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Intelligent application of Indigenous farm made fish feeds for sustainable production of Indian Major Carps (IMCs) in carp polyculture system in some selected region of Ganjam District of Odisha.

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Abstract

Carp polyculture is one of the most evolved and scientifically proven systems of aquaculture in the development of aquaculture enterprises in developing countries. Small and marginal fish farmers of developing countries often resort to semi intensive fish farming in the small sized earthen and un-drained aquaculture ponds. Natural pond productivity and supplementary feeding are key determiner for higher aquaculture production. But farmers cannot afford to rising cost of commercial fish feeds. To maintain enhanced production they rely on alternative indigenous farm made fish feeds to feed the cultured fish. Our study conducted in six different blocks (Aska, Bellguntha, Bhanjanagar, Polasara, Rangeilunda and Surada) of Ganjam district of Odisha to investigate the quality and quantity fish production due to application of locally available farm made fish feeds. In total 165 small and marginal fish famers (men and women) were interviewed. Out of them 109 farmers solely depend on farm made fish feeds and 56 farmers use both farm made fish feeds and commercial fish feeds. Locally available ingredients used in farm made fish feed production are commonly groundnut cake, mustard cake, Til cake, Rice bran, Cow dung, Wheat bran. Out of nearly 60% respondents produce and apply fish feeds without scientific protocol or proper standardization of formulation of fish feeds. Due to lack of proper knowledge about the nutritional content of traditional or farm made fish feeds, small marginal rural farmer can not apply the feed in desirable qualities. For which the fish production is not optimized under culture condition. Maximum production per acre achieved is 1.478 tons and 1.679 tons taking both the cases but it can be optimized to about 3-4 tons per acre as seen in several research studies. There is a mean production gap of 126.67 Kg per acre is observed between two types of interventions and difference of mean of profit margin found to be INR 21,461. So, Small scale farmers should be trained for preparation of fish feeds with balanced nutrients for sustainable and increased carp production towards their food and economic security.

Key words
Intelligent application. Indigenous. farm made fish feeds. Sustainable production. Indian Major Carps. Ganjam. Odisha

Introduction

Aquaculture sector is showing rocketed growth among the animal food production sector in developing world for supplying nutrient rich food, increasing income, generating employment, boosting livelihood, food and nutritional security (Sultana et al., 2016). The growth of nearly 3% per annum during 1961– 2017 which is double as compared to the rate of population growth (FAO, 2020).Global fisheries and aquaculture productions reached a value of 214 Mt in 2022 with an animal production of 178 Mt including 90.3 Mt from capture fisheries and 87.5Mt from aquaculture (62.2% inland) (SOFIA,2022).Fish and shell fish diversity in Indian water contribute to 10% of global biodiversity and numbers of species is 3137 with additional 462 exotic species (Lal and Jena, 2019).The aquaculture sector is glorifying the Indian economy and rejuvenating the foreign exchange earnings. India stands at second position in fish production since 2017.In addition to the contribution towards food and nutritional security it offers livelihood and employment opportunity to millions of people. Due to declining contribution of Agriculture to gross National GVA agricultural sector taking a diversified momentum towards a most profitable and lucrative sector like fisheries as blue revolution initiative. Between 1950-1960 fisheries was a simply livelihood option for the people close to the water bodies but the sector transformed to a large scale commercial sector due to intervention of modern technology with aquaculture interventions in the past four decades (Ayyappan, 2012; Ayyappan et al., 2013).There is a significant increase in contribution of fishery enterprise to GDP/GVA past years. It is increased from 0.46% to 1.24% between 1950-51 and 2018-19 at current prices. In the same period the contribution towards agricultural GDP/GVA significantly increased from 0.84% to 7.28% and scaled to INR 212915 crores (of total National GVA INR 17139962).The resultant effect is an indicator of increasing agricultural revenue, boosting export potential and doubling the farmers income(Kumar,2020). Odisha is one of the coastal state of India stood 4th among the top fish production states of India. Being a maritime state with 480 Kms. of coastline and ample of diverse water resources including 6.85 lakh ha. of freshwater and 4.18 lakh ha. of brackish water potential open of excellent opportunity for fishery development in the state.

