Hirakud Reservoir

Strategies for fisheries development

V. V. Sugunan & Y. S. Yadava

Bulletin No. 66

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Central Inland Capture Fisheries Research Institute
(Indian Council of Agricultural Research)
Barrackpore 743101 West Bengal India

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MESSAGE

Reservoirs have an unmistakable relevance in the development of inland fisheries in India. With riverine fisheries under the threat of eco-degradation and large-scale water abstraction, main emphasis of development has now been shifted to the man-made lakes.

Much of the available knowledge on the reservoirs and the existing guidelines for their management emanate from the researches conducted by the Central Inland Capture Fisheries Research Institute, Barrackpore during the last three decades. More than a dozen reservoirs, representing different classes in size, location, and eco-climatic regimen have been studied in detail. Surprisingly, Hirakud, the largest reservoir in the country remained outside the purview of these investigations.

This identification report is the result of an attempt to assess the problems and set the progress of investigations into motion. It lays out a clear cut strategy to be adopted for the fisheries development of Hirakud. The report envisages a scheme to investigate the lakes's ecology and production dynamics which in latter half, would convert into a development project to demonstrate the mode of management. I am confident that the timely launcing of the scheme proposed in this report will lead to many-fold increase in the fish production from Hirakud.

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FOREWORD

It is now widely accepted that reservoirs constitute one of the prime inland fisheries resource of India. Unlike the rivers, lakes and the other natural water bodies, which are under the increasing threat of environmental degradation, these man-made lakes offer ample scope for fish yield optimisation through adoption of suitable management norms. Notwithstanding the overriding importance of reservoirs in the inland fisheries development of India, this resource is not contributing to the fish production to the extent it should. It is estimated that the 3 million ha of reservoirs produce fish to the tune of 93 650 t, against a potential of 245 000 t. Dearth of a firm database and lack of requisite research support are often cited as the main factors that inhabit speedy development of reservoir fisheries in India. Out of 19 370 reservoirs of the country, only about 100 have been subjected to scientific scrutiny and catch details are available on 422 of them.

The 72 000 ha Hirakud reservoir, despite being the largest man-made watersheet in the country, remains by and large unexplored in terms of limno-chemical parameters and a sound database on production propensities and fish stock assessment of Hirakud is still lacking. The reservoir produces about 490 t of fish annually at an average yield of < 7 kg/ha. The available data pertain to the fish catch statistics and craft and gear. This document is the result of CIFRI's attempt to take stock of the scientific information available on the reservoir and to lay down the steps to be followed to foster fish yield optimisation. Dr. V. V. Sugunan and Dr. Y. S. Yadava have done a commendable job in compiling all available information on the reservoir. I am sure that the guidelines suggested by them will go a long way in initiating a management strategy aimed at bridging the gap between the present and potential yield.

S. P. Ayyar
Director
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INTRODUCTION

Reservoirs have been the mainstray of agricultural prosperity in the post-independndent India. Besides revolutionising the power and irrigation network, these impoundments have been a vital addition to the Indian capture fisheries resources. From a meagre area in the forties, the reservoirs now command an impressive 3.0 million ha. With the renewed accent on the river valley development projects, the reservoir area is expected to increase to 6.0 million ha by the turn of the centry. The fish yield from the Indian reservoirs has been, by and large, low. Notwithstanding the availability of scientific information on various reservoirs, covering different geo-climatic regimes, the fish yield from most of them still remains below 15 kg ha^{-1} yr^{-1}. Many reservoirs in the country have been subjected to scientific studies over the last three decades with the main objective of increasing their fish yield and the results have been commendable. In Gobindsagar, a hike in yield rate from 25.0 kg ha^{-1} yr^{-1} to 75.0 kg ha^{-1} yr^{-1} has been achieved due to adoption of scientific management practices. However, Hirakud, despite being the largest reservoir in the country, has so far escaped such scientific attention. This identification report is an attempt towards assessing the present fisheries status of Hirakud reservoir and suggesting measures for its sustainable development.

THE RESERVOIR - Physiographic and morphometric attributes

Hirakud is one of the first major multi-purpose river valley project in India. The reservoir, commissioned in the year 1957, is created across the river Mahanadi, a little below the confluence with its tributary, the river Ib. Situated within the geographical ordinates of 21°30' N to 21°50' N Latudude and 83°30' E to 84°05' E longitude (Figures 1 & 2), the reservoir has a water spread area of 71 963 ha at FRL (Table 1). The 1 248 , m long masonary dam has a height of 61 m and along with an earthen dam has a length of 25.8 km. The multi-purpose project, besides having an installed capacity of 270 mw power generation, irrigates 264 038 ha of land and provides an yearly crop of *c.* 350 t of fish.

The Mahanadi, rising in the Sihawa hills to the extreme south-west of Raipur district of Madhya Pradesh, drains an area of 141 600 sq.km., of which 53.0% is in Madhya Pradesh, 46.4% in Orissa, 0.5% in Bihar and 0.1% in Maharashtra. The total length of the river is 857 km and has a maximum discharge of 44 740 cubic m. sec. and an annual flow of 66 640 million cubic meter. The river Ib has its source in Raigarh. The total length of the river is 251 km and drains a catchment of 12 447 sq.km. The rivers are totally rain-fed and hence nearly 80% of the run-off occurs during the monsoon between June and October. Geologically, granite and gneisses underlie the catchment's soil mantle. Mixed red and black soil dominates the region surrounding the reservoir.

