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Introduction Of Green Economy-Based Bio-Floc Technology for Sustainable Fish Production in Some Drier Regions of Ganjam Districts of Odisha

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Abstract
Aquaculture is in one of the prime enterprises in the Ganjam district of Odisha. Out of monsoon deficient and drier blocks Rangeilunda, Kodala, Khallikote, Patrapur, Hinjili, Digapahandi, Chhatrapur three blocks namely Rangeilunda,, Khallikote and Hinjili were selected to study the efficacy of biofloc technology for fish production. Our study is conducted between October 2022 to October 2025. Growth performance of three different species of fish as Rohu (Labeo rohita), Bhakur(Catla catla) and Magur(Clarias batrchus) monitored as well as profit generated during this period. Fishes were found to be reared tank of radius 18 meter and volume 25000 litres. 1500 fingerlings catla and rohu in the ration 2:3 introduced per cycle with total of 3000 in two production cycles of the year. In similar way 2500 Clarias fingerlings introduced in other biofloc tank. With optimum feeding growth performance monitored in three sites in two cycles of the same year. Revenue and profit generated in the selected regions comparison between the species introduced and different regions performed by RBCD analysis and ANOVA. The mean production of Rohu and Catla fish for Rangeilunda, Khallikote and Hinjili was 1947.46±17.67 kg, 1950.03±17.19 kg and 1955.13±19.76 kg, respectively. The mean revenue generation for all the three locations was Rs. 292120.00±2651.42, Rs.292505.00±2579.16 and Rs. 293270.00±2964.19, respectively. Likewise, the mean profit was Rs. 163120.00±11136.87, 163505.00±11105.72 and 164270.00±11404.44, respectively. The ANOVA results in cultivation of Rohu and Catla indicate that there is a significant difference among the treatment means at 5 % level of significance. Significant at ($p< 0.01$), Significant at ($p<0.05$) and N/A = Non-Significant. But for Magur The ANOVA results indicate that there is no significant difference among Interaction means at 5 % level of significance. The system is found to be economically viable for fish farmers in the studied areas but due to lack of deeper knowledge production gap is persisting which can be nullified by proper training through experts.

Keywords: Green economy. Bio floc. Sustainable fish production. Drier region. Ganjam. Odisha.

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Introduction
Aquaculture is the most important sector for livelihood and economic prosperity in the developing world (Sultana et al, 2016). Fishery and aquaculture made a provision for recruiting about 58.5 million people directly in the primary sector in 2020 (FAO, 2020). As per the data of 2022 Aquaculture and fisheries employed 61.8 million people in the world and most of them are in Asia (FAO,2022). Since 1950s the growth of aquaculture is showing a fascinating positive trend. Commercial aquaculture increased nearly to 124% in between 2008 to 2020 because of the pressure executed on food production sector due to population explosion (Tacon et al, 2011; Tacon and Metian,2015). Aquaculture and fisheries production should be enhanced by 15% to substantiate the demand for nutrient rich food to the world by 2030 as per UN's SDG 7 keeping the resources at no risk. The main objective of the sustainable production is to reduce pollution, larger biodiversity making a provision for food and nutrition security, social wellbeing and equality (FAO, 2022).

Aiming the sustainable aquaculture for green economy the aquaculture production system evolved to optimize the production with efficient use of resources and reducing the discharge of waste from the production system (Ahmed and Thompson,2019; Naylor et al.,2021).The bio floc fish farming carried out in different parts of the world including India is profitable due to closed recirculation system with minimal external input and less disease outbreak (Jacob,2015).Biofloc technology is much more advantageous as compared to intensive pond aquaculture system as Intensive aquaculture sometimes shows over feeding which is not only the loss of expensive foods but alter the physiochemical parameter of aquatic system by reducing the dissolved oxygen, increasing the BOD and bacterial load (Craig and Helfrich, 2002). . The major challenge in aquaculture practices is the cost of feed which constitute

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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). Aquaculture feed producing industry is making substantial effort to reduce the use of FM and FO in commercial aquaculture feeds (Naylor et al,2009; Tacon et al,2011) and they are increasingly including agricultural crop products and residues as an alternative (Tacon et al.2011).