Fish production in the state increased from 2.6 lakh MT to 9.91 lakh MT between 2001-2021. The revenue generated in 2000-01 was 1047 crore increased nearly 10 times to a value of 10,825 crores in 2020-21. It contributes to 2.4% of GSDP. By the implementation of many centrally sponsored scheme is is witnessing 11.87% fish production by increasing water area for fish cultivation by about 19.32%.Government is trying to double the fishery production potential to generate the export value to 20,000 crores by effective utilization of inland water resources. Per capita fish consumption also increased from 7.71 Kg to 16.24 Kg between 2000 and 2019-20(NAFB, 2020).

In past decades Odisha was in a state of continuous import of freshwater fishes mainly IMCs from neighbouring state Andhra Pradesh. More is to be done at grass root level to solve the challenges and constraints faced by the farmers and improvement of fish feed application and other technologies and strategies to augment the fish production and productivity in a self sustainable manner. In the same perspective the aquaculture is witnessing the fastest growth during last two decades. It is moving towards a composite culture or polyculture for achieving the highest rate of production. Stocking of two or more compatible fish species with different feeding habit to maximize the fish production complete utilization of available ecological niches in a pond and with best utilization of all feeds is called poly culture or mixed culture or composite culture (Jhingran, 1991). Poly culture targeted to improve fish production in a pond or lake with exploitation of different feeding habit or range of distribution of the compatible and stocked fishes. Rohu, Catla and Mrigal are Indian Major Carps (IMCs) most commonly included in poly culture system in many parts of India where the culture is mostly semi intensive and farmers cultivate them in earthen ponds(Zimmermann et al.,2009).Further, polyculture directed to produce economically viable species plants and animals (most commonly fishes) (Stickney, 2013).

Farmers generally opt for semi intensive and intensive aquaculture practices to boost the fish production. Natural productivity and supply of fish feed to aquaculture system are the primary determiner of aquaculture production and hence supplementary feeding with fish feeds are the irreplaceable part of these interventions. The major challenge in aquaculture practices is the cost of feed which constitute nearly 60% of the cost of entire fish production and the supplementary feed protein is the most expensive one among all the components of commercial fish feed (Yang et al., 2003; Erondu et al., 2006).Poor, small and marginal rural fish farmers cannot afford to supplementary fish feeds due to their high cost or non availability in remote fish culture regions. So, alternate and low cost nutrient rich feed can be viable option for the small marginal farmers to be able to make the aquaculture system sustainable for reaching the highest possible productivity level under semi intensive aquaculture enterprise. Locally available farm made fish feeds can provide a plausible solution to the nutritional challenges in such aquaculture system. Locally available farm made fish feed constituents include cow dung, rice bran, wheat bran, groundnut oil cake, mustard oil cake, Til oil cake. These are rich in abundant crude protein, crude lipid, carbohydrate, dietary fibres, minerals and many micronutrients in abundant quantities as per the estimation (Dawwodu et al.,2012)

But use of these fish feed components in right proportion and its right application in the aquaculture intervention is difficult due to lack of knowledge awareness of the poor rural communities. Deficiency in any nutritional component in such formulated feeds resulted in decline in fish production. Sometimes water quality is deteriorated and organic loading in water body is observed due accumulation of excess feeds or minute fragments of feeds which are not devoured by the fishes (Munguti, 2014). Floating feeds are very useful but some amount of sinking pellet category of fish feeds are not consumed by fishes and unwontedly going waste and sink deep down to the benthic habitat of water body of cultured pond (Yaqoob, 2010). Hence it is highly essential to train the farmers towards intelligent application of locally available farm made fish feeds.

Materials and Methods

Research sites

Six different blocks of the Ganjam districts of Odisha including Aska, Bellguntha, Bhanjanagar, Polasara, Rangeilunda and Surada were included in study of aquaculture system. Two village sites are selected in each block to collect data regarding aquaculture interventions. Fish cultivation ponds of moderate size of around one acre are selected for investigation.