The three tier reservoir basin comprises a shallow terrace, gradual slopes and a deeper central plain. With a long shoreline of 643 km, the reservoir has a high shore development index of 13.5. the reservoir's vast catchment area (83 400 sq.km.), stretching over the Central Indian plateau, encompasses over 65% fertile land area. The total annual inflow to the reservoir has been estimated at 18.0 million acre ft. against an out-flow of 18.8 million acre ft. (1981 figures). The average annual rainfall in the region is *c.* 152 cm.

NUTRIENT STATUS - Production functions and nutrient flux

Hirakud reservoir, with an existence of over 35 years now, has emerged out of the initial phases of trophic burst and trophic depression and has entered into a stage of stabilised productivity. Morphometrically, the massive waterspread, high mean depth (11.3 m) and high shore development index (13.5) portray a positive influence on the productivity levels of the reservoir.

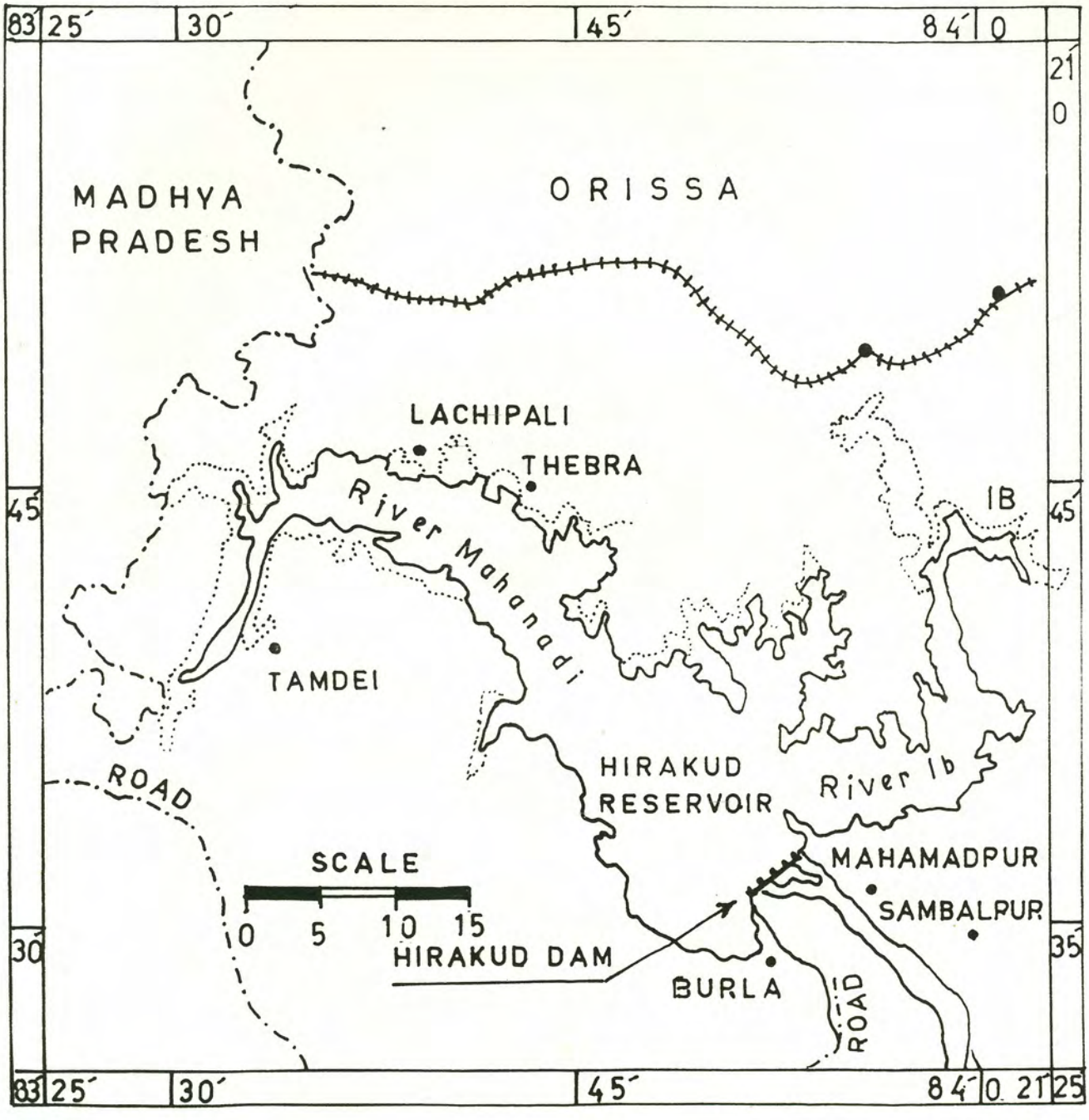


Figure 1. Map of Hirakud Reservoir

Hirakud reservoir

A panoramic view of the reservoir

Sunset over Hirakud

A close view of the reservoir

A major part of the reservoir margin is used for paddy cultivation during post monsoon months

