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Research article

A first experiment on cage culture of *Catla catla* in back water of Shankar Sagar reservoir, Vishnupuri Project Dist. Nanded, Marathwada (Maharashtra)

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Key words: Cage culture, *Catla catla*, Nanded, Marathwada, Daily growth rate.

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Abstract

This is the first attempt for cage culture in Marathwada Maharashtra State, Results of the experiments showed that Marathwada can be potential area for cage culture. The growth performance of *Catla catla*, in natural and in artificial feeding cages in terms of final weight, weight gain percentage, specific growth rate (SGR %), Daily growth rate (DGR), survival rate and total production was described in text. Their final weight was 6.25±0.62, 10.39±4.18, 22.06±8.14, 38.69±20.2, 64.73± 17.7 and 111±17.2gm for I, II, III, IV, V and VI th months respectively in natural feeding cage. Their final weight was 7.98±1.23, 15.27±3.75, 42.53±9.23, 84.83±19.85, 182.96±21.14 and 260±11.77 gm recorded in I, II, III, IV, V and VI th months respectively. In natural feeding cage, mean weight 111 gm of *Catla catla* was attained whereas in supplementary feeding cage 260 gm was recorded in 180 days of culture period. The total fish production of *Catla catla* in 180 days in cage culture with natural feeding was 7.8 kg. Whereas it was 20.3 kg in supplementary feeding cage.

Introduction

Aquaculture is the use of water resources for growing aquatic organisms under controlled conditions for economic and social benefits. Although it is not agriculture, it can make a unique contribution to nutrition by virtue of its extremely high productivity and protein content [2]. Aquaculture is a growing industry that strives to optimize and intensify traditional fish rearing techniques to supply much needed protein for humans, but also meet the needs of luxury demand and it contributed 51.7 million tonnes to total world production, including 31.6 million tons from inland waters [12]. Fish is one of the important sources of high-quality protein and provides at least 2.9 billion people with around 15% of their dietary protein [12]. Fish and fish oils are also a balanced source of protein components and essential fatty acids contents in human diets [19]. Fish and fishery products are of substantial social and economic importance and are worth around US$170 billion annually and employ up to 47.5 million people worldwide [12]. Due to increasing world population and decline of production from capture fisheries, aquaculture is expected to play a crucial role in meeting the increased demand of high quality protein rich food [8]. More than half of the world's aquaculture production is from freshwater [12] and the bulk of production occurs in the world's most popular nations, such as China and India [11].

Indian share in the global production has reached 4.36 percent with 9.92 percent share in inland and 2.8 percent in marine in 2009. For inland sector India is ranked second after China [28].

The origin of cage culture is a little vague. It can be assumed that at the beginning fishermen may have used the cages as holding structures to store the captured fish until they are sent to the market. The first cage which was used for producing fish was developed in Southeast Asia at the end of the 19th century. Wood or bamboos were used to construct these cages and the fish were fed by trash fish and food scraps. In 1950s modern cage culture began with the initiation of production of synthetic materials for cage construction. Cage culture is common in central and South East Asian countries such as China, Philippines, Indonesia and Thailand [3-6].

Fish production in cages became highly popular among the small or limited resource farmers who are looking for alternatives to traditional agricultural crops. Cage culture is advantageous for farmers as it offers a chance to maximum utilization of existing water resources. Therefore, the farmers do not have to invest on accumulating water. Cage aquaculture has certain advantages over other aquaculture systems that are potentially important in terms of uptake by rural poor and landless people. The integrity of cage unit means that large, communal water bodies can be used effectively and the ability to culture fish is not reliant on the ownership or leasing of land itself. Hence in theory, where access to a

water body can be achieved, landless people can grow fish in cages and obtain nutrition and income from the fish produced. In addition a common problem in traditional pond culture is that of multiple ownership. In cage aquaculture the ownership issue is very simple, in that owners of the cages are the owners of the fish within. Generally fish in cages do not escape, provided a top net is present and the cage remained undamaged. Cages also exclude predators and caged fish are easily managed and harvested. The culture of fish in cages can therefore be described as a promising aquaculture technology already proven in many other Asian countries [9].

The origin of the use of cages for holding and transporting fish for short periods can be traced back to almost two centuries ago in the Asian region [24]. Several species of marine fishes such as *E. tauvina, L. calcarifer* and *Lutjanus sp*. are cultured in cages in Singapore [17].

On the basis of the reported information, the major cage culture producers in 2005 are: Norway (652, 306 tonnes), Chile (588, 060 tonnes), Japan (272, 821 tonnes), United Kingdom (135, 253 tonnes), Vietnam (126, 000 tonnes), Greece (76, 577 tonnes), Turkey (78, 924 tonnes) and Philippines (66, 249 tonnes) [25].