In this respect Biofloc technology (BFT) is the most advanced form of intensive culture system where we need less space and water with the minimum water discharge and greater yield (Emerenciano, Gaxiola, & Cuzon, 2013; Khanjani & Sharifinia, 2020; Martinez-Cordova et al., 2022))

Ganjam district of Odisha is gifted with 11580 ha. of freshwater, 4023.04 ha. of brackish water. Potential inland water resources boosted tragic shift from a capture-based fishery to culture-based fishery intervention contributing towards employment generation, food, nutritional and livelihood security. Ganjam district projected to be the second highest freshwater fish producing district in the Odisha after Balasore with the production of about 76,23 MT (Balasore 77256 MT) (Fishery statistics, Govt. of Odisha,2024-25). The major challenge is some dry regions have irregular low monsoon rain fall and lack of proper irrigation facilities where biofloc technology can boost the fish farmers livelihood and contribute towards economic prosperity. Our study is aimed to evaluate the production, revenue and profit as well as the key challenges for maximizing the production through BFT.

Material And Methods

Research sites and aquaculture interventions

Eight different blocks of the Ganjam district such as Rangeilunda, Kodala, Khalikote, Patrapur, Hinjili, Digapahandi, Chhatrapur, and Ganjam were found to be drier regions. But among them, three blocks as Rangeilunda, Khalikote and Hijili were initially included as the primary site for the study of biofloc based aquaculture system.

Fig. 1 and 2 Biofloc tank set up

Fig. 3 and 4 Biofloc plant having culture of Rohu, Catla and Magur

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The farmers of the area those are adopting biofloc technology are moving into the implementation of some procedures of recirculation aquaculture system for getting water to be recirculated for aquaculture intervention by using minimum water. This procedure follows the steps like

i. Mechanical filtration
ii. Biological filtration
iii. Aeration
iv. Recirculation

The intervention of biofloc technology in the area has different components of expenditure as shown in table 1.

Table. 1 Split of total expenditure in setting two biofloc tanks of capacity 25,000 litre each.

Serial No	Investment type	Amount in Rs
1	Tank and liner	70000
	Shed or cover	30000
2	aeration system	40000
3	water supply pump	20000
4	Electrification and generator	20000
5	Water quality test kits and probiotics	15000
7	Miscellaneous (Nets, pipes and another accessories)	10,000
8	Feed, Electricity Probiotics	20000
9	Labour charges	20000
10	Total expenditure	Rs 245000 Subsidy of @40% of 245000 with a final investment of 1,47,000 in the first year of introduction of two bioflocs tank of 25,000 litre capacity
11	Expenditure in successive years (2nd and 3rd)	120000 in each year

Methods of data collection

Three stake holders in the selected research sites as Rangeilunda, Khalikote, Hinjili block involved in aquaculture by adopting bio floc technology (BFT) were interviewed with pre-structured questionnaire using PRA tools. Participatory strategy are most essential tools developed and used by fisherfolks, stakeholders, policy makers and research institutions for better management of small-scale fishery enterprises (Agrawal,1999: Berkes et al,2001: Berkes,2009). This kind of management approaches are vital for long term sustainability of small-scale fishery (Berkes, 2002: Younis,1997). This is responsible for generating a comprehensive data in the present study. Expenditure and production data were collected directly from the farmer involved in enterprise to avoid any bias incorporation in collected data.

Statistical analysis

Data collected from the eight fish farmers involved in recirculation aquaculture arranged in excel sheets. The results for investments, production and cost benefit calculation are made for finding statistical significance if any. RCBD analysis, ANOVA was applied to evaluate the revenues and profit generated in two biofloc system including culture of Rohu, Catla and another one involving the culture of *Clarias.*

Results And Discussion

The species normally cultured in in the area are China Kau (*Anabas testudineus*), Catfish magur (*Clarias batrachus),* Rohu (*Labeo rohita*) and Bhakur(*Catla catla*). Female stake holders are found to be involved in this biofloc fishery enterprise and hence some of the SHGs members empowered their socioeconomic status through the production optimization, revenue and profit generation with limited water resources. The interveiew of the female SHGs members as well as male members of the family resulted in drawing a conclusion that the female stake holders belonging to different areas were involved in aquacualture activities along with the male members. When production of fish in two types of intervention is studied then three species were found to be produced through their biofloc intervention. These are *Rohu, Catla,Clarias*(Fig 4 and 5).

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Fig. 5 Live Rohu And Catla from bio-flock **Fig.6 Live *Clarias* from bio-floc**

Table. 2 Production of Rohu and catla in biofloc system with two tanks of capacity 25000 litres each.

