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Scientific freshwater fish culture demonstration in some Tribal villages of Ganjam district, Odisha

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Abstract
Scientific aquaculture technology was demonstrated in Phailin-affected four adopted villages, namely Ambapur in Digapahandi Block; Daseipur in Sanakhemundi Block; Nuapada in Kukudakhandi Block and Sujanasahi in Khallikote Block of Ganjam District, Odisha for enhanced fish production from ponds, and livelihood and nutritional security of tribal farmers of that area. Sixteen ponds with total water area of 11.6 ha and 186 beneficiaries were adopted by ICAR-Central Institute of Freshwater Aquaculture through the Department of Science and Technology, Government of India sponsored project. Fingerlings of Indian Major Carps (catla, *Catla catla* 49-64 mm & 1.97-2.68 g, rohu, *Labeo rohita* 38-52 mm & 0.9-2.54 g and mrigal, *Cirrhinus mrigala* 33-47 mm & 0.55-0.78 g) were stocked with density 5,000/ha and ratio catla: rohu: mrigal :: 1:2:1 in October, 2017. After a culture period of 6-8 months, the growth of *C. catla* was 252-285 mm & 600-755 g, *L. rohita* 215-260 mm & 350-585 g and *C. mrigala* 195-250 mm & 380-530 g. Fish harvests were done in different villages during April-May, 2018 and productions achieved were 1.8-2.9 t/ha/yr from a pre-adoption level of 0.6-1.1 t/ha/yr. Plankton productivity of ponds was increased from 0.8-1.8 to 1.8-2.4 ml/50 l of water with adoption of better management practices (BMP), which contributed to 2.53-3.18 times higher fish production from ponds. The present investigation revealed that the fish production can be increased from small seasonal village ponds through proper BMP and the rural economy can be strengthened through the development of small-scale fish culture enterprises.

Keywords: aquaculture production, fish growth, technology demonstration, Indian major carp, tribal farmers, Ganjam District

1. Introduction
Aquaculture is an important sector of food production in India and contributes considerably to the food basket of the country. It not only ensures food and nutritional security amongst the population, but also, contributes significantly to the agricultural exports, and provides employment and livelihood to more than 14 million people around the Globe [1]. Mostly the small-scale fish farmers of the world (98%) are from developing countries and from rural areas [2, 3]. The promotion of aquaculture for rural development has had a poor record in many developing countries [4]. In last few decades India has seen a sizable expansion in freshwater aquaculture, but, those are concentrated in few states and few regions within the states. The remote, inaccessible and backward regions are often lagged behind in aquaculture development due to lack of access to aquaculture technologies [5].

Odisha State, situated in eastern part of India, had 41.9 million population in 2011, among which SC and ST population constituted 17.1% and 22.8% respectively and in combination constituted 39.9% of the total state population (www.censusindia.gov.in). This was comparatively higher than the all India figures of 16.6% SC and 8.6 % ST population. Agriculture sector absorbs about 80% of the total workforce and contributes 50% of state GDP. Nearly 85% of the state population lives in rural areas. The percentage of main workers and marginal workers are respectively 61.0% and 18.3 % of the total workers. Pressure in agriculture still continues to be high in Odisha. Out of the total workers, 24.1% are cultivators, 61.8 % are agricultural labors, 2.8% engaged in household industries and 25.6% are other workers (Odisha economic survey 2011 census). Ganjam District, Odisha is situated in 19.4º-20.17º North Lat. and 84.7º-85.12º East Long. As per 2011 census, the total population of the

District was 35, 20, 151, out of which SC and ST populations were 5, 86, 798 (16.67%) and 88,919 (2.53%) respectively. Around 41.8 % of state population depends on daily wages (Census, 2011). Aquaculture can be a profitable culture practice for farmers of Odisha as 80% of total population consumes fish as the source of animal protein. Hence, the expansion of aquaculture mainly depends on many factors, such as, availability of quality fish seed, fertilizer, feed, medicines and knowledge of better management practices (BMP**)** [6-13].