In India freshwater fishes raised in cages are essentially from family cyprinids comprising Indian major carps *(Catla catla, Labeo rohita* and *Cirrhinus mrigala),* exotic common carp *(Cyprinus carpio)* and silver carp *(Hypophthalmichthys molitrix).* Catfishes of the families Bogridae *(Mystus Seenghala),* Siluridae *(Ompok bimaculatus),* Anabantidae.*(Anabas testudineus)* and Heteropneustidae *(Heteropneustes fossilis)* have also given encouraging results when cultured in cages, especially the last 3 air breathing species. Cage culture of murrels (Channidae), viz. *Channa punctatus, Channa marulius* and *Channa striatus***,** has also been occasionally tried. During the last decade, culture of different fish species in cages was actively pursued. The species selected for cage culture, limnological conditions, types of cages, construction material, cage dimension and feed formulation varied very much in the experiments so far conducted in different ecosystems [14].

In India cage culture was attempted for the first time in cage of air breathing fishes like *Heteropneustes fossilis, Anabas testudineus* in swamps [10]. At Powai Lake, Mumbai shows that, *Labeo rohita* grew from 3.24 gm to 54.72 gm within 43 days with survival of 50.72%. Whereas during the same period *Cyprinus carpio* with a density 50 No/m^3 grew from 0.293 gm to 31.34 gm with a survival of 75.26% [15]. [7] Conducted study to determine and compare the growth and survival of *Labeo rohita* fry reared at different stocking densities in cages for optimization of stocking rate in Beel of Assam. Another experiment conducted by [21] on Growth, survival and production of carps fingerlings under different stocking densities in cages and pens in Dimbhe reservoir, Pune Maharashtra.

Marathwada is one of the most important parts of Maharashtra state. Fresh water resources of Marathwada are rivers, reservoirs, ponds, lakes, etc. out of them river Godavari is the important river and many projects are constructed in the basin of river Godavari and its tributaries such as Jayakwadi (Aurangabad), Mazalgaon (Beed), Purna Yeldari (Parbhani), Lower Terna (Beed), Purna Siddheshwar (Hingoli), Manar (Nanded) and Manjra (Latur) etc. and many more are being constructed in this river system. These projects are used to perform various activities such as irrigation, agriculture, domestic, industrial and aquaculture etc.

These resources can be used for Cage culture as cage culture practice in Marathwada is yet to start. If culture of fishes in cages becomes successful then this will be a boon for fishermen and will open a new chapter in fisheries development of Maharashtra. Hence this study was undertaken which will lead to "BLUE" revolution.

Experimental

Materials and Methods

Study area

One of the largest lift irrigation projects in Asia was constructed on the river Godavari, at Asarjan, Dist. Nanded for irrigation and water supply, in the year 1988. The back water of this project at Dhangar Takli 19°7'12"N 77°3'28"E was selected as a study area.

Site Selection

Site selection is the most important part of the cage culture. Proper site will reduce most of the problems arising during the culture period and also reduce the cost of culture.

Criteria for site selection

Lakes, reservoirs, ponds, quarries, rivers and streams can be used as potential sites provided that they should have adequate water with sufficient depth, so that cage can be arranged in this sediment free water. The cage units should be built to withstand against prevailing wind and wave conditions. Good water exchange is also an important factor to replenish oxygen and flush away wastes. Considering these factors we surveyed 40 km back water area for selection and then, Dhangar Takli, a small village situated on the bank of Godavari river was selected. It is about 8 km from Purna (Dist. Parbhani) on Nanded – Purna road.

Fabrication of cages

Cages were fabricated from strong, durable, and non-toxic iron material with suitable size mesh. The cage mesh should allow maximum flow of water through it and adequate flowing of oxygenated water is good for health of the fish and removes wastes from the cage.

Cage materials

Normally cage components consist of a frame, mesh or netting, feeding ring, lid, and floats. Cage may be round, square, or rectangular and all the materials which are used to fabricate according to the type of cage. The size of experimental cages was 6' X 4' X 4' and it was kept in submerged condition. Study area was the back water of Shankar Sagar reservoir. Farmers use this water for irrigation. The frame of the cages was made from iron square pipes by doing gas welding. The size of the mesh net was 1.8 cm and it was so small that it allows water to enter in the cages and prevents escape of fishes from cages. An opening was kept at the top for handling the fishes and also to provide food to them.

All sides of cages were covered with mesh except bottom. The galvanized sheet was fixed at the bottom by using nut and bolt. After fabrication cages were painted by using red oxide and sky blue oil paint, the mesh sheet was fixed to the frame with the help of binding wire. Feeding ring was fitted at the upper side of cage.

Selection of fish species

According to ecological niches and economic importance *Catla catla* was selected for culture in cages.