Location	Fish	Year	Expenditure*	Production per year (Kg)	Revenue generated in Rs (@150/Kg)	Profit (Rs)
Rangeilunda	Rohu and Catla	1st	147000	1920.8	288120	141120
		2nd	120000	1940.7	291105	171105
		3rd	120000	1980.9	297135	177135
Khallikote	Rohu And Catla	1st	147000	1923.6	288540	141540
		2nd	120000	1944.2	291630	171630
		3rd	120000	1982.3	297345	177345
Hinjili	Rohu and Catla	1st	147000	1925.3	288795	141795
		2nd	120000	1947.6	292140	172140
		3rd	120000	1992.5	298875	178875

*** setting up two tanks of capacity 25000 litres and diameter 18 metres and depth 1.5 metres**

Table. 3 Production of *Clarias batrachus* in biofloc system with two tanks of capacity 25000 litres each.

Location	**Fish**	**Year**	**Expenditure***	**Production per year (Kg)**	**Revenue generated in Rs (@300/Kg)**	**Profit (Rs)**
Rangeilunda	*Clarias*(Magur)	1st	147000	850.4	255120	108120
		2nd	120000	862.3	258690	138690
		3rd	120000	881.9	264570	144570
Khallikote	*Clarias(*Magur)	1st	147000	854.2	256260	109260
		2nd	120000	868.7	260610	140610
		3rd	120000	898.4	269520	149520
Hinjili	*Clarias(*Magur)	1st	147000	856.9	257070	110070

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		2nd	120000	869.2	260760	140760
		3rd	120000	903.5	271050	151050

Analysis for fish-1 (Rohu & Catla)

Table. 4 RCBD Analysis of Variance table for variable/Character- Production per year

Source of Variation	D.F.	Sum of Square	Mean Squares	F-value	p-value	CD (1%)	CD (5%)
Replications	2	5,968.676	2,984.338	520.272	0.000		
Treatment	2	91.376	45.688	7.965	0.040	N/A	5.429
Error	4	22.944	5.736				
Total	8	6,082.996					

Table 5.Descriptive Statistics for Product

Treatment	Count	Mean	Std. Dev.	Min	Max	Std. Error	95% C.I.
T1	3	1,947.467	30.616	1,920.800	1,980.900	17.676	(1871.412, 2023.521)
T2	3	1,950.033	29.782	1,923.600	1,982.300	17.194	(1876.052, 2024.015)
T3	3	1,955.133	34.228	1,925.300	1,992.500	19.761	(1870.107, 2040.159)

Coefficient of variation = 0.123

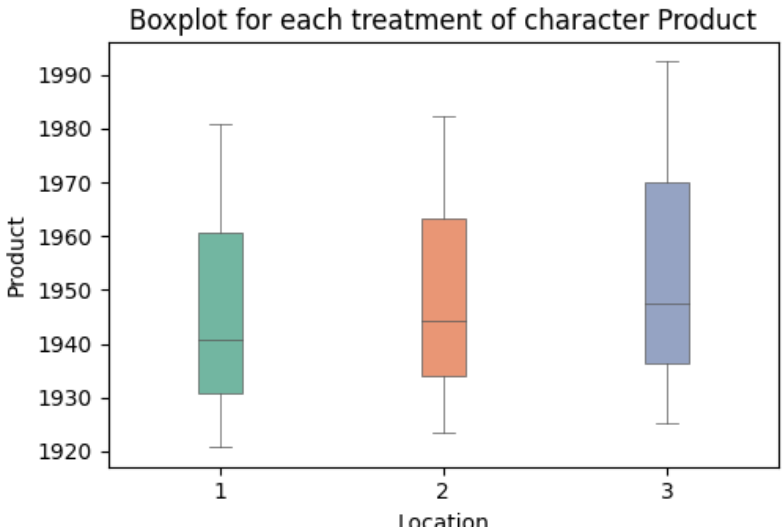

Fig. 7 Box plot for each treatment of character product.

The ANOVA results indicate that there is a significant difference among the treatment means at 5 % level of significance(Table 4,5 and figure 7).