Table 1. Morphometric feature of Hirakud reservoir

General		
Location	:	District Sambalpur (Orissa)
Name of the river	:	Mahanadi
Year of commissioning	:	1956
Prupose	:	Multipurpose
The Lake		
Geographical ordinates	:	21°30' - 21°50'N & 83°30' - 84°05' E
Catchment area (sq.km)	:	83 400
Elevation at FRL (m above MSL)	:	192.024
Elevation at DSL (m above MSL)	:	179.830
Gross storage capacity (million cub.m)	:	8 316
Live storage capacity (million cub.m)	:	5 818
Dead storage capacity (million cub.m)	:	2 318
Waterspread area at FRL (ha)	:	71 963
Waterspread area at DSL (ha)	:	36 190
Mean depth (m)	:	11.3
Length of shoreline (km)	:	643
Shoreline development index	:	13.5
Volume development index	:	0.52
The Dam		
Length of the masonary dam (m)	:	1 248
Number of under sluices	:	64
Number of crest gates	:	34
Crest level of spillway dam (m above MSL)	:	185.928
Spillway capacity (cub. m per sec.)	:	42 450
Maximum annual runoff (million ha m)	:	9.19
Minimum annual runoff (million ha m)	:	1.24

The water regime in the reservoir can be conspicuously compartmentalised into three zones. The shallow upper zone (*c.* 18 621 ha) retains, to certain extent, the lotic characteristics and serves as the breeding and nursing ground of commercial carps. The lower zone, next to the dam (*c.* 40 338 ha), is lacustrine in nature and supports a fishery round the year. the middle admixture zone (*c.* 13 004 ha). also sustains an year round commercial fishery.

Clarity of water is remarkably high in the reservoir. High transparency is observed from October to May which decreases during June to September. Hirakud, being situated within the tropics, is subjected to intense sunlight. From October to May usually cloudless skies prevail. The reservoir during this period experiences algal blooms due to Microcystis sp. The high gross and net primary production rates (GPP 900-2 250 mg C m^{-3} d^{-1} NPP 675-2 025 mg C m^{-3} d^{-1}) support the rich density of primary producers in the reservoir. Physico-chemical variables of water (Table 2) also reflect on the moderate to high productivity status of the reservoir water.

Table 2. Water quality in Hirakud reservoir

Parameters	Lentic Sector	Bay Sector
pH	8.2	8.2
Dissolved oxygen (mg l-1)	9.6	8.6
Chloride (mg l-1)	7.4	5.5
Total Alkalinity (mg l-1)	39.6	39.6
Total hardness (mg l-1)	60.0	48.0
Nitrate (mg l-1)	0.05	0.06
Phosphate (mg l-1)	0.04	0.025
Silicate (mg l-1)	7.0	10.0
Calcium (mg l-1)	52.0	40.0
Magnesium (mg l-1)	8.0	8.0
Sp. conductivity (μ mhos cm-1)	151.0	151.0

The reservoir experiences pronounced water level fluctuations with marked capacity reduction during April to June. Based on satellite pictures (IRS IA LISS II FCC Path/Row No. 22-52 and 22-53), the reservoir area is estimated at 46 381 ha during premonsoon and 55 243 ha during post monsoon. The more productive shelving contours within a depth of 2-3 meter are exposed during the summer months. Severe draw-down causes exposure of large aridals (*c.* 40% of the total area) in the shallower part, which again gets filled-up with the onset of monsoon. This alternate drying and

wetting helps mineralization and adds to the nutrient content of the reservoir. the high surface run-off also adds annually to considerable quantity of allochthonous nutrients. Heavy deforestation and poor soil conservation measures in the catchment have resulted in siltation (@ 23.14 million m^3 yr^{-1}) of the reservoir bed, affecting the basin topography. The silt discharge is also responsible for reducing transparency during the monsoon months.

FISH AND FISHERIES

The fishf fauna of the Hirakud reservoir, including that of the parent rivers, essentially comprises both plain and sub-mountainous forms with sizeable representation of carps and catfishes. A survey conducted by the erstwhile Central Inland Fisheries Research Station, Calcutta during the early fifties, recorded 86 fish species belonging to 20 families, of which 24 species were of economic significance. Many migratory species like *Tor mosal, Rhinmugil corsula* and *Macrobrachium* spp. have been affected by the dam, while species of Indian major carps and bagrid catfishes have adjusted well to the lentic conditions. the euryhaline sciaenids also form a lucrative fisheries in the reservoir now. Presently *c.* 40 species comprise the commercial fishery. they are broadly grouped as follows. :

Carps	*Catla catla, Labeo rohita, Cirrhinus mrigala, L. calbasu, L. gonius, L. fimbriatus, L. bata, C. reba, Tor mosal.*
Catfishes	*Wallago attu, Silonia silondia, Ompok bimaculatus, O. pabda, Mystus aor, M. seenghala, M. tengra, M. cavasius, Pangasius pangasius, Rita chrysea, Bagarius bagarius, Eutropiichthys vacha.*
Featherbacks	*Notopterus notopterus, N. chitala*
Live fishes	*Heteropneustes fossilis, Clarias batrachus, Channa gachua, C. punctatus, C. striatus.*
Prawns	*Macrobrachium malcolmsonii*
Misc. species	*Mastocembalus armatus, Nandus nandus, Glossogobius giuris, Gadusia chapra, Esomus danrica, Rasbora daniconius, Amblypharyngodon mola, Puntius sarana, P. ticto, Rohtee cotion* and *Sciaenid* spp.