Stocking of fish

Fingerlings of *Catla catla* was collected from Talni Pvt. Fish Seed farm. Tq. Biloli Dist. Nanded. Fingerlings was conditioned and brought in oxygenated polythene bag. Before stocking, length and weight of individual fish was measured and kept in different sets, one set with artificial food and second set was without artificial food i.e. with natural food. The stocking density was 100 fingerling/72 cubic foot. (Table No. 2)

Feeding

After stocking fishes were fed with commercial pelleted feed brought from Krishi Vigyan Kendra, Karda Tq. Risod Dist. Washim, as per their body weight i. e. 5% of their body weight, in the morning hours at 7:00 am every day.

Table 1. shows the ingredients and formulation of artificial feed to fishes in cages.

Sr. No	Ingredients	Inclusion level (%)
1	Ground nut oil cake + Rice bran	25
2	Soya bean cake	25
3	Maize powder	40
4	Fish powder/ Trash fish powder	09
5	Mineral mixture	01

Table 2. Shows stocking density and doses of feed.

Particular	Cage I		Cage II	
Stocking density	100 Fingerlings /72 cubic feet. Average length: 2 cm	1.3 fingerling/ cubic foot	100 Fingerlings /72 cubic feet. Average length: 2 cm	1.3 fingerling/ cubic foot
Feeding	Once in a day 5% body weight		No artificial feeding	
Feed ingredients	Pellet feed		Natural food	

Cage management

Cages were cleaned regularly before feeding, to remove dead fishes, uneaten food etc. to keep the environment good for fish. The cages were lifted partially from water every 8 days before feeding, to check the damage and remove algal blooms.

Checking and measurement of fishes

At regular interval fishes were harvested by a hand net from the cages to record length and body weight in cm and gm respectively.

Culture Period

Fingerlings were cultured in cages for 180 days.

Water Quality Parameters

During the study important limnological parameters such as Temperature, pH, Transparency, Total alkalinity, Dissolved Oxygen (DO), Free Carbon dioxide (CO_2), Chloride, Hardness, Calcium, Magnesium, and Productivity were analyzed by using standard method as suggested in [1].

Result and Discussion

Growth and Production Performance of *Catla catla* in Cage culture

The growth performance of *Catla catla*, in natural and in artificial feeding cages in terms of final weight, weight gain percentage, specific growth rate (SGR %), Daily growth rate (DGR), survival rate and total production are shown in table No.1 & 2.

Mean weight

The mean initial length of *Catla catla* was 2, 6.5, 9, 12.7, 17.7 and 20.4 cm for I, II, III, IV, V and VI th months respectively. Their mean final length was 6.5±0.52, 9±1.10, 12.7±1.09, 17.7±1.41, 20.4±1.42 and 23.3±1.81 cm for I st, II nd, III rd, IV th, V th and VI th months. Their final weight was 6.25±0.62, 10.39±4.18, 22.06±8.14, 38.69±20.2, 64.73± 17.7 and 111±17.2gm

for I, II, III, IV, V and VI th months respectively in natural feeding cage.

In artificial feeding cage, the mean initial length was 2.1, 7.8, 10.2, 14.8, 20.3 and22.4 cm their mean final length was 7.8±0.44, 10.2±0.94, 14.8±0.82, 20.3±1.08, 22.4±1.21 and 26±0.87 cm in I, II, III, IV, V and VI th months respectively. Their final weight was 7.98±1.23, 15.27±3.75, 42.53±9.23, 84.83±19.85, 182.96±21.14 and 260±11.77 gm recorded in I, II, III, IV, V and VI th months respectively. In natural feeding cage, mean weight 111 gm of *Catla catla* was attained whereas in supplementary feeding cage 260 gm was recorded in 180 days of culture period.