** = Significant at ($p < 0.01$), * = Significant at ($p < 0.05$) and N/A = Non-Significan

Table 6. RCBD Analysis of Variance table for variable/Character Revenue Generation

Source of Variation	D.F.	Sum of Square	Mean Squares	F-value	p-value	CD (1%)	CD (5%)
Replications	2	134,295,200.000	67,147,600.000	520.272	0.000		
Treatment	2	2,055,950.000	1,027,975.000	7.965	0.040	N/A	814.411
Error	4	516,250.000	129,062.500				
Total	8	136,867,400.000					

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Table 7. Descriptive Statistics for Revenue

Treatment	Count	Mean	Std. Dev.	Min	Max	Std. Error	95% C.I.
T1	3	292,120.000	4,592.409	288120	297135	2,651.429	(280711.822, 303528.178)
T2	3	292,505.000	4,467.239	288540	297345	2,579.162	(281407.763, 303602.237)
T3	3	293,270.000	5,134.128	288795	298875	2,964.190	(280516.118, 306023.882)

Coefficient of variation = 0.123

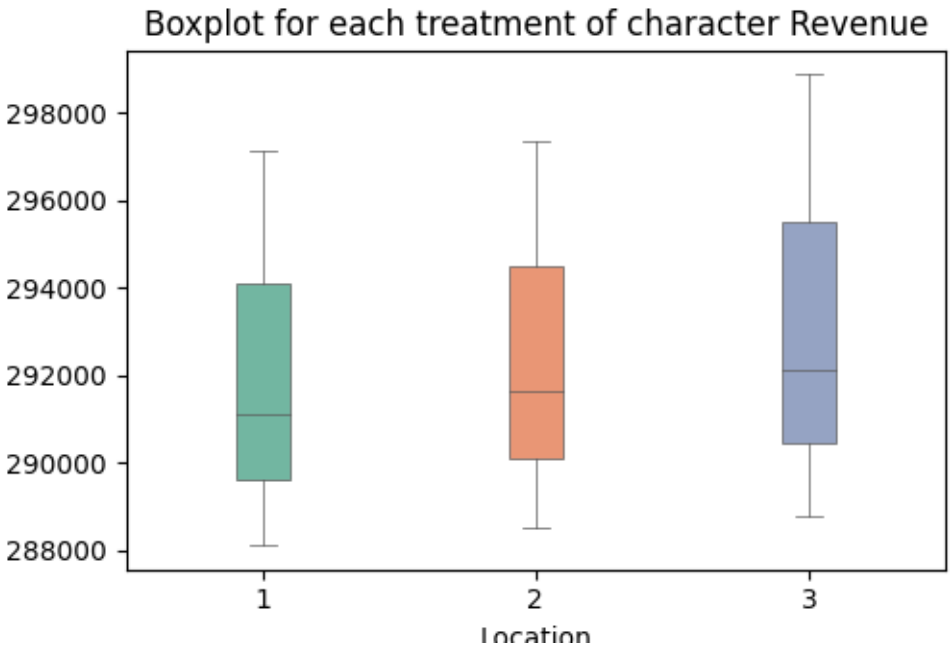

Fig. 8 Box plot for each treatment of character revenue

The ANOVA results indicate that there is a significant difference among the treatment means at 5 % level of significance(Table 6,7 and Fig 8).

Table 8. RCBD Analysis of Variance table for variable/Character Profit

Source of Variation	D.F.	Sum of Square	Mean Squares	F-value	p-value	CD (1%)	CD (5%)
Replications	2	2,264,055,200.000	1,132,027,600.000	8,771.158	0.000		
Treatment	2	2,055,950.000	1,027,975.000	7.965	0.040	N/A	814.411
Error	4	516,250.000	129,062.500				
Total	8	2,266,627,400.000					

Table 9. Descriptive Statistics for Profit

Treatment	Count	Mean	Std. Dev.	Min	Max	Std. Error	95% C.I.
T1	3	163,120.000	19,289.640	141120	177135	11,136.879	(115201.877, 211038.123)
T2	3	163,505.000	19,235.676	141540	177345	11,105.723	(115720.932, 211289.068)
T3	3	164,270.000	19,753.083	141795	178875	11,404.448	(115200.622, 213339.378)