An evaluation of the commercial fisheries of the reservoir since inception indicates progressive increase in the fish catch (Tables 3 & 4). From 51.9 t in 1961-62, the present yield has hiked to 489.5 to (1990-91), with an annual average of 350.0 t for the period 1985-91. The gradual increase in number of units of effort from 184 numbers in 1968 to 2044 in 1987-88 is primarily responsible for the enhanced catch during the latter phase.

Table 3. Annual fish landings of Hirakud reservoir (1961-62 to 1965-66)

Year	Catch (t)
1961-62	51.9
1962-63	32.4
1963-64	14.4
1964-65	15.1
1965-66	12.4

Table 4. Annual fish landings of Hirakud reservoir (1985-86 to 1990-91

Period	Catch (tonnes)	Value (Rs in lakhs)	Royalty (Rs. in lakhs)
1985-86	332.8	36.61	0.416
1986-87	483.0	53.13	0.384
1987-88	192.1	21.14	0.441
1988-89	263.5	28.99	0.449
1989-90	337.4	40.49	0.516
1990-91	489.5	58.74	0.504

The per hectare yield for the rservoir has been estimated at 6.95 kg ha^{-1} (based on the area allotted to cooperative societies and the government sector). This is too low against the State level average of 12 kg ha^{-1} yr^{-1} and the national average of 15 kg ha^{-1} yr^{-1}. However, the catch accounted for the estimation of the present yield level excludes a sizeable amount harvested from the reservoir through unfair means.

Although a sound scientific database for proper stock assessment of Hirakud is lacking, the available data indicate a decreasing trend in the population of carnivores (catfishes and featherbacks) and *Catla catla*. the omnivores in the carp group have, on the contrary, registered an increase in the catch composition (Table 5). *Mystus seenghala* and *Silonia silondia* among catfishes and *Catla catla* among carps dominated the catch during 1978 and 1979 (Table 6).

Table 5. Fluctuation of major commercial species in the annual landings

	Percentage of abundnce				
	1967-86	1977-78	1978-79	1980-81	1987-88
Carnivores (catfishes, featherbacks)	56.2	-	54.44	52.1	45.2
Omnivores (*Labeo* spp., *C. mrigala* & smaller cyprinids)	27.68	34.44	-	-	44.6
Catla catla	16.3	12.3	-	13.8	10.8

Table 6. Species-wise landings (t) from Hirakud reservoir during 1978 and 1979

Species	1978	1979
Mystus seenghala	95.3	125.1
Silonia silondia	94.2	97.8
Catla catla	91.8	62.5
Wallago attu	65.3	44.5
Rohtee cotio	56.3	55.0
Labeo rohita	49.6	27.6
Labeo calbasu	45.8	60.4
Labeo fimbriatus	37.7	43.8
Notopterus chitala	36.7	30.6
Gadusia chara	31.7	52.1
Eutropiichthys vacha	30.6	26.2
Cirrhinus mrigala	21.1	12.9
Rita chrysea	20.2	15.1
Labeo bata	18.7	28.2
Puntius sarana	15.6	15.5
Mystus aor	7.4	6.6
Rhinomugil corsula	6.3	4.9
Glossogobius giuris	6.0	10.3
Sciaeneid spp.	5.3	4.1
Barbus tor	4.7	1.9
Chela bacaila	4.6	5.3
Channa sp.	3.5	3.9
Notopterus notopterus	1.9	8.7
Mystus tengra	1.3	1.4
Bagarius bagarius	1.1	3.1
Others	1.0	2.3
Total	*753.7*	*749.8*

The fish stock assessment based on the available time series data indicate low levels of catch as compared to the maximum sustainable yield (MSY). With the progressive increase in effort, the maximum yield of 843.1 t was achieved against deployment of 1 609 individuals (Table 7). Further increase in effort to 2 044 individuals portrayed a decline in catch, with the present levels touching 489.5 t (1990-91). This reflects on the over exploitation in the reservoir. the catch per unit of effort varies from 0.33-10.0 kg depending on the gear and the season.

