bagmati and Kareh are the prime source of water for the chours in the area. A wet resistant variety of paddy is extensively being used for cultivation on the marginal areas of these chours. It was interesting to note that people had innovated a method for the useful utilization of decomposed and semi-decomposed refuse of water hyacinth (*Eichornnia crassipes*) as manure in the preparation of seed beds for this variety of paddy, locally known as "garma dhan". The size of individual chaur varies between 40 ha and 600 ha. The depth of these waterbodies ranges between 0.9 m to 2.5 m (Table I). The chours have multiple uses such as fishing, agriculture, horticulture, bathing, water routes etc.



Panoramic view of Kusheshwar sthan *chaur*



Marginal area of Larail *chaur* with *Eichhornia* infestation

MAP. 1 : NORTH BIHAR DISTRIBUTION OF WETLANDS

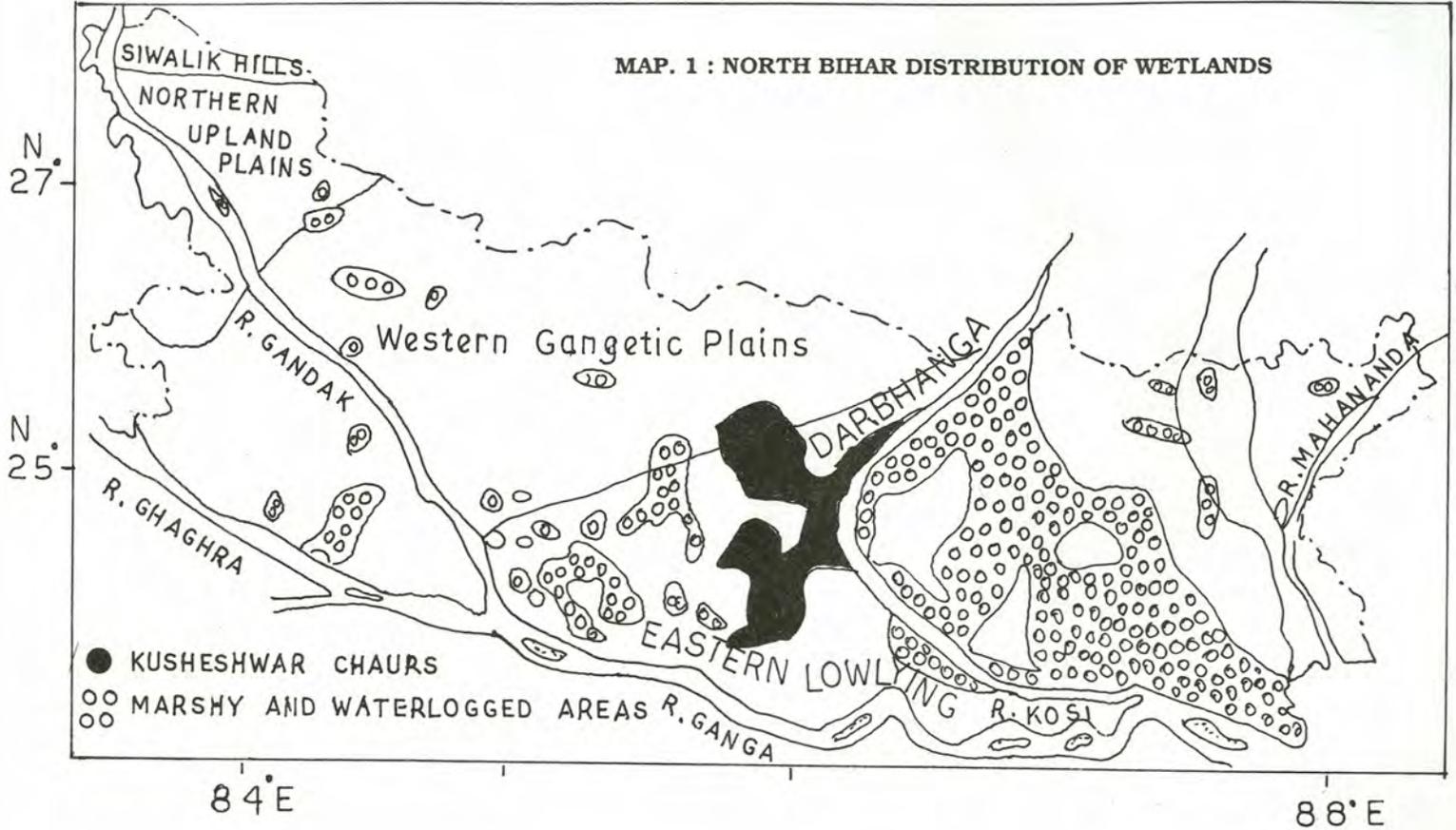


Table I : Kusheshwar sthan chauras at a glance

Total nos. of chauras	No. of chauras studied	Details of Investigated chauras				
		Name of chaur	Area(ha)	Depth range(m)	Coverage of weed(%)	Major fishery
16	4	Larail	600	1.0-2.5	35-50	Misc.+Major carps
		Mahisath	40	0.9-1.8	50-65	Misc. +catfish
		Dabadih	100	1.1-1.9	60-70	-do-
		Kamaldha	300	1.0-2.1	80-90	-do-

LIMNOLOGICAL STATUS

Given below is the limnological status of four of these chauras observed during December 1996 when this chaur area was surveyed by CIFRI scientists.

Physico-chemical properties

The physico-chemical properties of soil and water of four chauras of Kusheshwar sthan have been given in Table II & III respectively. Perusal of physico-chemical data which have bearing on the production functions revealed a mixed trend of aquatic productivity. The basin soil of the chauras, was found to be rich in organic carbon (0.48-2.1%), which indicated its productive characteristics. Soil with alkaline pH above 8.0 is considered highly productive and as the pH values in these chauras ranged between 8.07 and 8.36, the soil regime can be said to be favourable for good biotic production. The texture of the soil indicated the properties of sandy loam, having sand (65-73%) followed by clay (20-27% and silt (7-13%).