Coefficient of variation = 0.220

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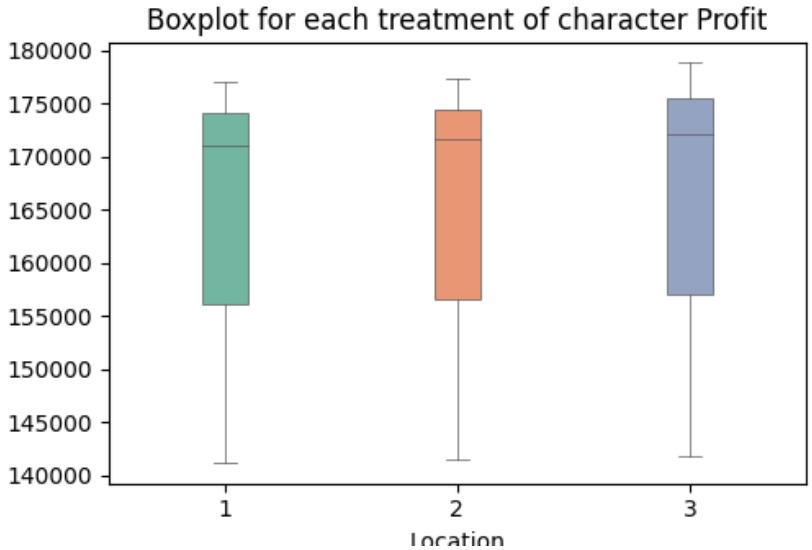

Fig. 9 Box plot for each treatment of character of profit

The ANOVA results indicate that there is a significant difference among the treatment means at 5 % level of significance(Table 8,9 and Fig 9).

Table. 10 Comparisons of means using Duncan test

Treatment No.	Product	Revenue	Profit
1	1947.467^{b}	292120.000^{b}	163120.000^{b}
2	1950.033^{ab}	292505.000^{ab}	163505.000^{ab}
3	1955.133^{a}	293270.000^{a}	164270.000^{a}

Note: The means with different Letters as superscripts are significant (P < 0.05).

The means with same letters or having common letter(s) are not significantly different(Table 10).

Interpretations of Results:For character Product: The data suggests that treatments 1, 2 have Non-Significant means, being al categorized under group 'B'. The data suggests that treatments 2, 3 have Non-Significant means, being all categorized under grou Treatment no 3 stands out with the highest mean of 1955.133 among all treatments. Treatment 1 exhibits the lowest mean of 194 indicating a lesser effect compared to other treatments.

For character Revenue: Upon examination, it is evident that treatments 1, 2 exhibit similar effects (non-significant differences) they are all part of group 'B'. Upon examination, it is evident that treatments 2, 3 exhibit similar effects (non-significant differenc they are all part of group 'A'. The treatment no 3, with the mean of 293270.0 has highest mean that surpasses others in terms of ef Compared to others, treatment 1 has the smallest effect with a mean of 292120.0.

For character Profit: Upon examination, it is evident that treatments 1, 2 exhibit similar effects (non-significant differences) since they are all part of group 'B'. The data suggests that treatments 2, 3 have Non-Significant means, being all categorized under group 'A'. Treatment no 3 stands out with the highest mean of 164270.0 among all treatments. Compared to others, treatment 1 has the smallest effect with a mean of 163120.0.

Analysis for Magur

Table 11. RCBD Analysis of Variance table for variable/Character Production per year

Source of Variation	D.F.	Sum of Square	Mean Squares	F-value	p-value	CD (1%)	CD (5%)
Replications	2	2,604.882	1,302.441	62.846	0.001		
Treatment	2	222.976	111.488	5.380	0.073	N/A	N/A
Error	4	82.898	20.724				
Total	8	2,910.756					

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Table 12. Descriptive Statistics for Product

Treatment	Count	Mean	Std. Dev.	Min	Max	Std. Error	95% C.I.
T1	3	864.867	15.906	850.400	881.900	9.183	(825.354, 904.38)
T2	3	873.767	22.531	854.200	898.400	13.009	(817.796, 929.738)
T3	3	876.533	24.150	856.900	903.500	13.943	(816.541, 936.525)