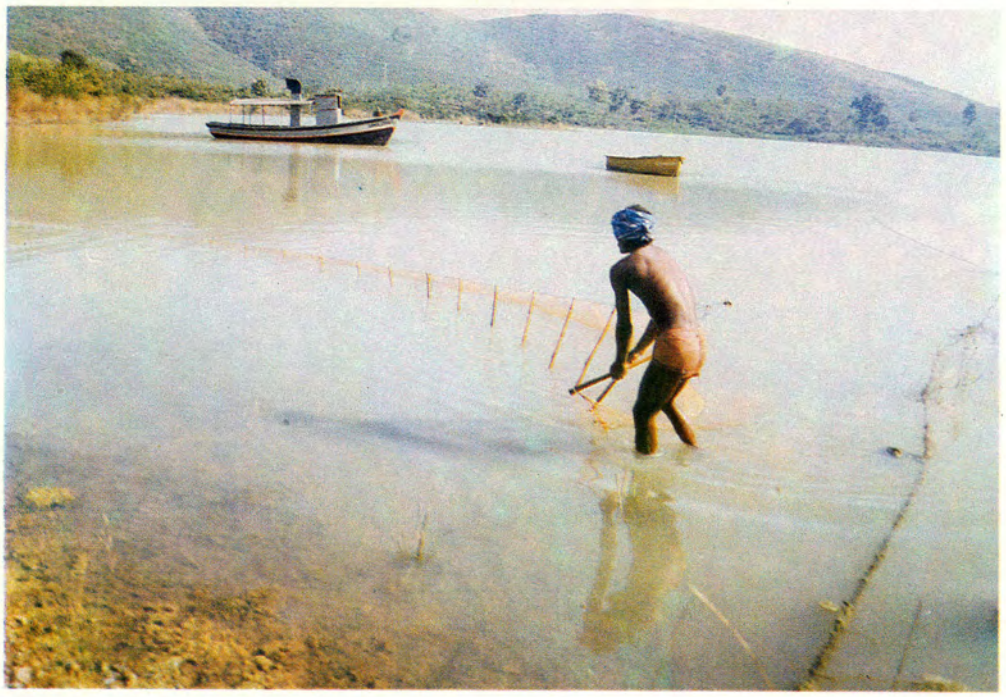
The low yield rate and the undesirable species mix can be traced to poor management measures, specially during the initial phases of the impoundment. Realising this very late, the State fisheries department has embarked on a stocking programme in the reservoir. During the period 1988-89 to 1990-91, a total of 4.26 million IMC fingerlings have been stocked. This appears to have little impact on improving the species mix, primarily due to a very low stocking density. the meagre stocking rate ranged from 10-47 fingerlings per ha. However, the prior to arriving at any definite conclusion, detailed investigations on the stock assessment are imperative. Better stock management with adequate conservation measures are necessary to achieve the MSY, keeping the present effort level static or even bringing a marginal increase in the fishing effort.

FISHING AND POST-HARVEST OPERATIONS

The fishing rights of Hirakud were transferred to the State Fisheries Department in the year 1960. The reservoir is divided into six sectors, of which five are leased to Fishermen Cooperative Societies @ Rs. 100 per sq. mile per annum. Sector No. III adjacent to the Dam is reserved for security reasons. However, experimental fishing and licensed non-commercial fishing is permitted in this sector. More than 94% of *c.* 3 000 fishermen scattered over 120 peripheral villages have fisheries as the major means of sustenance.

Gill nets, drag nets, cast nets, stake nets and long lines comprise the major fishing tackles operated in Hirakud. Gill nets, mainly of 3 types are operated within 3-10 m water depth. Drag nets of 4-5 types, simple to big shore seines and hooks and lines are used round the year. Gear with varying mesh sizes (0.5"-8.0") are regularly used, though the regulation prohibits the use of gill nets of < 4" mesh size.

The presence of numerous underwater obstructions limit the use of active gear like the trawls, seines and drifting nets in Hirakud. Passive gear like the set gill nets appear more suitable. Extensive siltation has, however, eased the operation of dragged gear in some areas of the reservoir.



Small shore seine operated in the bay region

Gill net - the most common gear employed for fishing in the reservoir

Locally crafted fishing boats in vogue

Table 7. Effort *vis-a-vis* fish yield in Hirakud reservoir

Year	effort (nos)	catch (t)	Remarks
1968	184	63.9	-
1969-70	262	65.7	-
1976-77	341	220.2	Marginal increase in effort
1977-78	464	576.6	Introduction of shore seine and surrounding nets increased the yield
1980-81	1609	843.1	Maximum catch recorded in the reservoir
1981-82 to 1987-88	2044	185.5	Declining trend
1990-91	2044	489.5	Improvement in the catch

Recent trials on trwling by the Burla Research Centre of the Central Institute of Fisheries Technology have also yielded fruitful results.

The monsoon months, August and September witness maximum and the period April to July record minimum catch in the reservoir. Commercial fishing is carried out exclusively at night with set gill nets which are hauled next morning. During the period September to November, a large number of IMC juveniles of the size range of 5-25 mm are caught by the use of shore seines. It is thus necessary to impose seasonal restrictions on the use of shore seines. the crafts are mostly country boats (wooden) with sizes ranging from 18-20'. Larger boats are used for transportation. Mechanisation of boats in a phased manner is warranted to make the fishing more remunerative.

The fish catch of the individual fisherman/party is handed over to the cooperative society, which in turn sells it to fish traders. besides a small percentage of catch being sold locally, a sizeable quantity is despatched to Howrah and other urban conglomerates in Orissa as well as neighbouring states. A flourishing trade of dried and smoked fish exists in the region, where the involvement of women fisherfolk is very conspicuous. Mostly, unmarketable surplus is used in the trade and fishes are sold in 1 kg tins, the cost ranging from Rs. 20 to Rs. 40 per tin. Post-harvest channels are largely governed by the traders or the middlemen. Their influence also promotes direct disposal of catch to their agents by the fishermen, leading to unaccountability. This also leads to erosion of the cooperative structure, ultimately resulting in collapse of the societies.

FISHERY COOPERATIVES AND THEIR MANAGEMENT

Fishing activities in Hirakud are totally under the cooperative sector. Of the six sectors, five have been leased out to five Primary Fishery Cooperative Societies; the sixth, which covers vital dam installations have been retained by the authorities for security reasons. the five cooperatives, among themselves, have a share capital of Rs. 92 213 which is supplemented by a government share of Rs. 284 500 and subsidies totalling Rs. 304 150 (Table 8).