Research design for Data collection

Data from state fishery department and local fishery officials, District Fishery Officer (DFO) and Fishery Extension Officer collected regarding the aquaculture and fishery practices in the district and farmers fishery interventions types in regional basis. On the basis of the secondary data, six different blocks of the Ganjam districts of Odisha including Aska, Bellguntha, Bhanjanagar, Polasara, Rangeilunda and Surada were included in study of aquaculture system. Two fish ponds in the village areas of each site were selected for the study in the villages of these blocks.

Information regarding aquaculture status and farmers involvement was collected from regional fishery offices, DDFOs in Ganjam. Farmer communities are actively participated in the interview process. Well designed and standardized structural questionnaire was prepared prior to interview and executed for the conduction of interview to gather information regarding poly culture intervention, fish feed application, fish production,

Numbers of fish farmers interviewed are in the villages area are 27, 22, 22, 22, 37, 35 of the blocks like Aska, Bellagundha, Bhanjanagar, Polasara, Rangeilunda, Surada respectively. Farmers are interviewed with the use of pre-structured questionnaire with reference to the pond area of the fish culture, economic condition of the farmer, type of fish feed they use, challenges they are facing and the annual production of fishes. Information is cross checked with the help of key informants or expert persons from the same area having a special knowledge of the fishery development in the area including fishery extension officers. Cross checked data finally validated to taken into calculation and final observation for finding outcome of the fishery interventions.

Data Analysis

Collected data is tabulated and analyzed with the help of Microsoft Excel tools. Fish feed application and the production are compared. Mean and standard deviation also calculated. Net gain in two types of intervention is tabulated and compared.

Laboratory estimation of Crude protein, Lipid and dietary fibre estimation

Crude protein estimation in the fish feed samples were made in the laboratory by using Macro-Kjeldahl method. Crude lipid analysed by acid hydrolysis and diethyl ether. Crude fibre calculated by using weende method.

Results and discussion

Poly culture intervention studied in six different blocks of Ganjam district. The study was conducted from June 2022 to May 2023 taking, twelve fish culture ponds. Most of the small and marginal famers have moderate sized ponds(around one acre) only against the larger farmers having large holdings and pond sixe between 5 -10 acres. Small and marginal farmers are ventured into semi intensive fish farming from unregulated traditional fish farming in respect to intensive farming by large stake holders. In the poly culture interventions the IMCs found to be cultured in all the ponds selected for observation. The Catla,Rohu and Mrigal fingerlings size of size nearly 10-15 cm are introduced into the pond with and stocking ratio of 3:4:3 respectively. In total 450 Catla, 600 Rohu and 450 mirgal introduced into the pond.

Large stake holders found to be strongly relied on formulated commercial fish feeds in addition to a small percentage of farm made fish feeds for large scale production in short time. But due to higher cost of the commercial fish feeds farmers of the small, marginal and poor farmers solely depend on the locally available farm made fish feeds. Out of the 165 respondents (fish farmer) 109 farmers accepted that they rarely us the commercial fish feeds. Only 56 farmers acknowledged to use of a small amount of commercial fish feeds in addition to farm made fish feeds. As all the regions are in the rural locations cow dung is available with no cost as Gopal communities of the area have large herds of cows and buffalos. In addition as the region is agricultural hub people conveniently got rice bran collected from rice meals of the area. Further coconut oil cake, Til oil cake and mustard oil cake are also available locally and commonly used in farm made fish formulations. We have estimated some proximate compositions used in local fish feed formulations. The range of crude protein in these constituent varies between 8.1%(in Rice bran) to 43.5%(in ground nut). Similarly Crude lipid estimated to be between 0.55(in cow dung) and 18.9 %(Rice bran), Crude fibre nearly between 1.2% (in Til oil cake) and 49%(in Wheat bran) and the carbohydrate between 13%(Til oil cake) and 54%(Ground nut cake) (Table 1). In addition the availability of other mineral nutrients is also very significant as per the observation of several research studies (Dawwodu et al., 2012).