Coefficient of variation = 0.522

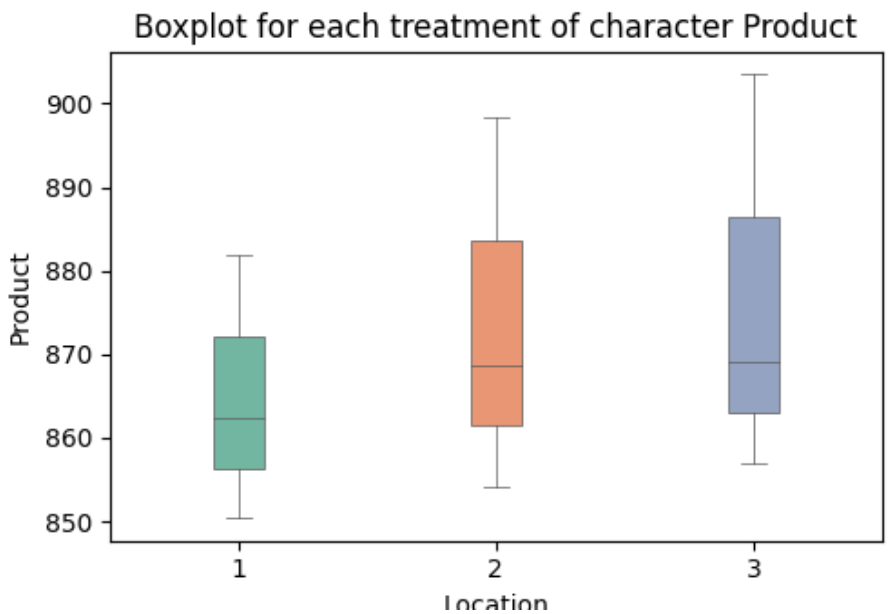

Fig. 10 Box plot for each treatment of character product

The ANOVA results indicate that there is a no significant difference among the treatment means hence multiple comparison cannot be performed(Table 11,12 and Fig 10).

Table 13. RCBD Analysis of Variance table for variable/Character Revenue

Source of Variation	D.F.	Sum of Square	Mean Squares	F-value	p-value	CD (1%)	CD (5%)
Replications	2	234,439,400.000	117,219,700.000	62.846	0.001		
Treatment	2	20,067,800.000	10,033,900.000	5.380	0.073	N/A	N/A
Error	4	7,460,800.000	1,865,200.000				
Total	8	261,968,000.000					

Table 14. Descriptive Statistics for Revenue

Treatment	Count	Mean	Std. Dev.	Min	Max	Std. Error	95% C.I.
T1	3	259,460.000	4,771.824	255120	264570	2,755.014	(247606.133, 271313.867)
T2	3	262,130.000	6,759.416	256260	269520	3,902.550	(245338.681, 278921.319)
T3	3	262,960.000	7,245.005	257070	271050	4,182.906	(244962.409, 280957.591)

Coefficient of variation = 0.522

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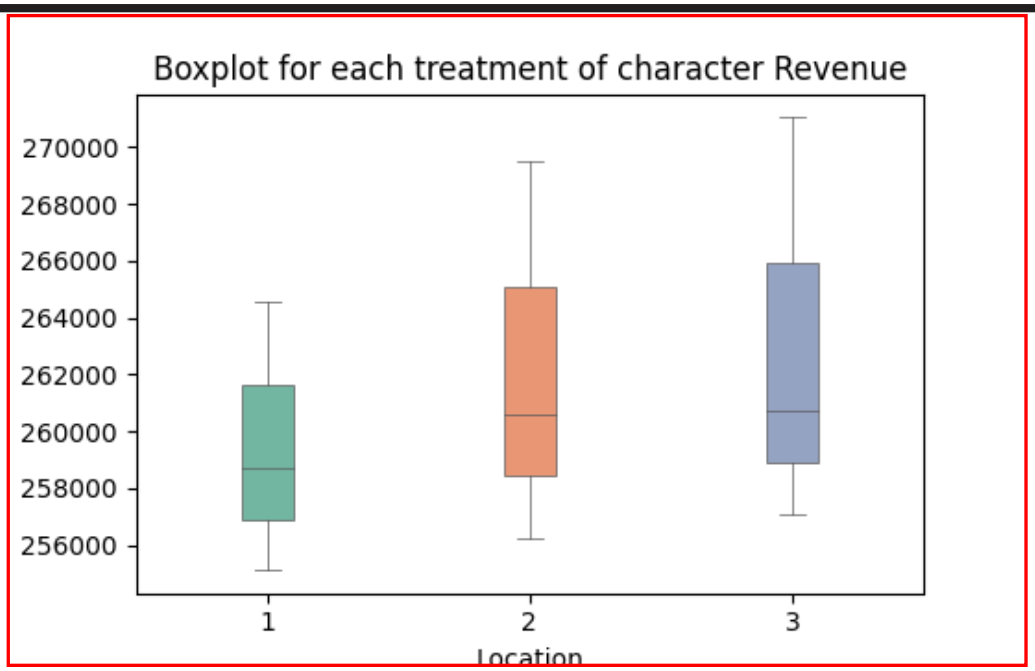

Fig. 11 Box plot for each treatment of character revenue

The ANOVA results indicate that there is a no significant difference among the treatment means hence multiple comparison cannot be performed(Table 13,14 and Fig 11).