Table 8. Status of Primary Fishery Co-operative Societies of Hirakud reservoir

COOPERATIVES	FISHING AREA (sq.km.)	MEMBERS SC	ST	Others	Total	TOTAL SHARES Member's	Govt.
TAMDEI	67.34	403	44	108	555	3333.00	2000.00
LACHHIPALI	41.44	195	118	66	379	21830.00	23200.00
THEBRA	111.37	233	324	100	657	48010.00	207600.00
MAHAMADPUR	116.55	248	472	102	822	12870.00	42200.00
IB	98.42	452	107	58	617	6170.00	9500.00
TOTAL	**435.12***	**1531**	**1065**	**434**	**3030**	**92213.00**	**284500.00**

*Excluding 68 sq.km. area reserved for dam security

Mahamadpur PFCS has the maximum operational area (11 655 ha), and Lachhipali has the minimum (4 144 ha). Based on average catch for 1989-90 and 1990-91, Thebra recorded maximum yield (11.02 kg ha^{-1}) from the area under its fold (Table 9). the societies appoint merchants to lift the catch from the landing centres. Price of fish is fixed according to its category *i.e.*, carps big, carps small, non carps big, non-carps small, *chana* etc. the societies normally reimburse the sale price of fish to the fishermen after deducting a commission ranging from Rs. 0.5 *(chana)* to Rs. 3.00 (carps big). The procurement price of fish and the commission vary from society to society.

Lachhipali

Established in 1979, the Lachhipali Primary Fishermen's Cooperative Society has a strength of 379 and a membership share capital of Rs. 21 830, supplemented by matching government share to the tune of Rs. 23 200. The scheduled caste and scheduled tribes constitute 51.45 and 31.33 percent of the total membership respectively. The society has, under its fold, a waterspread of 4 144 ha, most of which dries up during summer months due to drawdown. While fishing activity is at its peak during August to September, it is adversely affected from April to July every year. About fifty percent of the members of Lachhlipali society solely depend on reservoir fisheries for a living.

Table 9. Average annual harvest of the cooperative societies of Hirakud

Sector	Area (ha)	Av. catch (kg)*	Yield (kg ha^{-1})
Govt. Sector	6 800	-	-
Mahamadpur	11 655	30 691	2.63
Thebra	11 137	122 682	11.02
Ib	9 842	30 201	3.07
Tamdei	6 734	29 510	4.38
Lachhipali	4 144	29 832	7.20

* average of 1989-90 and 1990-91

A variety of fishing tackle is used by the members for fishing. The comprise surface gill nets, drag nets, shore seines (operated by 10-15 people), hook and line, cast nets, and a variety of traps. the annual fish catch by the members of the society varied from 22.3 t in 1989-90 to 49.7 t in 1991-92 (Table 10). the society charges a commission @ Rs. 2.00 per kg of big carp, small carp and big catfish; Rs. 1.00 per kg of small cat fish and Rs. 0.50 per kg of miscellaneous fishes.

Table 10. Fish landings (kg) of Lachhipali PFCS during 1988-92

Months	1988-89	1989-90	1990-91	1991-92
April	1 332	-	2 723	2 087
May	1 457	-	2 385	2 517
June	2 248	-	4 465	5 292
July	3 663	2 319	5 282	8 122
August	8 653	5 780	6 354	9 396
September	3 117	2 421	2 973	10 394
October	4 920	3 553	3 441	11 870
November	1 889	1 511	2 628	-
December	1 418	1 146	2 045	-
January	859	1 975	2 207	-
February	878	1 848	2 496	-
March	955	1 801	314	-
TOTAL	*31389*	*22354*	*37313*	*49678*

Under a NABARD assisted scheme, the society received financial assistance to the extent of Rs. 608 400. The scheme, basically intended to extend financial assistance to the fishermen for procuring carft and gear, supported 36 fishing units in the reservoir @ Rs. 2 500 for boat and Rs. 1 440 for nets; each unit comprising three fishermen.

Thebra

Situated at the Lakhimpur block of District Sambalpur and established in the year 1964, the Thebra Primary Fishermen Cooperative Society is the oldest society in the Hirakud reservoir. It enjoys the fishing rights of 11 137 ha of reservoir area. the society has a total membership of 657, which include 233 members belonging to the scheduled caste and 324

scheduled tribes. TPFCS is the most prosperious among the cooperative societies, having a members' share of Rs. 48 010 and government share f Rs. 207 000. The society also received subsidy to the tune of Rs. 304 150. Out of the total 657 fishermen operating in the area, 604 are active and wholly dependent on the reservoir for their livelihood (Table 11).

Table 11. Fish landings (kg) of Thebra PFCS during 1988-92

Months	1988-89	1989-90	1990-91	1991-92
April	-	11 169	10 212	7 627
May	-	11 820	11 573	12 100
June	-	25 684	24 674	27 813
July	13 290	14 264	15 233	29 454
August	15 125	14 663	7 913	11 725
September	9 755	7 839	4 790	7 010
October	10 902	8 294	6 045	6 001
November	9 251	7 302	6 979	-
December	8 457	7 616	8 450	-
January	5 150	8 275	5 692	-
February	5 935	6 236	6 027	-
March	9 296	8 376	6 239	-
TOTAL	*87161*	*131538*	*113827*	*101730*

The Thebra Society collects a higher commission from the fishermen @ Rs. 3/- for carps, Rs. 2/- for catfish and Re. 1/- for small catfishes. In the year 1985, the society received financial assistance from the National Cooperative Development Corporation (NCDC) in the form of loan and share capital worth Rs. 1 107 000. A total of 357 members were benefitted by the NCDC loans. the package included a pick-up van and 2 motor launches for facilitating easy transport of catch by the society. Thebra Society, which is logistically better equipped for undertaking the marketing of fish to the Howrah wholesalers, leave the catch at the disposal of private merchants who cut away large chunks of the profits. The diesel pick-up van and the motor launch are kept idele, to the detriment of fishermen's interests.

