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Freshwater aquaculture technology demonstration in area saturation mode to the tribal farmers of Jamushahi cluster of Daspalla Block, Nayagarh district, Odisha

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Abstract
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 for fish production, livelihood and nutritional security of tribal farming community of that area. Fourteen ponds with total water area of 4.6 ha from six villages, namely Jamusahi, Durgaprasad, Banibiri, Gundiribari, Tanganadi and Pamporada with 4,725 tribal population were adopted by ICAR-Central Institute of Freshwater Aquaculture for technology demonstration. Ponds were stocked with the fingerlings of Indian major carps (IMC) *i.e.*, *Catla catla* (Catla), *Labeo rohita* (Rohu) and *Cirrihinus mrigala* (Mrigal) with size range of 40-84 mm length and 2.7-7.2 g weight, density 5,000 nos/ha and species ratio 1:1:1 in October 2015. After an average culture period of 7.5 months, the fishes were harvested during May-June, 2016. In all ponds 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. Prior to adoption per capita fish availability from pond culture for consumption of the tribal population of that area was 0.39 kg/yr, which rose to 1.80 kg/yr after adoption. The present investigation of ICAR-CIFA revealed that the fish production can be enhanced through integrated use of seed, feed and fertilizer as inputs from small seasonal homestead ponds. The study also revealed that the rural economy can be strengthened through the development of small-scale fish culture enterprises.

Keywords: Aquaculture production, area saturation mode, technology demonstration, Indian major carp, tribal farmers

1. Introduction
Aquaculture, the culture of aquatic organisms (fish and shell fish) including aquatic plants remain as a sunshine sector providing food, nutritional security and livelihood to more than 14 million people around the world [1]. Fisheries in India is a very important economic activity and also flourishing sector with varied resources and potentials. The vibrancy of the sector is seen by sixteen fold increase, that India achieved in fish production in just six decades *i.e.*, from 0.75 MMT in 1950-51 to 11.60 MMT in 2016-17 [2]. Over last decades, aquaculture became the fastest growing food producing sector; however it is inadequate to meet the nutritional demand throughout the country, particularly in tribal communities. Almost all small-scale fish farmers of the world (98%) are in developing countries - mostly in rural areas [3, 4] and the promotion of aquaculture for rural development has had a poor record in many developing countries [5].

Odisha State is situated in the eastern part of India, occupies 4.7% of country's landmass and accounts for 3.74% of India's population. Total population of Odisha, which was 36.8 million in 2001, increased to 41.9 million in 2011, among which SC and ST population constitute 17.1% and 22.8% respectively and in combination constitute 39.9% of the total state population (www.censusindia.gov.in). This is comparatively higher than the all India figures of 16.6% SC and 8.6% ST population. About 41.8% of the total state population depends on daily wages (Census, 2011) among which the percentage of main workers and marginal workers are 61.0% and 18.3% of the total workers respectively. Aquaculture will be a profitable culture practice for farmers of Odisha as 80% of total population consumes fish as a

source of animal protein. Hence, the expansion of aquaculture mainly depend on availability of quality fish seed, other inputs and knowledge of better management practices (BMP) [6-12].

Odisha poses to be a rich source of aquatic resources, such as tanks and ponds, reservoirs, lakes, swamps, bheels, canals and rivers spread across 30 districts and inland fish production was 2.94 lakh tones in 2013-14) [13]. Despite having such rich resources of aquaculture, 36,965 tonnes of fish are being imported from neighbouring state of Andhra Pradesh to meet growing demand for fishes [14]. One of the basic premises of rural development is to productively utilize the available resources in local areas. The ponds and tanks available in the villages are often remain unutilized and underutilized due to various reasons like lack of technical knowledge, lack of investment and support of inputs, marketing system, etc. In most of the villages, available water resources are owned, controlled and managed by the village communities or self help groups or panchayats, and the benefits are shared among the community members [15]. Sometimes one or two ponds fail to generate enough benefits to attract members to sustain their effort in aquaculture.

Hence, sustained effort need to be undertaken to transfer many aquaculture technologies like hatchery management, seed rearing practices, grow out fish culture, feed preparation, etc to a large number of farmers located within the vicinity [15]. Here the study was focused on socio-economic development of tribal communities in Jamushahi cluster of Nayagarh 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 Tribal Sub Plan (TSP) Scheme of ICAR-CIFA during 2013-16. The tribal communities in the area were educated on various aspects of aquaculture for adoption as an option for livelihood development. During the study period, various water bodies of the area were examined and feasibility of their utility for aquaculture production was also found out by visits of the team and discussion with the tribal communities including women and youth.