Table II : Soil characteristics of Kusheshwar sthan

Parameters	Values
Sand (%)	65-73
Silt (%)	7-13
Clay (%)	20-27
pH	8.07-8.36
Organic carbon content(%)	0.48-2.1
CaCO ₃ (%)	5.0-21.25
Phosphate(ppm)	0.02-0.06
Sp. Conductance(mmhos ⁻¹)	2.40-390

Table III : Water Quality of Kusheshwar sthan Chauras

Parameters	Kusheshwar	Kamaladaha	Dabadih	Mahisath
Water temp(°C)	28.4-28.8	28.2-28.7	28.2-28.7	28.2-28.7
pH	6.91-7.79	7.0-7.6	7.2-7.4	7.0-7.5
DO(mgl ⁻¹)	7.04-8.20	5.4-6.6	5.0-6.2	5.0-6.4
Total Alkalinity (mgl ⁻¹)	56-60	60-68	55-70	65-75
Phosphate (mgl ⁻¹)	Nil	Tr-0.001	Tr-0.005	Tr-0.003
Nitrate(mgl ⁻¹)	Traces-0.09	0.01-0.06	0.0-0.05	0.02-0.10
Sp. conductance(umhos ^{-cm})	420-440	160-280	210-228	180-365

The rich nutrient level of the soil was not reflected at the water phase as the value were very low in traces. However, total alkalinity (56 to 75 ppm) and the specific conductance (160-440 mmhos cm⁻¹), indicated moderate productivity of these waterbodies. The dense proliferation of aquatic macrophytes in certain chauras acts as a bulwark to the release of nutrients in the water phase from the soil, due to locking of nutrients in the hydrophytic chain. Further, recurrence of flood in the chaur area accelerates the deposition of silt, which in turn might have been forming canopies over

the oxidative-microzones of the system, resulting in poor release of necessary nutrients. The granulometric texture of Kusheshwar sthan chaur generally contains sand, as high as 65-73%, a factor not conducive for absorption and release of nutrients because in such soil condition, leaching of nutrient is very high. The diel variations of moderately high dissolved oxygen (7.04 - 8.20 ppm) was also suggestive of good production potentialities and the water can support a healthy spectrum of flora and fauna.

Biotic properties

Kusheshwar sthan is a typical water body originated from geomorphological depression of land mass and a repository of diverse flora and fauna due to its shallow nature. The chaur area displays conducive thermal regime and productive soil basin, which can support reasonably good primary and secondary productivity with judicious input of men and materials.