Table1. Farm made fish feeds used by farmers and their Crude protein and Crude lipid content (per cent) per 100 gm of sample estimated (Dry weight)

Sl. No	Farm made Fish feed	Crude protein	Crude lipid	Crude fiber	Carbohydrate
1	Cow dung	11.2	0.55	22±0.9	21.2±0.3
1	Rice Bran	8.1	18.9	14±0.3	46±0.7
2	Wheat bran	18.6	3.6	49±0.76	17.6±0.9
3	Ground nut Cake	43.5	7.5	3.1±0.16	54.6±0.6
4	Mustard cake	36.3	5.8	12±0.5	20±0.17
5	Til oil cake	35.8	4.7	1.2±0.6	13±0.2

While preparing farm made fish they prepare a mixture containing 10 Kg of cow dung, 2 kg of Bran of normal category and 1 kg of rice bran of sweet category, ½ kg of urea, ½ kg of lime to a total formulation of 13 kg to be used in each week. Along with ½ kg of lime also used. In total nearly 52 kg of these formulation used per acre/month. In average a total of 696 kg of the mixed and formulated feed used per acre/year. Ground nut cake, Mustard oil cake and Til oil cake applied separately in alternate days. This kind of farm made fish feeds application is followed by 109 fish farmers. The cost estimation comes about 3522 (Table 2) Remaining 56 farmers' use commercial and floating fish feeds in addition to the above formulations in alternate week. The additional cost accrued due to commercial fish feed use is calculated to be INR 12,000 to a total of INR 15522(Table 3)

Table2. Cost of farm made fish feed (INR per Kg) and total cost per annum used per acre of pond for farmer solely depend on farm made fish feeds

Sl. No.	Farm made fish feed component	Price per Kg(in INR)	Total use per acre of pond per year in Kg	Total cost in INR
1	Cow dung	Nil	240	Nil
2	Rice Bran Normal	6	96	576
3	Rice Bran(sweet type)	22	48	1056
4	Rashi or Til oil cake	30	30	900
5	Ground nut cake	32	20	640
6	Mustard oil cake	35	10	350
Total			**444**	**3522**

Table.3. Cost of farm made fish feed (INR per Kg) and total cost per annum used per acre of pond for farmer solely depend on farm made fish feeds

Sl. No.	Farm made fish feed component	Price per Kg(in INR)	Total use per acre of pond per year in Kg	Total cost in INR
1	Cow dung	Nil	240	Nil
2	Rice Bran Normal	6	96	576
3	Rice Bran (sweet type)	22	48	1056
4	Rashi or Til oil cake	30	30	900
5	Ground nut cake	32	20	640
6	Mustard oil cake	35	10	350
7	Commercial fish feed (Growfin)	60	300	12000
Total			**744**	**15522**

Fig.1 and 2.Farm made fish components are thoroughly mixed before application Cost of ancillary components like

Table.4. Ancillary Cost for fish pond management per acre in INR

Sl. No.	Ancillary component	Cost per piece Kg	Total use per acre of pond per year in Kg	Total cost in INR
1	Lime	INR 35	300	10,500
2	Urea	INR 120	10	1200
3	Biofit Probiotic	INR 1000	10	10000
Total			**320**	**21,700**

Table.5. Total investment in pond aquaculture per year in INR

Sl. No.	Component	Total cost in INR
Type 1 pond	Fingerling of total 1500@ INR 1.5	2250
	Fish feed	3522
	Lime + Urea+ Biofit	21700
Total investment		**27472**
Type 2 pond	Fingerling of total 1500@ INR 1.5	2250
	Fish feed	15522
	Lime + Urea+Biofit	21700
	Total	**39472**

Type 1 pond –Only the use of farm made fish feed.
Type 2 pond – Use of farm made fish feed and commercial fish feed

Fig.3 and 4. Floating fish feeds

We have monitored the pond management carried out be respective fish farmer. In the month of some large sized fish are harvested in the month of March and final harvest was made in the month of May. The average survival rate observed in all these locations was found to be 90% for Rohu 87% for Mrigal and 86% for Catla. With proper management with the use of farm made fish feeds and farm made fish feed with some amount of commercial fish feeds reflected difference in fish production in both cases. With the introduction of same numbers of fingerlings the mean production ins found to be less in type 1 intervention (Table 6) as compared to the type 2 intervention (Table 7). Difference in mean of production is found to be 126.67 Kg (Tablem 8). Mean and standard deviation is calculated in both the cases(Table 6,7 and 8) and found to be significant. Further, the revenue generated in intervention with the addition of commercial fish feeds had given a profit of nearly 21,461.