2. Materials and Methods

2.1 Study area

Before adoption, the research team from ICAR- CIFA visited the area several times to find out the background socio-economic conditions of the tribal communities in different villages, namely Jamusahi (20.105085ºN altitude and 85.118515ºE latitude), Durgaprasad, Banibiri, Gundiribari, Tanganadi and Pamporada of Daspalla Block in Nayagarh District of Odisha, India. The villages are approximately 180 km away from Bhubaneswar, the capital city of Odisha and the distance among them is 5.0 km approximately. During visits surveys were made to find the water sources and their utility for fish farming. Assessment was done with vivid discussions with the people involved in aquaculture directly or indirectly and identified the possible interventions required in the area. Awareness programmes were conducted involving men, women and youths of those tribal villages. Mostly the ponds (thirteen) are seasonal and only one pond is perennial with water flow in to it from a perennial hill stream. The livelihood of people is primarily from crop and cultivation of few vegetables. The vegetables are generally sold in the farm itself. Though the villages have 14 ponds, those were not cultivated with scientific fish farming practices and did not have any sustainability in fish production. The small seasonal ponds dry on the onset of summer. Therefore, the harvesting used to be done from all those ponds before drying to avoid loss due to poaching and mortality.

Fig 1: Geographical situation of Jamusahi, Bock- Daspalla, Dist. - Nayagarh

2.2. Baseline-line surveys

Baseline surveys of all villages were done with planned questionnaires. The sizes of adopted ponds ranged between 0.2 and 0.8 ha with varying depths of 0.5-2.0 m. Thirteen ponds are seasonal having water retention capacity for 6-8 months and only one pond is perennial, getting water from nearby hill stream. The composite fish culture was practiced without any scientific basis.

2.3 Inputs supplied

As the tribal villages are in remote area and do not have much access with the outside resources, the water samples from ponds were collected and tested for assessing the pond heath for fish firming. The farmers were unaware of scientifically preparation of their ponds for stocking of fish seed and subsequent aquaculture processes. Hence, the steps for educating the tribal communities in this area regarding fish

farming were supported by TSP-ICAR-CIFA. Initially the ponds were limed (@ 200-250kg/ha) followed by fertilization by applying raw cow dung (@ 1000-1500 kg/ha) and prepared for stocking of fish seed. The carp fingerlings were supplied from ICAR-CIFA for stocking of the ponds. The fingerlings were stocked with size range of 40-84 mm length and 2.7-7.2 g weight with density 5,000 nos/ha and species ratio 1:1:1 in the month of October, 2015. The pelleted floating carp feed @ 1-2% was also supplied and the feeding strategy was explained to the villagers. Several visits were made to the area to bring confidence among the farmers and to monitor the culture practices.

2.4 Water quality parameters

The water quality parameters (physico-chemical) of the ponds were analyzed as per standard laboratory procedures [16] a regular interval bringing the water samples to ICAR- CIFA.

2.5 Awareness and trainings programmes conducted

The TSP team from ICAR-CIFA had conducted several training and awareness programmes on scientific aquaculture activities to motivate the villagers prior and during adoption. The details of the progammes are enlisted in Table 1.

Table 1: The awareness and training programmes conducted in Jamushahi Cluster

Sl. No.	Title	Venue	Duration	Number of participants
1	Interaction meet with farmers	Jamusahi, Daspalla Block	11 December, 2013	44 farmers from seven villages, like Jamushahi, Durgaprasad, Dhudukipadu, Gunduriadia, Tanganali, Bhagamunda and Pamporada
2	Awareness programme on aquaculture for tribals	Jamusahi, Daspalla Block	14 August, 2014	50 farmers from seven villages
3	Several visits for discussion with farmers to develop confidence among them for adoption of aquaculture technology	All villages	2015-2016	With available farmers of different villages

3. Results and Discussion

3.1 Creation of awareness among tribal farmers

Two orientation programmes were conducted with tribal farmers of adopted villages to create awareness for fish culture among them. The main objectives of meetings were to disseminate the knowledge of better management practices (BMP) to enhance fish pond productivity and production of fish in adopted village ponds in a sustainable way. Besides this, field surveys and interactions with villagers were done regularly to encourage the fish farmers for doing scientific aquaculture in the adopted villages.