Table 15. RCBD Analysis of Variance table for variable/Character Profit

Source of Variation	D.F.	Sum of Square	Mean Squares	F-value	p-value	CD (1%)	CD (5%)
Replications	2	2,561,839,400.000	1,280,919,700.000	686.747	0.000		
Treatment	2	20,067,800.000	10,033,900.000	5.380	0.073	N/A	N/A
Error	4	7,460,800.000	1,865,200.000				
Total	8	2,589,368,000.000					

Table 16. Descriptive Statistics for Profit

Treatment	Count	Mean	Std. Dev.	Min	Max	Std. Error	95% C.I.
T1	3	130,460.000	19,569.116	108120	144570	11,298.234	(81847.621, 179072.379)
T2	3	133,130.000	21,146.624	109260	149520	12,209.009	(80598.874, 185661.126)
T3	3	133,960.000	21,319.477	110070	151050	12,308.806	(80999.483, 186920.517)

Coefficient of variation = 1.031

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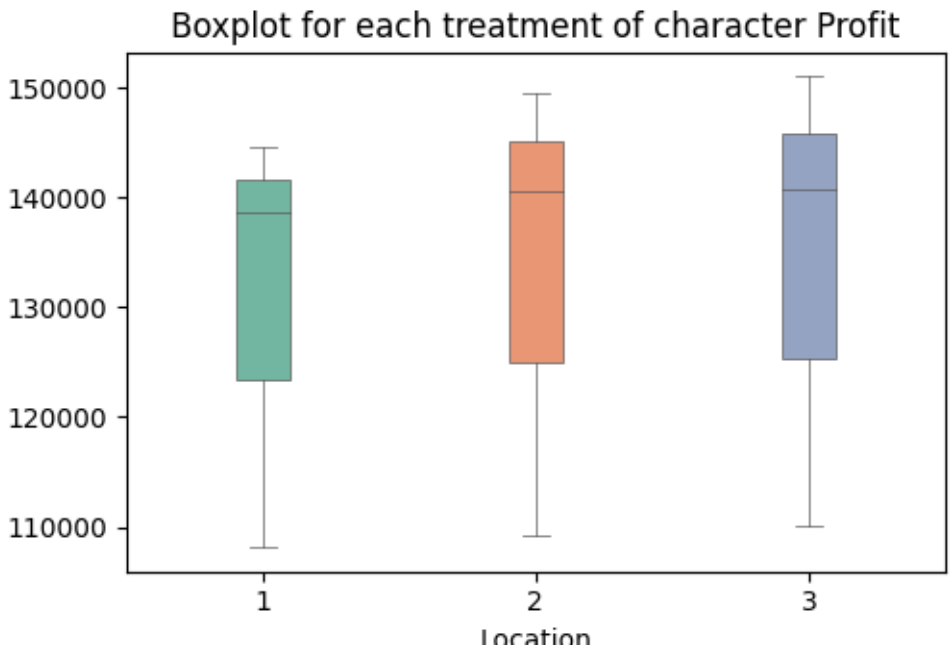

Fig. 12 Box plot for each treatment of character of profit

The ANOVA results indicate that there is a no significant difference among the treatment means hence multiple comparison cannot be performed (Table 15,16 and Fig 11).

Table 17. Comparisons of means using Duncan test

Treatment No.	Product	Revenue	Profit
1	864.867ᵃ	259460.000ᵃ	130460.000ᵃ
2	873.767ᵃ	262130.000ᵃ	133130.000ᵃ
3	876.533ᵃ	262960.000ᵃ	133960.000ᵃ

Note: The means with different Letters as superscripts are significant ($P < 0.05$).

The means with same letters or having common letter(s) are not significantly different(Table 17).

Interpretations of Results:

For character Product: Upon examination, it is evident that treatments 1, 2, 3 exhibit similar effects (non-significant differences) since they are all part of group 'a'. Treatment no 3 stands out with the highest mean of 876.533 among all treatments. Treatment 1 exhibits the lowest mean of 864.867, indicating a lesser effect compared to other treatments.

For character Revenue: The data suggests that treatments 1, 2, 3 have Non-Significant means, being all categorized under group 'a'. Treatment no 3 stands out with the highest mean of 262960.0 among all treatments. Compared to others, treatment 1 has the smallest effect with a mean of 259460.0.