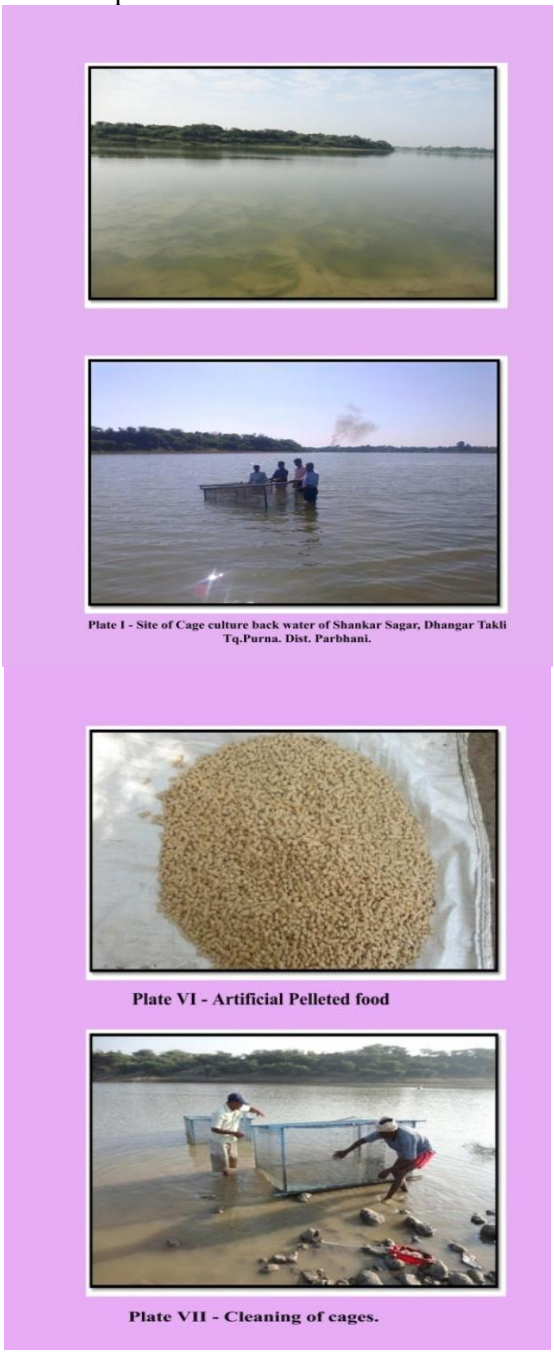


Figure 1. Site of Cage culture, Artificial pelleted food and cleaning of cages.

Figure 2. Harvested *Catla catla* fishes from cages

Weight gain %

Weight gain % is one of the important growth parameter. In natural feeding cage, the percentage of weight gain was 212.5, 66.24, 112.3, 75.38, 67.30 and 71.48% whereas in supplementary feeding the weight gain percentage was 262.7, 91.35, 178.5, 99.45, 115.6 and 42.10 % in I, II, III, IV, V and VI th months respectively.

Specific growth rates (SGR)

The variations of specific growth rates (SGR) with treatments are given in Table 1 and 2. The treatments in natural feeding attained the least mean SGR154.2%/day/fish, 86.8%/day/fish, 55.43%/day/fish, 38.9%/day/fish, 13.8%/day/fish and 14.16%/day/fish, respectively.

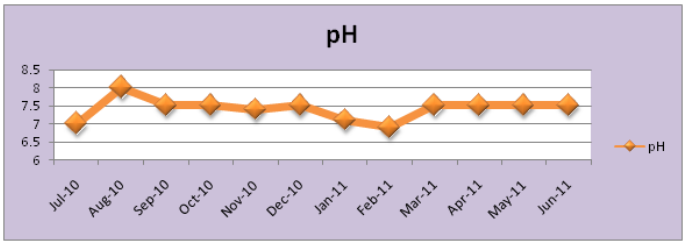


Figure 3. pH of river Godavari at Dhangar Takli from July 2010- June 2011.

The fish attained the maximum mean SGR 256.8%/day/fish and the minimum mean SGR 19.2%/day/fish among the supplementary feeding cage. In natural cage had significantly lower specific growth rate than the feeding one.

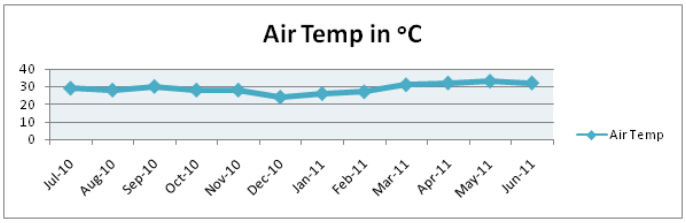


Figure 4. Air Temperature of river Godavari at Dhangar Takli from July 2010- June 2011.

Daily growth rates (DGR)

Mean daily growth rates were calculated between natural feeding cage and supplementary cage. The maximum (mean) (1.54 gm / day) and minimum (mean) (0.13gm /day) daily growth rates were observed in natural cage, A mean daily growth rate of 3.2 g / day, 2.5 g / day, 1.41g / day, 0.90 g / day, 0.24 g/ day and 0.19 g / day was recorded in supplementary feeding cage.

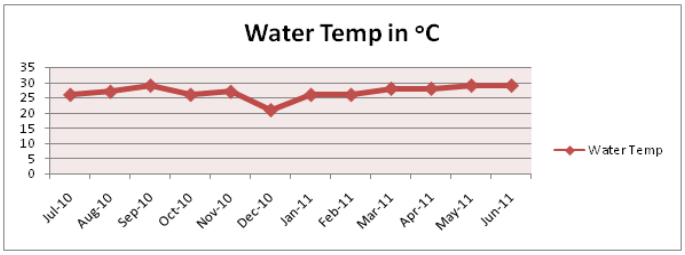


Figure 5. Water Temperature of river Godavari at Dhangar Takli from July 2010- June- 2011.