Tamdei

The Tamdei Primary Fishery Cooperative Society (TPFCS) has a share capital of Rs. 5 333 and enjoys fishing rights of 6 734 ha of reservoir area. The total fish landings from the area varied from 28 570 kg in 1989-90 to 30 455 kg in 1990-91 and yield ranged from 3.35 to 5.27 kg ha^{-1} (Table 12). The society normally deducts commission at a flat rate of Re. 1 per kg of fish.

Table 12. Fish landings (kg) of Tamdei PFCS during 1988-91

Months	1988-89	1989-90	1990-91
April	-	1 402	673
May	-	1 663	2 939
June	-	2 906	1 152
July	1 156	1 560	939
August	5 315	5 326	6 226
September	6 643	6 179	1 655
October	5 243	2 088	2 087
November	3 340	1 969	2 643
December	3 620	2 685	3 037
January	1 164	925	2 663
February	1 411	614	3 145
March	1 659	1 253	3 296
TOTAL	*29 551*	*28 570*	*30 455*

Mahamadpur

Mahamadpur is the largest primary Fishermen's Cooperative Society in Hirakud, both in terms of membership and the area of water body under its control. The society has a total share capital of Rs. 55 070, which includes the government's share of Rs. 42 200. The society's fishing territory is confined to sector 2 and records the lowest catch among all the cooperatives. The catch varies from 14 132 kg in 1988-89 to 32 076 kg in 1989-90 (Table 13). The corresponding yield rates are 1.75 kg ha^{-1} to 3.85 kg ha^{-1}.

Table 13. Fish landings (kg) of Mahamadpur PFCS during 1988-92

Months	1988-89	1989-90	1990-91	1991-92
April	-	609	2 028	2 140
May	-	2 544	3 905	7 251
June	-	3 125	6 962	7 195
July	3 158	1 484	3 992	5 881
August	3 226	3 648	2 832	4 418
September	2 082	5 050	1 662	1 059
October	1 004	1 427	2 342	549
November	2 303	2 288	1 361	-
December	-	2 019	-	-
January	1 319	2 494	-	-
February	846	1 093	-	-
March	194	6 295	4 221	-
TOTAL	*14 132*	*32 074*	*29 305*	*28 493*

Ib

The Ib Primary Fishermen's Cooperative Society (IPFCS) controls 9 842 ha of the reservoir area. This is a 617 member society with a share capital of Rs. 15 670, which includes the government's share of Rs. 9 500. More than 73% of the members belong to the scheduled castes and 17.34% to the scheduled tribes. annual fish catch by the members varied from 15 525 kg in 1988-89 to 39 978 kg in 1989-90, with corresponding yield rates of 2.04 and 3.59 kg ha^{-1} (Table 14).

Table 14. Fish landings (kg) of Ib PFCS during 1988-92

Months	1988-89	1989-90	1990-91	1991-92
April	-	609	2 028	2 140
May	-	2 544	3 905	7 251
June	-	3 125	6 962	7 195
July	3 158	1 484	3 992	5 881
August	3 226	3 648	2 832	4 418
September	2 082	5 050	1 662	1 059
October	1 004	1 427	2 342	549
November	2 303	2 288	1 361	-
December	-	2 019	-	-
January	1 319	2 494	-	-
February	846	1 093	-	-
March	194	6 295	4 221	-
TOTAL	*14 132*	*32 076*	*29 305*	*28 493*

The reservoir area under the control of Ib society encompasses one of the important sectors of the reservoir from biological and economic point of view. This stretch provides the possible breeding grounds for Indian major carps and it assumes significance while formulating conservation norms. the Ib sector also receives the maximum pollution load. A paper mill in Brajraj Nagar discharges its effluents into the Ib river which find their way to the reservoir. Fish kills have been reported on account of pollution. Brood stock of fishes ascending the Ib river for breeding are susceptible to over exploitation and strict vigil is needed to protect the fishes on their breeding run.

DEVELOPMENTAL STRATEGIES

Hirakud, despite being the largest man-made watersheet in the country, remains one of the least explored in terms of its fishery potential. Ironically, the fish production from this aquatic dendowment is also one of the lowest. this reservoir is in existence for the last thirty-five years and having passed through the initial phases of trophic burst and trophic depression, has now stabilised to a very low level of fish productivity. The sheer biogenic waste from such a large aquatic resource is a colossal national loss. Lack of understanding of biological production functions leading to irrational development of the reservoir fisheries that took place in the earlier

phases can be attributed to this low productivity. Fish species subsisting on higher food chain and other uneconomic varieties now dominate the catch structure, which reflects on the poor conversion of the primary energy into fish flesh and resulting in the present impasse.