Plankton

The Kusheshwar sthan group of chaur depicted contrasting assemblage of plankton population (Table IV). The survey of the chaur area revealed that barring Kusheshwar (Larail) Chaur (1071-1927 u/l), other investigated waterbodies had reasonably good crop of plankton; Mahisath (3317-4725 u/l), Dabhadih (3525 - 3841 u/l) and Kamaldaha (2930-3262 u/l). Phytoplankton community was dominant as compared to zooplankton. The phytoplankton spectrum, indicated the dominance of green algae in almost all the chaur (Chlorophyceae>Bacillariophyceae > Mysophyceae > Dinophyceae) except Kamaldaha, where blue green algae was dominant (Myxophyceae>Chlorophyceae> Bacillariophyceae > Dinophyceae). The zooplankton fauna revealed the overall dominance of copepods in the sequence of copepods> rotifers>cladoceraans>protozoans.

Table IV : Plankton abundance in Kusheshwar sthan Chours

Chours	Plankton u/l	Phyto u/l	Zoo u/l	% of phyto- groups			
				Chl.	Myx.	Baci.	Others
Larail	1169-2058	1071-1927	98 -131	60.19	3.39	31.29	5.13
Mahisath	3482-4935	3317-4725	165-210	58.29	6.51	32.88	2.32
Dabhadih	2190-2550	2010-2325	180-225	59.74	10.96	28.21	1.09
Kamaladah	2210-2313	1990-2040	220-273	30.34	49.29	12.08	8.29

Macrophytes

The group of chours around Kusheshwar sthan exhibited diverse infestation of macrophytic infestation. The chours which receive bulk of the riverine waters (Larail, Mahisath etc) indicated relatively less colonisation of macrophytes compared to those chours which are at the periphery of Kusheshwar chaur. In general, however, an average biomass of 6.82 kg/m² was recorded from these chours (Table V). A 0.50 kg/m² dry biomass of aquatic macrophytes in any water is suggestive of their mesotrophic status as such barring Larail chaur which has less biomass (0.32 kg/m²) and falls under oligotrophic category all other chours are passing through mezotrophic phase of trophicity.

Proliferation of macrophytes, beyond a level, has negative impact in the ecosystem as bulk of the available nutrients are consumed by them and very little is available for the growth and maintenance of phytoplankton, which form the basis of aquatic productivity. To be precise, the chours around Kusheshwar sthan, indicated somewhat broken grazing chain, affecting the fish and fishery adversely. The macrophyte spectrum of the chaur area was represented by 40 species, belonging to various niche viz. submerged, emergent, floating and marginal. The floating weed, *E. crassipes*, has been dominating the area followed by *Hydrilla veticillata*, a submerged weed. Members of charophytic group were predominant towards the marginal shallow areas and among them *Chara* spp. were highly pronounced.

Table V : Macrophytes density in Kusheshwar sthan Chours

Chours	Wet weight(kg/m ²)	Average wet weight(kg/m ²)	Average dry weight(kg/m ²)
Larail	3.1 - 4.5	3.8	0.32
Mahisath	4.0 - 6.2	5.1	0.59
Dabhadih	5.6 - 8.0	6.8	0.62
Kamaldaha	10.0-12.4	17.7	0.93

Dominant species: *Eichhornia crassipes*, *Hydrilla verticillata*, *Nymphoides indicus*, *Pistia stratoites*, *Lemna quadrifolia*, *Ipomea aquatica*, *Aponogeton natans*, *Potamogeton pectinatus*, *Vallisneria spiralis*, *Jussiaea repens*, *Scripus articulatus*, *Typha angusta*, *Trapa bispinosa*, *Eyrale ferox* etc.

Benthos

The benthic communities in various chours, under study, indicated significant variations both in terms of quality and quantity. In general, however, the benthic production revealed poor to moderate productivity. The community size of the benthic population ranged between 835 nos m⁻² (Larail) and 4217 nos m⁻² (Kamaldaha). The qualitative texture of macrobenthic fauna indicated the overall dominance of gastropods and bivalves. However, in certain chours an upsurge in the population of chironomids was also observed (Table VI). In weed choked impoundments like Kamaldaha, Mahisath etc. *Lymnaea ovata* was the most dominant gastropod followed by *Guyrarulus* sp. and *Indoplanorbis exustus*. In Larail chour which is relatively less infested with macrophytes, *Pila globosa* was the dominant gastropod.

Table VI : Benthos of Kusheshwar sthan chours

Chour	Total abundance/M ²	% abundance of different group			
		Gastropods	Bivalves	Chironomids	Others
Larail	833	80.39	18.17	0.37	1.07
Mahisath	2778	90.13	6.29	1.48	2.10
Dabadih	1993	71.65	26.94	-	1.41
Kamaldaha	4217	60.84	28.93	8.08	1.15

Primary production

As seen in Table VII the chaurs of Kusheshwar sthan have shown reasonably fair rate of primary production in the range of 2220.96 mg Cm⁻³d⁻¹ (Kamaldaha) to 2919.12 mg Cm⁻³d⁻¹ (Larail). The energy assimilated through the phytoplankton chain varied between 19988 cal m⁻³d⁻¹ and 26136 cal m⁻³d⁻¹.