Inland fish production in Odisha was 2.94 lakh tones in 2013-14**)** [14]. Despite having rich resources for aquaculture development, 36,965 tonnes of fish are imported annually from neighbouring state of Andhra Pradesh to meet the growing demand of people for fishes [15]. One of the main factors of rural development is to utilize productively the available resources in local areas. The ponds, tanks and small reservoirs available in villages are often remain unutilized and underutilized due to various reasons, such as, lack of technical knowledge, lack of investment and support for inputs, marketing system, etc. In most of the villages, available water bodies are owned, controlled and managed by the village development communities (VDC) or self-help groups (SHG) or panchayats, and the benefits from aquaculture are shared among the community members [16]. Sometimes one or two ponds fail to generate enough benefits to attract members to sustain their effort in aquaculture.

Hence, sustained efforts are needed to transfer many aquaculture technologies to a large number of farmers for visible impact [16]. Here the study was focused on socio-economic development of tribal communities of four adopted villages, namely Ambapur in Digapahandi Block; Daseipur in Sanakhemundi Block; Nuapada in Kukudakhandi Block and Sujanasahi in Khallikote Block of Ganjam District, Odisha and one proven technology developed by ICAR-CIFA *i.e.*, carp culture was demonstrated to the farmers of the area. The study was conducted under the Department of Science and Technology (DST), Govt. of India sponsored project for that area during 2017-18. The tribal farmers of the area were educated on various aspects of scientific aquaculture for adoption of it as an option for their livelihood development. During the study period, the water bodies of the area were examined and feasibility of their utility for aquaculture production was also found out by regular visits of the team. Regular discussions were held with the tribal communities including women and youth.

2. Materials and Methods

2.1 Study area and location

Four villages, namely Ambapur in Digapahandi Block; Daseipur in Sanakhemundi Block; Nuapada in Kukudakhandi Block and Sujanasahi in Khallikote Block of Ganjam District, Odisha, India were surveyed and adopted for the study. Total of 186 beneficiaries (SC-4, ST-157, OBC-24, General-1) having 11.6 ha pond (16 nos.) area were adopted in the scheme. Most of them are under educated and their primary occupation is paddy cultivation, bamboo craft work and daily wages. During visits, surveys were made to access the water resources and their utility for fish farming. Awareness programmes and group discussions were conducted regularly involving men, women and youths of those villages. Mostly the ponds (fourteen) are seasonal and two are perennial. Though the villages have 16 ponds, those were not utilized for aquaculture purpose by adopting scientific fish farming practices and did not have any sustainability in fish production. The pre-adoption level of fish production was 0.8-1.1 t/ha/yr. The small seasonal ponds dry during May-June of the year, during summer. Therefore, the harvesting of fish has to be done from all those ponds before drying to avoid loss due to poaching and mortality.