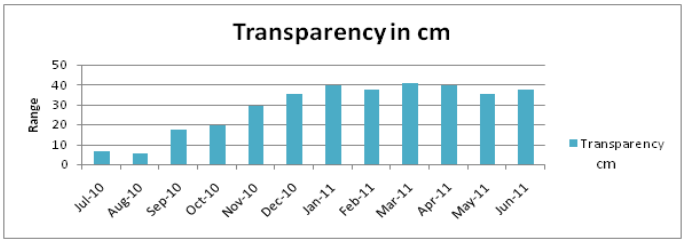


Figure 6. Transparency (cm) of river Godavari at Dhangar Takli from July 2010- June – 2011.

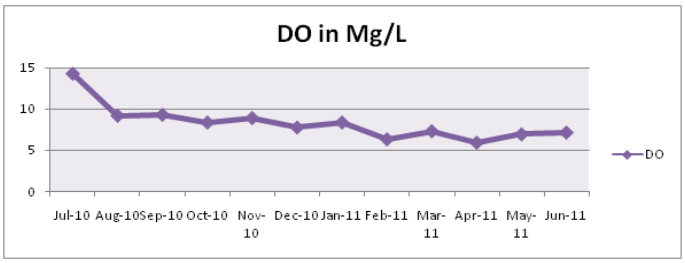


Figure 7. DO (mg/L) of river Godavari at Dhangar Takli from July 2010- June – 2011.

Mortality %

Mortality of the fish in natural feeding cage was high as compared to supplementary feeding cage. In supplementary feeding cage 22 fishes were dead in first week. Afterwards there was no mortality among the fishes. In natural feeding cage, 29 fishes died during the first 15 days of experiment.

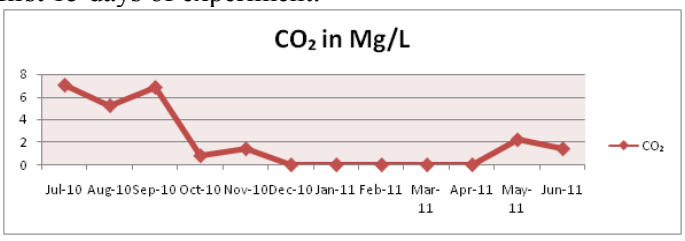


Figure 8. CO_2 (mg/L) of river Godavari at Dhangar Takli from July 2010- June – 2011.

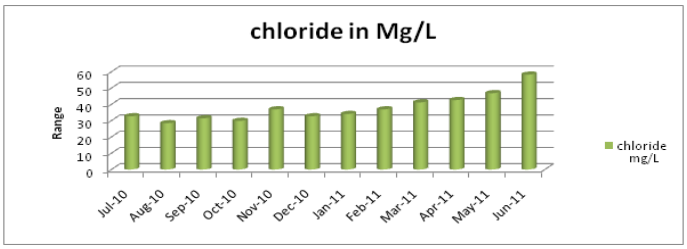


Figure 9. Chloride (mg/L) of river Godavari at Dhangar Takli from July 2010- June – 2011

Survival %

Survival rate was 71% for natural feeding cage, whereas it was 78% in Supplementary feeding cage. Most of the deaths were encountered in the first fifteen days of the experiment period.

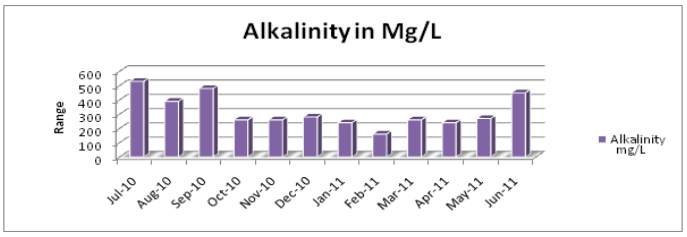


Figure 10. Alkalinity (mg/L) of river Godavari at Dhangar Takli from July 2010- June – 2011.

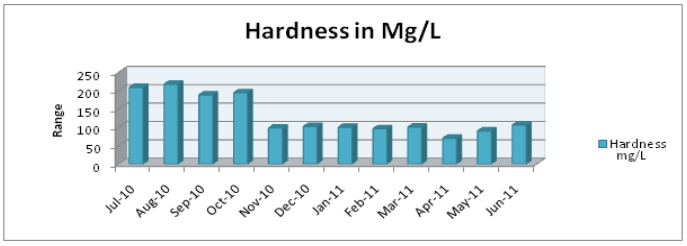


Figure 11. Hardness (mg/L) of river Godavari at Dhangar Takli from July 2010- June – 2011.

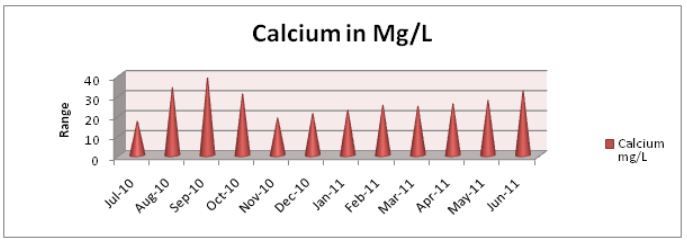


Figure 12. Calcium (mg/L) of river Godavari at Dhangar Takli from July 2010- June – 2011.