Detrital load/bottom energy

Shallow macrophyte dominated waterbodies generally possess very rich detrital load at the benthic niche. This high energy reserve invariably remains under utilized in the wetlands of Kosi-Gandak basin. Study conducted during the present survey revealed the presence of detrital load in the range of 293.8 gm⁻²(Larail) to 389.6 gm⁻² (Kamaldaha) and therefore, energy available at the benthic niche varied between 38.66 x10⁴ Cal m⁻² and 51.26 x10⁴ Cal m⁻². In absence of effective grazers like *Cirrhinus mirgala* or *Cyprinus carpio* in sufficient number, this huge energy reserve is not being harvested at desired level.

**Table VII : Primary production and energy conversion
Kuseshwar sthan Chaurs**

Chaurs	Primary production MgC m ⁻³ hr ⁻¹	Energy fixation Cal m ⁻³ d ⁻¹	Available bottom energy Cal m ⁻²
Larail	89.07-154.11	26136	38.66x10 ⁴
Mahisath	75.08-110.0	19988	39.13x10 ⁴
Dabadih	95.20-103.05	21411	46.29x10 ⁴
Kamaldaha	41.09-190.06	24975	51.26x10 ⁴

FISH AND FISHERIES

The Kusheshwar ashtan group of chaurs have shown great potentialities both in terms of fish faunistic diversity and harvesting of wild fish population. Fishing activities, in these chaurs, have long history and are a traditional means of livelihood for thousand of fishermen living in and around Kusheshwar sthan. These lakes, however, are being



Fish landing at Kusheshwar sthan *chaur*
with *Wallago attu* dominance



Fish landing at Kusheshwar sthan *chaur*
with forage fish and *Ompok pabda*



Drying of forage fish from Kusheshwar *chaur*



Marginal area of Kusheshwar *chaur* with paddy seedlings (*Garma dhan*)

exploited considering them to be a perennial source of renewable energy till date. No corrective measures have so far been taken to compensate the depleting fishery due to considerable change in the hydrological regime in the area. A significant shift in the harvestable fish crop could be observed as the fishery today is more of larger catfishes and minnows rather than major carp of earlier days. Barring Kusheshwar chaur (Larail chaur) which acts as a collection sink of riverine stock all other waterbodies in the area have the dominance of *Wallago attu* followed by murrel, (*Channa punctatus*) and other cat fishes together with high catch of minnows.

Present Production Trend

The chaur of Kusheshwar sthan have multispecies commercial fishery but *Wallago attu*, *Channa punctatus*, *Ompok pabda*, *Mystus seenghala*, *Mystus aor*, *Notopterus chitala*, *N. notopterus*, *Clarius batrachus*, *Mastacembelus armatus* and a number of minnows dominate the catch. The contribution of major carp at the present is a meagre 5% or even below. The average catch composition of various group of fishes (based on observation during present survey and informations gathered from local fishermen) is given in Table VIII.

Table VIII : Fish catch composition of Kusheshwar sthan chaur

Group	Dominant species	% abundance
Major carp	<i>Labeo rohita</i> , <i>Catla catla</i> , <i>Cirrhinus mrigala</i>	3.0 - 5.0
Minor carp	<i>Cirrhinus reba</i> , <i>Labeo gonius</i> , <i>Puntius sarana</i>	5.0 - 10
Cat fish	<i>Wallago attu</i> , <i>Mystus seenghala</i> <i>Ompok pabda</i> , <i>Clupisoma garua</i>	60.0 - 80.0
Murrels	<i>Channa spp.</i>	10 - 15
Airbreathing fish	<i>H. fossilis</i> , <i>C. batrachus</i>	5 - 8
Minnows	<i>Nandus nandus</i> , <i>Puntius spp.</i> <i>Chela spp.</i>	10 - 30

The period between November and June is the main period for fishing in these chauras, while the period from end of June to October has negligible fishing due to flooded condition of the chauras. No authentic fish catch data on annual production from individual chaur has been maintained. However, from the discussions with the fishermen and cooperative society office bearers, it could be known that during the main period of fishing (November to June) the fish landing from the Kusheshwar sthan chauras ranges between 2000 to 2500 kg per day. Based on these figures the annual production of Kusheshwar sthan group of chauras could be computed as 420 t to 525 t. This annual production figure also includes the catch from the dead channel of river Kamala.