3.2. Physico- chemical properties of pond water

Physico-chemical parameters and availability of plankton in the water of adopted ponds were analyzed in every two months during the adoption period. The range of water temperatures, pH, dissolved oxygen, total alkalinity, conductivity and transparency were analyzed and recorded for all ponds and presented in Table 2.

Table 2: Physico-chemical properties of pond water of Jamushahi Cluster

Water quality parameter	Value
Temperature (ºC)	28.7 – 35.2
Dissolved oxygen (mg/l)	2.6 – 5.4
pH	6.54 – 8.25
Total alkalinity (mg/l)	104.0 – 168.0
Total hardness (mg/l)	96.0 - 164.0
Conductivity (µ mhos/cm)	186 – 218
Water transparency (cm)	6.1 – 14.4
Plankton density (ml/50 l)	0.8 – 1.9

The physico chemical properties of the pond water *i.e.*, pH, conductivity, total alkalinity and total hardness were found suitable for aquaculture purpose [17]. Productivity of adopted fish culture ponds was measured in terms of plankton volume which was found in the range of 0.8-1.9 ml/50 liter 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 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 [18]. In a study conducted at Jemamantadeipur and Kantabada Villages of Begunia Block, Khordha District, Odisha, the water parameters of the ponds were ranged for pH 7.3-7.9, conductivity 384-872 m.mho/cm, total alkalinity 60-100 mg/l and total hardness 60-90 mg/l. The ponds were found less productive in terms of plankton volume 0.6-1.4 ml/50 liter water and number of different species were recorded 15 nos (phytoplankton 9 nos. and zooplankton 6 nos) [15].

3.3. Fish production achieved

For demonstration of scientific fish farming, the ponds (surveyed and prepared) of 4.6 ha water spread area in Jamusahi Cluster were stocked with fingerlings in October 2015. The farmers were able to produce a quantifiable amount of fish from their ponds after successful demonstration of various aspects of scientific aquaculture technologies. Final harvesting was done during May-June, 2016. Growth of fishes and production status are given in Table 3 and 4 respectively.

Table 3: Growth of IMC in farmers' ponds in Jamushahi Cluster

Species	Initial stocking		Size at the time of harvest	
	Length (mm)	Weight (g)	Length (mm)	Weight (kg)
C. catla	48-78	3.4-6.6	210-270	0.8-1.25
L. rohita	42-77	4.1-7.2	125-250	0.4-0.9
C. mrigala	40-84	2.7-5.2	140-240	0.45-0.8

Table 4: Fish production from farmer's ponds in Jamushahi Cluster

Sl. No.	Name of the Village	Pond size (ha)	Culture period (months)	Avg. body weight (in g)	Species harvested (in kg)			Total fish harvested (in kg)	Fish harvest (in kg/ha/yr)
					Rohu	Catla	Mrigal		
1	Durgaprasad	0.4	8	950	130	80	50	260	975
2		0.4	6	1000	125	98	45	268	1340
3		0.4	9	750	75	80	45	200	666
4	Banibiri	0.2	7	800	85	47	40	172	1474
5	Gundiribari	0.2	6	500	140	35	45	220	2200
6		0.4	7	700	110	60	80	250	1071
7	Tanganadi	0.2	6	800	120	105	80	305	3049
8		0.2	9	700	90	85	40	215	1433
9		0.8	8	650	170	210	92	472	885
10	Jamusahi	0.4	8	900	50	80	60	190	712
11		0.4	10	800	120	95	60	275	825
12	Pamporada	0.2	8	725	35	40	25	100	750
13		0.2	7	600	50	40	60	150	1285
14		0.2	6	750	110	80	60	250	2500
Total		4.6	7.5 (avg.)	759	1410	1135	782	3327	19165

Table 5: Comparison of fish production before and after adoption in Jamushahi Cluster

Sl. No.	Name of the Village	Pond size in (ha.)	Total months of culture	Total fish harvested (in kg) before adoption	Total fish harvested (in kg) after adoption	Fish harvested (in kg/ha/yr) before adoption	Fish harvested (in kg/ha/yr) after adoption
1	Durgaprasad	0.4	8	65	260	244	975
2		0.4	6	50	268	250	1340
3		0.4	9	75	200	250	666
4	Banibiri	0.2	7	30	172	257	1474
5	Gundiribari	0.2	6	25	220	250	2200
6		0.4	7	60	250	257	1071
7	Tanganadi	0.2	6	25	305	250	3049
8		0.2	9	40	215	267	1433
9		0.8	8	110	472	206	885
10	Jamusahi	0.4	8	65	190	244	712
11		0.4	10	85	275	255	825
12	Pamporada	0.2	8	35	100	263	750
13		0.2	7	25	150	214	1285
14		0.2	6	30	250	300	2500
Total		4.6	7.5	720	3320	3506	19165