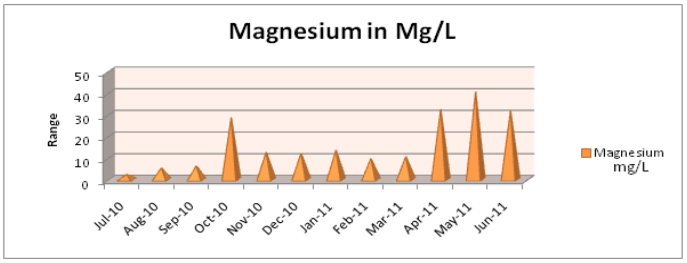


Figure 13. Magnesium (mg/L) of river Godavari at Dhangar Takli from July 2010- June – 2011.

Yield/ Total Production

The total weight gained (yield) for each treatment per cage is reported in Table 1 and 2. The weight increases were significantly different with and without supplementary feeding experiments. The total fish production of *Catla catla* in 180 days in cage culture with natural feeding was 7.8 kg. Whereas it was 20.3 kg in supplementary feeding cage.

Table Analyzed	One-way ANOVA data
Column B	Artificial Feed
vs.	vs.
Column A	Natural Feed
Unpaired t test with Welch's correction	
P value	< 0.0001
P value summary	****
Significantly different? (P < 0.05)	Yes
One- or two-tailed P value?	Two-tailed
Welch-corrected t, df	t=11.33 df=98.72
How big is the difference?	
Mean ± SEM of column A	23.36 ± 0.2156, n=71
Mean ± SEM of column B	26.05 ± 0.09916, n=78
Difference between means	2.690 ± 0.2373
95% confidence interval	2.219 to 3.161
R squared	0.5654
F test to compare variances	
F,DFn, Dfd	4.305, 70, 77
P value	< 0.0001
P value summary	****
Significantly different? (P < 0.05)	Yes

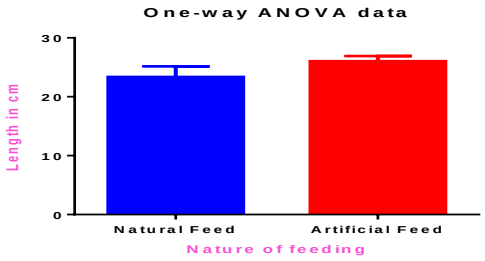


Figure 14. t test with Welch's correction for Length of *Catla catla* (Cage culture).

Table Analyzed	One-way ANOVA data
Column B	Artificial Feed
vs.	vs.
Column A	Natural Feed
Unpaired t test with Welch's correction	
P value	< 0.0001
P value summary	****
Significantly different? (P < 0.05)	Yes
One- or two-tailed P value?	Two-tailed
Welch-corrected t, df	t=61.17 df=122.1
How big is the difference?	
Mean ± SEM of column A	111.0 ± 2.044, n=71
Mean ± SEM of column B	260.3 ± 1.333, n=78
Difference between means	149.3 ± 2.441
95% confidence interval	144.5 to 154.1
R squared	0.9684
F test to compare variances	
F,DFn, Dfd	2.141, 70, 77
P value	0.0012
P value summary	**
Significantly different? (P < 0.05)	Yes

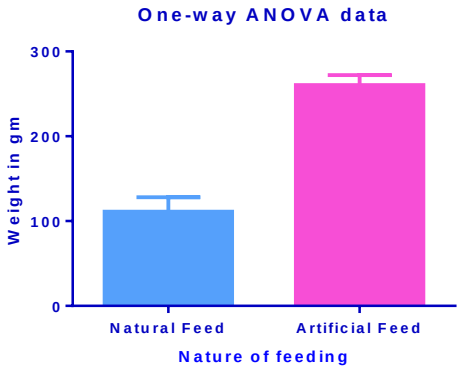
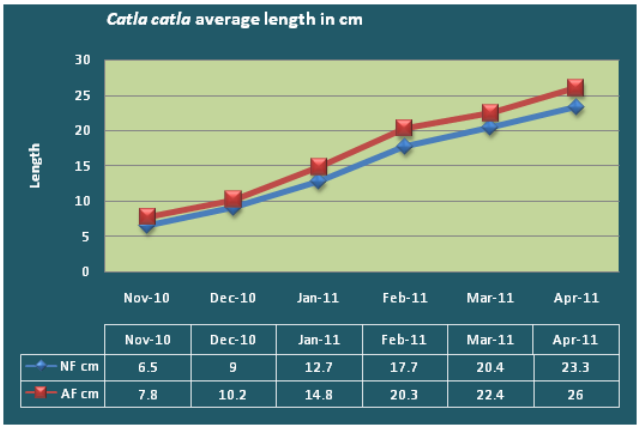


Figure 14.1. t test with Welch's correction for weight of *Catla catla* (Cage culture).