Production Potential

The production potential of the chauras in this area, based on the rate of energy assimilation and the available energy reserves, comes to around 1500 kg/ha/yr. With the current level of fish production of about 150 kg/ha/yr, enough scope is there to raise the yield to 500 kg/ha/yr (30% level of production potential). Therefore, a three fold increase in fish production can be achieved, with proper management, from Kusheshwar sthan chauras.

Crafts and Gears

The crafts and gears in the area are traditional ones, commonly used in Gangetic plains. Small plank boats (15' x 4') are extensively used. Drag nets, *chatijal* (made of musquito netting cloth) in particular, gill net of varying mesh size but more of smaller mesh, hook and lines etc. are widely being used. Traps of various sizes and shape are very popular gears in these chauras, owing to massive growth of macrophytes with their operation being regulated by the available water depth of the chauras..

Marketing

The daily catch of fishermen is normally purchased by the fish marchants at the site itself. Only the smaller group of fishes, come to the local markets or are sold in the nearby villages. Bulk of the fish catch of higher size group is being exported to Patna or Muzaffarpur or even to Calcutta by fish traders.

The retail price of fish was found varying according to species and the availability. The price ranges of fishes observed in local Supol fish market have been given in Table IX.

Table IX : Retail price of commercial fish in Supol

Group	Per kg. Price (Rs.)
<u>Indian major carp(Rohu, Catla, (Mrigal)</u>	
< 1.0 kg	20 - 25
1.0 - 2.0 kg	25 - 30
>2.0 kg	35 - 40
<u>Cat fishes</u>	
<i>W. attu</i>	25 - 30
<i>M. seenghala</i>	25 - 30
<u>Murrels</u>	
<i>Channa sp.</i>	24 - 28
<u>Airbreathing fishes</u>	
<i>H. fossilis</i>	35 - 40
<u>Minnows</u>	
<i>Chela sp.</i>	10 - 15
<i>Setipina sp.</i>	
<i>Puntius sp.</i>	

FISHERMAN AND PER CAPITA INCOME

Kusheshwar chaur area encompass 109 fisherman villages comprising 1,50,000 fishermen population. The fisherman community in the area has poor land holdings and generally depends on fishing in Kusheshwar group of chaur for their livelihood. The Kusheshwar Fisherman Cooperative Society has 2000 active fisherman who in general, are poor and have little assets under their possession. An estimated 40% of the fishing community have their own nets and crafts, while the rest are either assisting the relatively well off fisherman in fishing activities or do fishing through hired boats and gears. During the main period of fishing (November to June) the average catch per fisherman per day

has been estimated to be 2 kg of fish of mixed type. Therefore, the average income per fisherman per day can be said to be Rs.. 25 to Rs. 30 during the months of November to June. In the remaining period of the year with negligible fishery, the fishermen are able to earn almost nothing from these chauras.

RECOMMENDATIONS

Kusheshwar group of chauras are one of the prime resource for fish and fisheries. Fishing in these chauras has bearing on the economy of the area. The entire population in general and the fishermen in particular are wholly or partially dependent on these chauras for their bread and butter. Sizeable extension of perennial waters, fertile basin soil and rich biodiversity of these chauras offer tremendous scope for fisheries development, which may go a long way to raise the living standard of fisherman community of the area. However, in order to achieve permanent and sustainable development certain basic issues, need be addressed immediately.

Infra-structural aspects

Strengthening of flood protecting embankments

The ingress of huge mass of riverine waters due to the incomplete embankments of river Kamala, Bagmati and Kareh, is a real deterrant in taking up any measure for fisheries development. The chauras lose their identity during the flood season as such management of fish stock is impossible in the present conditions. It is suggested therefore, that the embankments be completed at the earliest.

Improvement of approach roads/bridges

The approach road to Kusheshwar sthan is not at all conducive for taking up any development measures. Any developmental activity requires transportation of lot of men and materials and therefore, condition of the approach road must be reasonably good. It is suggested that the deplorable road and bridge conditions be improved for achieving meaningful development.