The main accent on development of fisheries in the Indian reservoirs has been on optimum utilisation of the inherent production potentialities through stock manipulation. Since the lake whas already crossed its formative years, any attempt towards substantial change in stock quality would be an uphill task. Nevertheless, a holistic approach comprising judicious environment management and stock manipulation can bring in a reversal of the trend. Considering the enormous size of the reservoir, overall development would revolve around the capture fisheries norms of utilising the natural populations to the optimum extent. The key parameters thus identified for sustainable development of Hirakud reservoir include :

i) a better appreciation of the scientific attributes influencing productivity at different trophic levels;

ii) suitable stocking and harvesting policies;

iii) adequate post-harvest infrastructure;

iv) strong cooperative base; and

v) sound conservation measures.

The limno-chemical propensities of any water body largely govern the productivity rhythm and, therefore, a deep insight into the production functions is essential before any meaningful conclusions are arrived at. Hirakud with infirm database in terms of soil and water quality, needs a detailed scientific study to assess the flux of nutrients and related production dynamics. Nevertheless, the little information in hand does reflect some positive indicators of productivity in the reservoir.

Accurate data on total catch, effort, catch per unit of effort and size composition of the catches are essential for a proper understanding of the available resources, their level of exploitation and the effect on the abundance of fish stock. This, in turn, will enable estimation of the level at which the stock has to be maintained for obtaining a sustained yield. Thus, a proper assessment of the existing populations of fishes is to be made on the basis of a statistically designed survey. Such studies would also form the edifice of a long term stocking and harvesting policy for the reservoir. this would, inter alia, include the stocking density, stocking schedule, species mix, gear selection and mesh size regulations.

Gear selection is an important component of fisheries management norms. sufficient information exists on the efficacies of different fishing tackles suitable for such large water bodies, mainly through the experiments conducted by the Burla Centre of the Central Institute of Fisheries Technology. this expertise has to be utilised while formulating guidelines for gear selection.

Fisheries of Hirakud reservoir is totally under the cooperative sector. However, the activities of the societies are not brought to their logical conclusions. for instance, despite the imposing presence of the five cooperative societies, which enjoy the fishing rights of the entire reservoir, middlemen operate freely in the post-harvest operations leading to erosion of profit earned by the societies. Market functions has been vested with the private fish merchants without any valid reasons. There is a need for an apex body to coordinate the activities of the cooperative societies and to pool and share the resources available at the disposal of different societies. all the market functions including procurement of fish from the fishermen, their transport by water to the landing centres, and trade with the wholesale merchants at Howrah should be done under a cooperative network.

Since capture fisheries development depends heavily on the biotic communities present in the ecosystem, the management norms for such water bodies centre around principles of habitat conservation and optimum exploitation of the wild stock. Man's intervention in the ecosystem management is restricted to augmentation of stock through artificial recruitment and fishing effort manipulations. Pollution from industrial units, agricultural wastes, thermal power plants and domestic effluents are the common causes of environmental degradation in reservoirs. Hirakud reservoir is already threatened with environmental hazards from :

i) *Industrial effluents from paper mill, refractories and cement factories*

ii) *Wastes from collieries*

iii) *Thermal wastes from power plant*

iv) *River bed modification through removal of gravel*

v) *Pesticide residues from the agricultural operations in the peripheral areas of the reservoir*

Ib river is a possible route to link the carp breeding grounds with the reservoir. this and other areas having a bearing on the carp breeding run need to be thoroughly studied to determine the areas to be declared as sanctuaries for the conservation of desirable carp species.

Environmental pollution in the region

A view of the denuded catchment of Hirakud

A thick layer of colliery dust on the local flora

An inflow draining pollutants into Hirakud

ACTION PLAN FOR FISHERIES DEVELOPMENT IN HIRAKUD

It has been seen from the above chapters that some baseline information on essential parameters like environmental variables and biotic communities are sine qua non to plan any meaningful manoeuveres for development of fisheries in Hirakud on scientific lines. considering the size of the reservoir and its intrinsic diversities in terms of vital parameters, the exercise needs to be exaustive in nature. Apart fr9om the sectoral variations, the seasonality is also to be taken into consideration. The fish production potential of a reservoir of Hirakud's size requires large samples commensurate with the wide temporal and spatial variations. Similarly, an objective assessment of biotic communities needs a protrafted period of investigations. Only in the light of the scientific attributes collected systematically over a period, management norms can be formulated. Therefore it is suggested that a research-cum-development scheme be launched for the purpose. The active prarticipation of Central Research Institutes and Developmental agencies of Orissa State is proposed for this endeavour.

The Scheme will have two distinct components *viz.*,

i) *a research component to gather all relevant information for the formulation of development strategies and*

ii) *a development component to formulate, initiate and demonstrate the scientific management of the reservoir.*

The ideal duration of the scheme is five years. the first two years will be devoted for collection of limno-chemical data, assessing the production potential at various trophic levels, enumerating the biotic communities at different strata, making an inventory of the fishing efforts in terms of implements, manpower and organisational structure. In the light of information collected during the first two years, formulation of management norms can be attempted from the third year onwards, when the development component would overlap the research component of the scheme. The last two years may be devoted to demonstrate the validity of the scheme.

CONCLUSION

The nation has set a target of 4 million t of fish from the inland waters by the year 2000 A.D. Realisation of this target entails both horizontal and vertical expansion of inland fisheries. Reservoirs constituting the frontline areas in the realm of capture fisheries in the country will form an active component in the inland fisheries development activities in the years to come. In such perspectives, Hirakud, being the largest reservoir offers immense production potential. Thus, the fish yield optimisation from Hirakud needs priority attention from planners and policy makers in the current plan period.