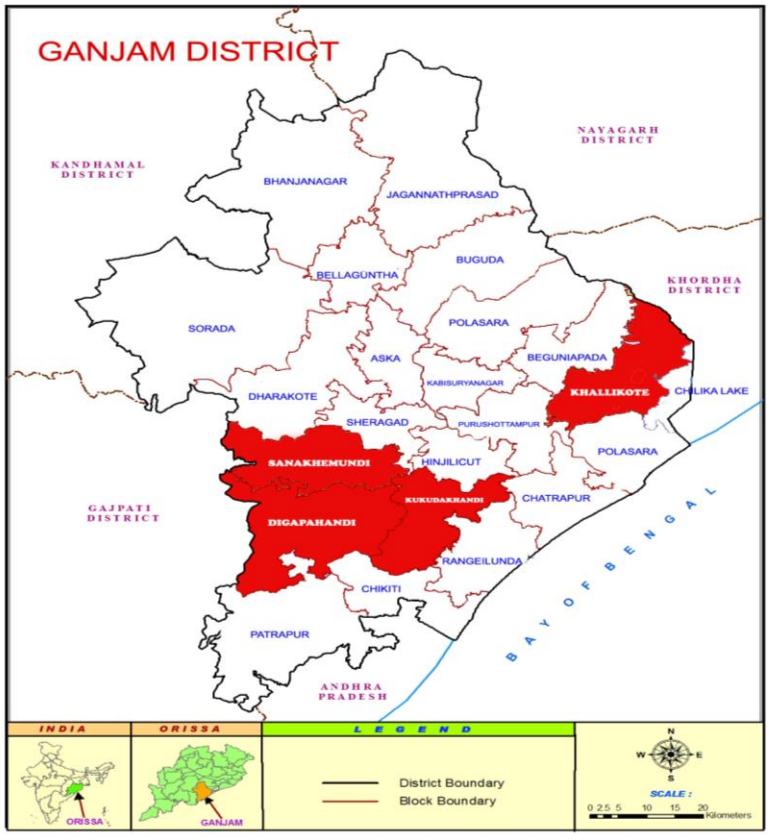

Fig 1: Geographical situation of adopted Bocks of Ganjam District, Odisha

2.2. Pond preparation and input supply

The ponds in different villages were cleaned of weeds and predatory fishes; and prepared as per standard procedures followed for aquaculture. The water samples from ponds were collected in every two months and tested for determining the pond health status for fish farming. The ponds were limed (@150-200 kg/ha) followed by fertilization by applying raw cow dung (@ 1000-1500 kg/ha) before stocking of carp seed (fingerlings). The inputs like, lime, urea and single super phosphate (SSP) were supplied from the project for application in the ponds based on their area and water quality. Regular fertilization was done by applying raw cow dung (@8-10 t/ha/year) in ponds in monthly intervals splitting the yearly dose to months. Organic and inorganic fertilizers were applied in every month. Urea and single super phosphate (SSP) were used as inorganic fertilizer @120 kg/ha/year and 300 kg/ha/yr.

2.3 IMC seed stocking and feeding

Fingerlings of Indian Major Carps (catla, *Catla catla* 49-64 mm & 1.97-2.68 g, rohu, *Labeo rohita* 38-52 mm & 0.9-2.54 g and mrigal, *Cirrhinus mrigala* 33-47 mm & 0.55-0.78 g) were stocked with density 5,000/ha and ratio catla: rohu: mrigal :: 1:2:1 in October, 2017. Seasame oil cake and rice bran @ 1.0% approximately was used as fish feed in ponds of Ambapur Village, Digapahandi Block. In other places the pond productivity was managed through BMP and application of oil cake and rice bran available with villagers.

2.4 Fish harvest

The cultured fishes were harvested from all ponds of the adopted villages during the months of April-May, 2018; fish growths were estimated by sampling method with measurements of length-weight of the species; survivality was calculated based on total fish stocked and harvested; production data for each pond was converted to the unit 't/ha/yr' for comparison purposes; comparisons were made between the pre-adoption and post-adoption fish productions; and economics of village-wise fish production was prepared.

2.5 Physico-chemical parameters of pond water

Physico-chemical parameters such as water temperature (^{0}C), pH, dissolved oxygen (mg/l), total alkalinity (mg/l), total hardness (mg/l), conductivity (µS/cm), ammonium-N (mg/l), nitrite-N (mg/l), nitrate-N (mg/l), phosphate-P (mg/l) and plankton volume (ml/50 l pond water) were analyzed in every two months during the culture period by standard laboratory procedures of APHA [17].

3. Results and Discussion

3.1. Fish production achieved

For demonstration of scientific fish farming amongst tribal farmers, 11.6 ha ponds in Ganjam District were stocked with IMC fingerlings in October, 2017. The farmers were able to harvest a quantifiable amount of fish from their ponds after successful demonstration of various aspects of scientific aquaculture to them. Final harvesting was done during April-May, 2018. The growth of the fish in different villages is presented in Table 1. After a culture period of 6-8 months, the growth of *C. catla* was 252-285 mm & 600-755 g, *L. rohita* 215-260 mm & 350-585 g and *C. mrigala* 195-250 mm & 380-530 g. Fish production before and after adoption in relation to pond size in different villages is presented in Tables 2 and 3. Fish production before and after adoption in different blocks is presented in Figure 2. Fish productions achieved were 1.8-2.9 t/ha/yr with survivality range of 33% to 68% from a pre-adoption production level of 0.6-1.1 t/ha/yr.