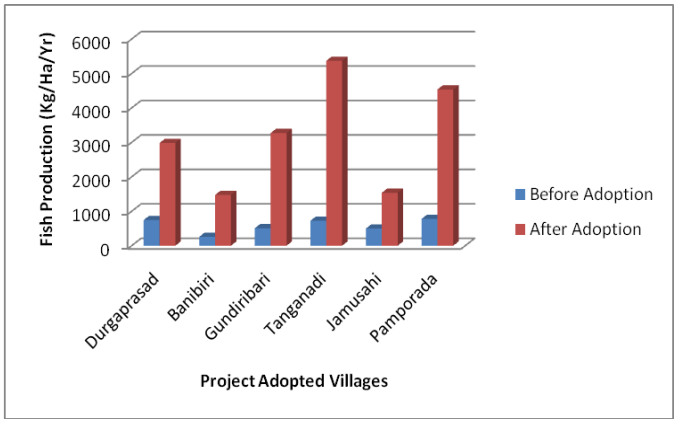

Fig 2: Comparison of fish production before and after adoption in Jamushahi Cluster

Total fish production from all adopted ponds (WSA of 4.6 ha) was 3,327 kg in 6-10 months of culture operation. Initially they were getting 720 kg of fish from those ponds in 6-10 months. It was calculated to be 250 kg/ha/yr. It rose to 666-3,049 kg/ha/yr (average 1,367 kg/ha/yr) in all fourteen ponds of six adopted villages. The gain after scientific adoption of fish culture was of 1,117 kg/ha/yr.

Area saturation model of freshwater aquaculture technology demonstration for livelihood development of tribal farmers of Niladriprasad Gram Panchayat of Banpur Block, Khordha District, Odisha was undertaken by ICAR-CIFA during 2015-2016 [12]. The fish production was enhanced 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. A total of 6,171 kg of fish were harvested during the culture period of 6.5 months and the estimated average fish production was 1,372.6 kg/ha/yr. In the present study the fish production achieved was in the similar range. Under a DBT (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 baseline value of 250 and 408 kg/ha/yr respectively [19]. Through a participatory approach, KVK (Khordha), Kausalyaganga mobilized communities, stocking ponds and adopted all Scientific Management Practices in Khordha District of Odisha. During 2011-13, it demonstrated fish culture in five community ponds covering an area of 6 ha. An average production of 2,241 kg/ha/year was achieved against the farmer's practice of 1546 kg/ha/yr [20].

3.4. Livelihood development

The direct interaction with people regarding their need, motivating the whole community (including youth and women) towards aquaculture, regular visits to their place, supply of inputs, demonstration and time to time trainings on various aspects of aquaculture enabled them to take the

aquaculture in a scientific way. Many studies have shown that livelihood interventions that are successful during the project support period to ultimately fail after the project support is removed. Reasons are many for this like prevalent poor resource, literacy, marginal economic condition of tribals along with their inability to cope with changing social, economic and ecological contexts. In this study ICAR-CIFA provided them the technical support for continuation of scientific aquaculture practices in their ponds as and when they needed.

The survey has revealed that the tribal farmers are engaged with different types of primary agricultural practices and aquaculture comes as secondary or tertiary option may be due to lack of scientific idea for it and poaching. Hence, the ponds were found abandoned in those villages. 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 [21]. People-centered approaches have identified that seasonal ponds are especially attractive for people who are poor, first time fish farmers or risk-averse farmers. The utilization of the ponds available not only increases their economic condition, rather it may support their nutritional security in respect of availability of animal protein at family level.

4. Conclusion

The ICAR-CIFA is on wheel of planning and executing the available technologies for aquaculture development of the farmers in the studied areas with support of TSP. The direct interaction with people regarding their need, motivating the whole community (including youth and women) towards aquaculture, regular visits to their place, supply of inputs, demonstration and time to time trainings on various aspects of aquaculture has enabled them to take the aquaculture in a scientific way. By the this first time adoption the fish production from their ponds could increase from 250 to an average of 1,367 kg/ha/yr.

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