The one way ANOVA was tested for length of *Catla catla* the natural feed caged fishes and supplement feed caged fishes described in Figure 15. The Welch's corrected t test was 11.33 whereas degree of freedom was 98.22, these results were found significant at P <0.05.

The F test performed for comparison of variance this was also significantly different i.e. P <0.05 for length of *Catla catla.*



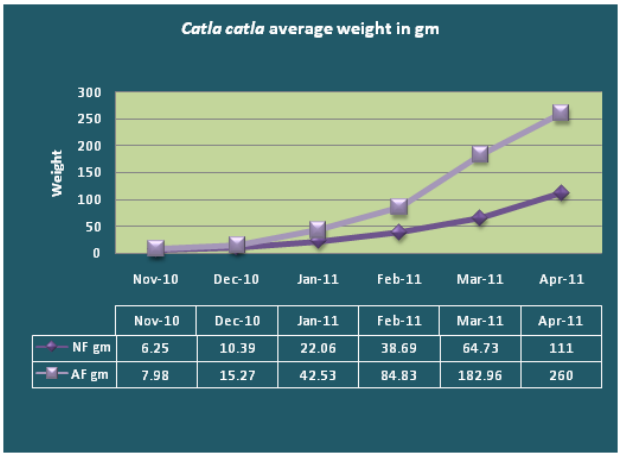


Figure 15. Monthly average length and weight of Catla *catla* in cage culture.
NF- Natural Feeding
AF- Artificial Feeding

In relation to weight the P-value calculated by using one way ANOVA depicted in Figure 14.1. The P-value for the weight was significantly different i. e. P <0.05. The Welch's corrected t test was 61.77 and the degree of freedom was 122.1 observed at 95% confidence interval. The comparison of variances for F-test F value, degree of freedom numerator (Dfn) and (Dfd) were 2.141, 70 and 77 respectively. The P-value observed was 0.0012 and hence the weight of the *Catla catla* was significantly different in natural feed and artificial feed caged fishes. Hence this study shows significant difference.

Water quality parameters

Water quality parameters were analyzed in this experiment to observe any appreciable changes that might

have occurred in response to cage culture. Physical parameters like temperature, pH and transparency and chemical parameters such as dissolved oxygen (DO), Free Carbon dioxide (CO_2), Chloride, Alkalinity, Hardness, Calcium and Magnesium were measured for monthly interval throughout the study period. All the parameters were more or less within the acceptable range for fish culture. Mean values (±SD) of water quality parameters of different treatments are shown in Table 3.

Table 3. Physico chemical parameters of river Godavari at Takli from July 2010- June 2011.

Months	pH	Temperature (°C)		Transparency (cm)	DO mg/L	CO_2 mg/L	Chloride mg/L	Alkalinity mg/L	Hardness mg/L	Calcium mg/L	Magnesium mg/L
		Air	Water								
July	7	29	26	6.5	14.28	7	32.66	530	208.6	16.83	2.40
August	8	28	27	5.5	9.18	5.2	28.4	390	217.2	33.66	5.36
September	7.5	30	29	17.5	9.3	6.8	31.4	480	188	38.47	6.33
October	7.5	28	26	19.5	8.36	0.8	29.82	260	194	30.46	28.75
November	7.4	28	27	29.5	8.9	1.4	36.92	260	98	18.43	12.66
December	7.5	24	21	35.5	7.75	Nil	32.66	280	102	20.84	12.18
January	7.1	26	26	39.5	8.36	Nil	34.08	240	100	22.44	13.62
February	6.9	27	26	37.5	6.32	Nil	36.92	160	96	24.84	9.74
March	7.5	31	28	40.5	7.3	Nil	41.18	260	100.6	24.28	10.72
April	7.5	32	28	39.5	5.91	Nil	42.6	240	70	25.65	32.45
May	7.5	33	29	35.5	6.93	2.2	46.86	270	90	27.25	40.59
June	7.5	32	29	37.5	7.14	1.4	58.22	450	106	32.06	31.82
SD	±0.29	± 2.69	±2.20	± 13.00	±2.17	±2.70	±8.49	±114.71	±53.71	±6.44	±12.65