Table 1: Growth of fish in farmers' ponds in four blocks of Ganjam District

Name of the Village & Blocks	Species cultured	Growth estimation during stocking (October 2017)		Growth estimation during harvest (April-May 2018)	
		Length (mm)	Weight (g)	Length (mm)	Weight (g)
Ambapur, Digapahandi	*C. catla*	57-64	1.97-2.19	280-285	640-755
	L. rohita	45-52	1.67-2.54	252-260	575-580
	C. mrigala	36-47	0.53-0.78	245-248	520-530
Nuapada, Kukudakhandi	*C. catla*	49-52	2.02-2.68	252-258	642-660
	L. rohita	38-49	0.90-1.20	257-258	570-585
	C. mrigala	33-47	0.41-0.74	195-225	290-410
Sujanasahi, Khallikote	*C. catla*	56-64	2.10-2.60	276-278	600-615
	L. rohita	45-48	1.00-1.20	245-260	550-565
	C. mrigala	36-39	0.56-0.75	210-250	480-495
Daseipur, Sanakhemundi	*C. catla*	95-96	9.81-10.23	280-285	635-690
	L. rohita	85-91	8.35-8.76	215-245	350-460
	C. mrigala	95-98	8.92-9.15	210-212	500-510

Table 2: Fish production from farmer's ponds in four blocks of Ganjam District

Name of the Village & Block	Pond code	Pond area (ha)	Stocking (nos.)	Culture period (months)	Final fish harvest				
					Catla (kg)	Rohu (kg)	Mrigal (kg)	Total production (kg)	Survivality (%)
Ambapur (Digapahandi)	A1	0.4	2000	8	202	374	164	740	64
	A2	0.4	2000	8	210	390	143	743	64
	A3	0.4	2000	8	210	360	210	780	67
	A4	0.4	2000	8	188	410	185	783	68
Daseipur (Sanakhemundi)	D1	0.6	3000	7	156	353	176	685	41
	D2	0.6	3000	6	140	296	124	560	33
	D3	1.2	6000	7	335	680	345	1360	40
	D4	2.4	12000	7	987	2160	872	4019	59
	D5	2.4	12000	7	1020	2034	986	4040	60

Nuapada (Kukudakhandi)	N1	0.4	2000	8	124	283	113	520	46
	N2	0.2	1000	8	70	148	62	280	49
	N3	1.2	6000	7	482	1127	391	2000	57
	N4	0.2	1000	8	79	168	68	315	54
Sujansahi (Khallikote)	K1	0.4	2000	8	158	384	98	640	58
	K2	0.2	1000	8	84	223	73	380	68
	K3	0.2	1000	8	93	210	69	372	67

Table 3: Pre- and post-adoption comparison of fish production in ponds of Ganjam District

Name of the Village and Block	Pond size in (ha)	Culture period (months)	Fish production pre- adoption (kg)	Fish production post- adoption (kg)	Fish production pre- adoption (kg/ha/yr)	Fish production post- adoption (kg/ha/yr)	Fish production increased (times)
Ambapur, Digapahandi	0.4	8	250	740	938	2775	2.96
	0.4	7	210	650	900	2786	3.10
	0.4	8	245	740	919	2925	3.18
	0.4	8	265	730	994	2938	2.96
Daseipur, Sanakhemundi	0.6	7	230	685	657	1956	2.98
	0.6	6	185	560	617	1867	3.03
	1.2	7	455	1360	650	1943	2.99
	2.4	7	1340	4020	957	2871	3.00
	2.4	7	1345	4040	961	2886	3.00
Nuapada, Kukudakhandi	0.4	8	170	520	638	1950	3.06
	0.2	8	100	280	750	2100	2.80
	1.2	7	660	2000	943	2857	3.03
	0.2	8	105	315	788	2363	3.00
Sujanasahi, Khallikote	0.4	8	220	640	825	2400	2.91
	0.2	8	150	380	1125	2850	2.53
	0.2	8	125	380	938	2792	2.98
Total	11.6	(Avg.) 7	6350	18915	13597	40259	2.96