Creation of hatchery/rearing facilities for stocking materials

An estimated 2.5 million advanced size fingerling (4" size) may be required for the stocking purpose in these chauras to achieve the yield target of 500 kg/ha/yr. It is essential therefore, that suitable hatchery facilities in the vicinity are created under the

Department of Fisheries, Govt. of Bihar to cater the needs of seed requirements. For rearing purpose, however, the village ponds in the area (1800 in nos.) can be fruitfully utilized. The fish seed may be supplied by the Government and the raised fingerlings taken back for stocking in the chaur. This arrangement will have two edge impacts viz. (a) the poor fish farmers will get assured income from the sale proceeds of fingerlings and (b) the village ponds will be automatically stocked for raising table size fish. Further, the dependence for fish seed from West Bengal will considerably be reduced, at least in this area.

Strengthening of cooperative/marketing system

The Kusheshwar sthan Fishermen Society has only 2000 active members which accounts for only 6.5% of the total fishermen which operate in these chaur. Further, the marketing of fish catch is not at all systematic and is done by individual fisherman who are invariably exploited by fish traders. It is suggested at least two landing centres, one at Kusheshwar sthan and another at Supol be created and the entire yield and marketing be taken care of by the Cooperative Society so that individual fisherman gets better receipts from the fish sale.

Creation of fish processing and preservation units at Kusheshwar sthan

It has been observed that drying of fish, specially forage fishes, is done in the area crudely. It is proposed therefore, that processing facilities be created in the area for better marketing of processed fish. It has also, been observed and reported by the local fisherman that a good percentage of fish catch gets spoiled at times, in absence of ice for preservation and proper transport to export the fish in time. Arrangements need be made for efficient transportation. Insulated carrier may be arranged under the Cooperative Society to avoid spoilage of fish catch.

Removal of conflicts of ownership rights

Kusheshwar sthan chaur has witnessed lot of conflicts between private owners and Bihar State. It is essential, therefore, that the entire Kusheshwar sthan chaur area be brought under ownership of State Government to make the development of fisheries more effective.

Technical aspects

The fisheries of the chauras need be developed on the principle of pen/cage culture in marginal shallow areas leaving the deeper zone exclusively for capture fisheries. This would require undermentioned developmental measures.

Stocking in chauras

To achieve the proposed harvestable fish yield of 500 kg/ha/yr the chauras need to be stocked with fast growing breeding species. It is suggested that a stocking density of 1000 numbers per hectare of advanced fingerlings (>4") be followed. The stocking component need be completed in five years. This would establish a breeding population in the "Chaur" and result in autostocking in future.

In view of the greater dominance of carnivore fish species, *Wallago attu* in particular, stocking of fingerling less than 4" size will be a futile exercise. The chauras in the area have high infestation of weeds as such have very rich periphytons and detrital load at the column and bottom respectively. These important components of the food chain largely remain under utilized. It is suggested, therefore, that the waterbodies be stocked with IMC in the ratio of 2:2:1 (*L. rohita*:*C. mrigala* : *C. catla*).

Weed clearance

The massive infestation of aquatic weeds in these chauras is a serious threat to the fish and fisheries. It is essential to bring the weed infestation to manageable level. It is proposed that bio-controller of weeds, Weevils (*Neochetina eichhornie* and *N. bruchi*) may be introduced in these chauras, besides periodic manual clearance, which have been found very effective in this regard.

Introduction of fish husbandry

In order to generate additional income and employment fish husbandry like pen and cage culture be introduced in the marginal areas on a large scale. Besides the peripheral chauras, the dead channel of river Kamala can form very good habitat for pen culture. Technologies for these have been developed and demonstrated by CIFRI. Culture of airbreathing fishes may be done in cages and in shallow chauras. Pen culture has proved



Dead channel of river Kamala with *Eichhornia* beds for paddy seedlings



Deplorable bridge condition near Kusheshwar sthan

highly profitable in wetlands, being a low cost technology with less labour input. A yield of 3 to 4 t/ha/yr can be achieved through this mode of fish husbandry. Pen culture can be very handy in the effective utilization of marginal areas of such water bodies without disturbing the general ecological regime.

Regulation of nets

The chaur in this area have been subjected to indiscriminate fishing through 'chati jal' (a drag net of mosquito netting), which has proved highly damaging to the fisheries. It is proposed that this type of nets be banned immediately as a corrective measure.

Ban on bird trapping

The migratory and resident variety of birds are the important component of the chaur ecosystem as they help in maintaining ecological balance by consuming the forage fishes. It is proposed that killing of birds be banned by enforcing suitable measures.

The above suggested recommendations would also need some additional measures for proper development. They are in form of timely and adequate bank loan facilities to fishermen for culture operation as well as purchase of crafts and gears, relevant technology transfer and human resource development.