In India *Catla catla, Labeo rohita, Cirrhina mrigala, Ctenopharyngodon idella, Hypophthalmichthys molitrix, Cyprinus carpio* and *Channa Sps* are important particularly for freshwaters, [23]. Lipton [18] fed the cage reared *Heteropneustes fossilis* regularly with artificial pelleted feed at the rate of 3% body weight. Murugesan *et al.,* [22] reported that the quantity of the feed given to the stock depends on the utilization and it works to 3 to 5% body weight of the cage reared air breathing fishes. Luchini *et al.,* [20] conducted the first experimental cage culture of South American catfish *(Rhamdia sapo)* in the Salto Grande Reservoir Entre Ríos. Argentina from January to May 1985 using eight cages. The individual weights in each cage showed considerable differences. Same results were also found in our study. Some previous studies have suggested that higher levels of protein are required for optimal growth of freshwater fish in cages compared to ponds, possibly due to supplementation of essential amino acids by selective foraging of free-ranging fish in ponds [27, 29 & 30]. Herzberg *et al.,* [13] also did cage culture of prawns and suggested that cage culture technique has number of advantages for fish culture and the endangered fish species can be culture in cages. Kumaraiah [16] studied the effects of stocking density of advanced fingerlings (46 g) of L. rohita in grow out culture for 89 days in circular floating cages (1 m2 area). They concluded that the optimum stocking density could be between 30 and 50 fish/m^2, without considering the profitability under different stocking densities. It is obvious that the stocking density of a species is considered optimum when it fetches both higher production and profit.

Kohli *et al*., [15] also conducted experiments on cage aquaculture with *Catla catla*, *Labeo rohita, Cyprinus carpio*, *Tor pititora* and *Tor Khudree*. They recommend that the cage culture is viable for raising fingerlings. They feel that cage culture technology for seed rearing should be taken up as a fish enhancement programme in which true economic gains will be reflected only when the production of the reservoir is increased. When it is successful in other countries it cannot be failure in India. Tamot Praveen *et al*., [26] had done cage culture with *Catla catla* and *Labeo rohita* as a candidate species in Madhya Pradesh. The survival % of *Catla catla* was 58.9% and 78.7% whereas it was 63.3%, 57.3% and 74.2% in cages culture. These findings were similar with our results. The higher growth rate was achieved in the experiments & may be due to artificial feeding as compared to natural feeding. Growth rate also depends on the water quality and other factors such as season, durations, densities etc.

Extension Programme

Organization of one day workshop on "*Cage culture*"

The rearing and raising of fishes in cages is gaining importance all over the world because of its increasing technical, ecological, social and economic advantages over the capture fisheries and conventional aquaculture.

Hence the workshop was organized to introduce the idea of fish culture in cages among the fish farmers, businessman, teacher's researchers and students so that activity of fish culture will increase. That would also contribute to countering of the ongoing declining trend in

capture fisheries. This will help for addition of another chapter "BLUE" revolution in Marathwada.

This workshop was organized on 06/09/2013 with collaboration with College of Fishery Science, Tq. Udgir Dist. Latur. (MAFSU, Nagpur). 150 plus participants were present for workshop. During the workshop Dr. Ajay Kulkarni, Asst. Prof, College of Fishery Science, Tq. Udgir. Dist. Latur, Dr. S. P. Chavan, Asso. Prof. School of Life Sciences, S. R. T. M. University, Nanded and Dr. A. N. Kulkarni, Asst. Prof. & Head Dept of Fishery Science, N. E. S. Science College, Nanded, had delivered their plenary lectures on cage culture and importance of cage culture in this area.

After this a demonstration was arranged at college fish tank, in demonstration all information was given to the participants i.e. construction of cage, suitable species for culture, artificial feed etc. after this workshop many fish farmers were interacted with us for cage culture but due to scarcity of rain from last 4 years they couldn't start their cage culture yet. For that purpose training programme, workshops for manufacture of cage material and structure by locally available material can be organized. This will reduce the cost of construction and generate employment opportunities.

This is the first attempt for cage culture in Marathwada, Results of the experiments showed that Marathwada can be potential area for cage culture.

Conclusion & Recommendation

Considering the objective of providing cheap animal protein for household consumption, intensification through high-cost culture methods requires more extensive economical evaluations. Thus, under the eco-socio-economical condition of India, where a large number of freshwater impoundments are available for aquaculture, rearing of *Catla catla* through cage culture may be considered as the ideal method of choice for a sustainable fish production. For a country like India with enormous population, cage culture is most needed intensively in order to meet the future food demands and also to improve the aquaculture business.

It is found that all the studied hydro biological parameters are within the permissible limits for culture of fishes in cages.

Idea of cage culture is unknown to the fishermen and businessman of this region hence more extension programme is required at root level so that people will accept this culture techniques.

Successful cage aquaculture of this species may bring about socioeconomic sustainability of the rural people. Raising fry to fingerlings in the cages for stocking in the reservoirs is the need of the day. Therefore this technology is to be demonstrated in large scale.

Training programme, workshops for manufacture of cage material and structure by locally available material can be organized. This will reduce the cost of construction and generate employment opportunities.

All the water bodies of Marathwada can be developed for the promotion of cage culture activity.

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