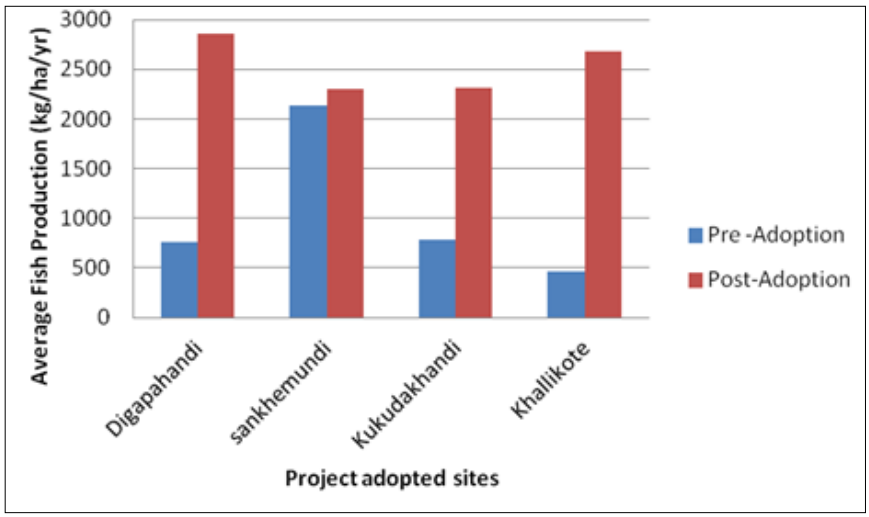

Fig 2: Comparative fish production data of adopted sites

Freshwater aquaculture technology demonstration for livelihood development of tribal farmers of Niladriprasad Gram Panchayat, Banpur Block, Khordha District, Odisha was undertaken in an Area saturation mode by ICAR-CIFA during 2015-2016 [12]. The fish production increased from the baseline level of 250 kg/ha/yr to a range of 428.5-2,880 kg/ha/yr in twenty adopted villages of the block. Total 6,171 kg of fish were harvested in 6.5 months of culture period and the estimated average fish production was 1,372.6 kg/ha/yr. In the present study the fish production achieved was 1.8-2.9 t/ha/yr from a pre-adoption level of 0.6-1.1 t/ha/yr. Under the Department of Biotechnology (Govt. of India) funded project, ICAR-CIFA could produce 2,986 kg/ha/yr (1,750-4,667 kg/ha/yr) in SC/ST adopted ponds in Nayagarh District and 2,433.5 kg/ha/yr (1,050-5,075 kg/ha/yr) in Mayurbhanj District of Odisha from the baseline value of 250 and 408 kg/ha/yr respectively [20]. Through the participatory approach mode, KVK (Khordha), Kausalyaganga mobilized communities, stocking ponds and adopted all Scientific Management Practices in Khordha District of Odisha. During 2011-13, it demonstrated the fish culture in five community ponds with WSA 6.0 ha. Average production of 2,241 kg/ha/year was achieved against the farmer's practice of 1,546 kg/ha/yr [21]. Recently, scientific demonstration of freshwater aquaculture technology was conducted in an area saturation mode in the ponds of Jamushahi Cluster of Daspalla Block, Nayagarh District, Odisha. Fourteen ponds with total WSA 4.6 ha from six villages, namely Jamusahi, Durgaprasad, Banibiri, Gundiribari, Tanganadi and Pamporada with 4,725 tribal population were adopted by ICAR-CIFA for technology demonstration. Ponds were stocked with the fingerlings of Indian major carps (IMC) *i.e.*,