Table6. Fish production in six sampling ponds (each one acre pond area) with the use of mainly farm made fish feeds and revenue generated in INR

Sl. No	Fish species	Production in different ponds in Kg						Total in Kg	Average in Kg	Revenue generated in INR
		A 1	B 1	C 1	D1	E1	F 1			
1	Rohu	480	488	475	504	491	501	2939	489.83	88,169.40
2	Catla	455	464	471	459	502	461	2812	468.66	74,985.60
3	Mrigal	431	439	455	445	461	459	2690	448.33	76,216.10
	Total	1366	1391	1401	1408	1454	1421			
	Revenue	86400+ 72800+ 73270 =	8784 0+7 4240 +74	85,5 00+ 7536 0+7	90,7 20+ 7344 0	8838 0+8 0,32 0+7	9018 0+7 3760 +78	Mean of total =2,39,	Standard deviation = 4945.1943	

	Total	2,32,470	630 = 2,36,710	7350 =2,38,210	+75650 =2,39,810	8370 =2,47,070	030 =2,41,970	362	

Pond located on region denoted by with the use of farm made fish feed only A 1 – Aska, B 1 – Bellaguntha, C 1 – Bhanjanagar, D 1 – Polasara , E 1 – Rangeilunda, F 1 Surada

Table7. Fish production in six sampling ponds (each one acre pond area) with the use of Both commercial and farm made fish feeds and revenue generated in INR

Sl. No	Fish species	Production in different ponds in Kg						Total in Kg	Average in Kg	Average Revenue generated in INR
		A 2	B 2	C 2	D2	E2	F 2			
1	Rohu	522	516	525	533	497	537	3130	521.66	93900.00
2	Catla	503	494	512	524	494	526	3053	508.83	81413.30
3	Mrigala	502	491	504	513	492	516	3108	503	88060.00
	Total	1527	1501	1541	1570	1483	1579			
	Revenue Total	93960+80480+85340=2,59,780	92880+79040+83470 = 2,55,390	94,500+81920+85,680=2,62,100	95,940+83840+87210=2,66,990	89460+79040+83640=252140	96660+84160+87720=268540	Mean of total =2,60,823.33	Standard deviation 6406.474	

Pond located on region denoted by with the use of commercial fish feeds alon g with farm made fish feed A 2 – Aska, B 2 – Bellaguntha, C 2 – Bhanjanagar, D 2 – Polasara , E 2 – Rangeilunda, F 2 - Surada

Table8. Fish production in 12 sampling ponds (each one acre pond area) in both mode of operation and cost benefit calculation

Pond type	Total investment in INR	Mean of total fish production in Kg	Mean of Revenue generated in INR	Differences in investment in INR	Difference in Fish production in Kg(Mean)	Difference in profit in INR
Type 1	27472	1406.83	2,39,362			
Type 2	39472	1533.50	2,60,823			21,461
Mean of Two sample		1470.16	2,50,092.5	12,000	126. 67	
Standard deviation		89.569	15175.22			

Conclusion

Nutritive values of the different types of ingredient used at the time of fish feed application is not known to most fish farmers(nearly 97.2%) and they never consider the nutritional requirement of different fish which are cultivated in the poly culture system. Respondents do not have idea of fish feed formulation from the ingredients but, mix up the available feeding constituents without proper weight or right or desirable proportions. For this net production per acre is maximum around 1.5 tons per acre. But semi intensive culture can give a production of 3 – 4 tons per acre per year. So there is a huge gap lies in optimization or all the management including water quality parameters and feed applications. Sufficient scientific and technological training must be imparted to these marginal and poor rural communities for the sustainable livelihood by intelligent utilization of water resources by intelligent application of farm made fish feeds for a sustainable future.

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