Catla catla, *Labeo rohita* and *Cirrihinus mrigala* with 5,000 nos/ha and species ratio was 1:1:1 in October 2015. After 7.5 months of culture period, the fish production was increased from 250 kg/ha/yr (prior to adoption) to an average of 1,157 kg/ha/yr (after adoption). Final fish harvest was ranged between 666-3,049 kg/ha/yr in all fourteen ponds of six adopted villages [13]. The present fish production in Ganjam District is comparable with the fish productions reported from different places of the country.

3.2 Physico- chemical properties of pond water

The sampling data (Table 4) revealed that the water parameters of all experimented ponds were found almost found suitable for aquaculture purpose [18].

Table 4: Physico-chemical properties of pond water in Ganjam District

Water quality parameter	Value
Temperature (ºC)	22.7-35.8
Dissolved oxygen (mg/l)	2.4-5.8
pH	7.2-8.5
Total alkalinity (mg/l)	104-150
Total hardness (mg/l)	70-176
Conductivity (µ mhos/cm)	110-429
Ammonium (mg/l)	0.234-1.629
Nitrite (mg/l)	0.014-1.594
Nitrate (mg/l)	0.04-1.306
Phosphate (mg/l)	0.671-0.977
Plankton density (ml/50 l)	1.8-2.4

The water quality required for IMC culture in pond is more than 3.0 mg/l for dissolved oxygen, 20-30 cm transparency, 100-200 mg/l total alkalinity and more than 40 mg/l total hardness [19]. Plankton productivity of ponds was increased to 1.8-2.4 ml/50 l of water from 0.8-1.8 ml/50 l of water. Productivity increases with the production of plankton in ponds, which serves as fish food. All the ponds were found suitable for fish rearing with better management practices (BMP) advices. The plankton species found in pond waters of Ganjam District were Phytoplankton: Blue green algae (Anabaena, Rivularia); Green algae (Ankistrodesmus, Protococcus, Microspora, Botryoccous); Diatoms (Melosira, Diatoma, Navicula, Synedra, Frustulia) and Zooplankton: (Diaptomous, Daphnia, Copepods, Cladocerans, Cyclops, Monia). All the ponds were found suitable for fish culture with better management practices (BMP) advices [16]. and major phytoplankton species recorded were 11 nos. and zooplankton 6 nos.

3.3 Livelihood development

Direct interaction with people regarding their need, motivating the whole community (including youth and women) towards aquaculture, regular visits to them, supply of inputs, demonstration of technology and trainings on various aspects of aquaculture enabled them to take the aquaculture in a scientific manner. The survey revealed that the tribal farmers are engaged in different types of primary agricultural practices and aquaculture comes as secondary or tertiary option for them due to ignorance to scientific farming techniques and poaching of fish. Since the variable costs and revenues increase with size of pond, smaller seasonal ponds can generate a good crop of fish at a lower investment cost [22]. People-centered approaches have identified that the seasonal ponds are especially attractive for people who are poor, first time fish farmers or risk-averse farmers. The utilization of these ponds available not only increases their economic condition, rather it supports their nutritional security in respect of availability of animal protein to them.

4. Conclusion

The present programme of fish culture demonstration was undertaken in four C.D. Blocks namely Sanakhemundi, Kukudakhandi, Digapahandi and Khallikote of Ganjam District, Odisha under the DST, Government of India sponsored project operating at ICAR-CIFA. Before adoption, the productivity of ponds in terms of plankton volume was 0.8-1.8 mg/50 liter pond water and was rectified to 1.8-2.4 mg/50 liter with adoption of BMP. The fish production from their ponds could increase to 1.8-2.9 t/ha/yr from the pre-adoption level of 0.6-1.1 t/ha/yr. The study also provided some information on the prevailing conditions of the ponds of the district from aquaculture point of view.

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