For character Profit: The statistical comparison indicates no significant difference between treatments 1, 2, 3 as they all fall under same group 'a'. The treatment no 3, with the mean of 133960.0 has highest mean that surpasses others in terms of effect. Treatment 1 exhibits the lowest mean of 130460.0, indicating a lesser effect compared to other treatments.

Table 18. Two Factor RCBD Analysis of Variance table for variable/Character Product

Source of Variation	D.F.	Sum of Square	Mean Squares	F-value	p-value	CD (1%)	CD (5%)
Replication	2	8,228.743	4,114.372				
Treatments	5	5,240,909.560	1,048,181.912	23,258.990	0.000		
Factor A (Year)	2	283.573	141.787	3.146	0.087	N/A	N/A

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Source of Variation	D.F.	Sum of Square	Mean Squares	F-value	p-value	CD (1%)	CD (5%)
Factor B (Fish)	1	5,240,595.209	5,240,595.209	116,287.977	0.000	10.029	7.051
A X B	2	30.778	15.389	0.341	0.719	N/A	N/A
Error	10	450.657	45.066				
Total	17	5,249,588.960					

Table 19. Two-way Mean Table of Location and Fish for Product

A/B Levels	B_1	B_2	Mean A
A1	1,947.467	864.867	1,406.167
A2	1,950.033	873.767	1,411.900
A3	1,955.133	876.533	1,415.833
Mean	1,950.878	871.722	1,411.300

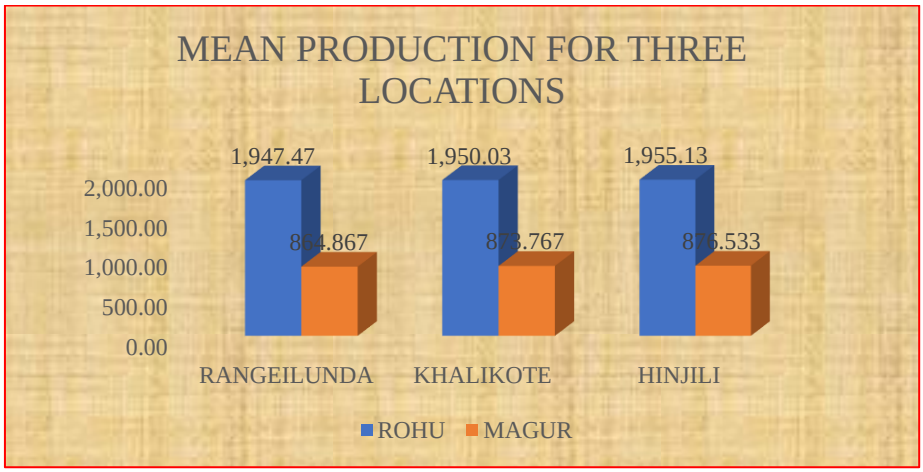

Fig. 13 Mean production for three locations.

Interpretation:
The ANOVA results indicate that there is no significant difference among the levels of Location means at 5 % level of significance.
It is observed that $\mathbf{B_1}$ is statistically significant with $\mathbf{B_2}$ at the 1 percent level of significance.
It is observed that $\mathbf{B_2}$ is statistically significant with $\mathbf{B_1}$ at the 1 percent level of significance.
The ANOVA results indicate that there is no significant difference among Interaction means at 5 % level of significance.

Table 20. Two Factor RCBD Analysis of Variance table for variable/Character Revenue

Source of Variation	D.F.	Sum of Square	Mean Squares	F-value	p-value	CD (1%)	CD (5%)
Replication	2	361,755,700.000	180,877,850.000				
Treatments	5	4,378,768,262.500	875,753,652.500	585.555	0.000		
Factor A	2	16,749,775.000	8,374,887.500	5.600	0.023	N/A	1,573.217
Factor B	1	4,356,644,512.500	4,356,644,512.500	2,912.984	0.000	1,827.092	1,284.526
A X B	2	5,373,975.000	2,686,987.500	1.797	0.215	N/A	N/A
Error	10	14,955,950.000	1,495,595.000				
Total	17	4,755,479,912.500					

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Table 21. Two-way Mean Table of Location and Fish for Revenue

A/B Levels	B_1	B_2	Mean A
A1	292,120.000	259,460.000	275,790.000
A2	292,505.000	262,130.000	277,317.500
A3	293,270.000	262,960.000	278,115.000
Mean	292,631.667	261,516.667	277,074.167

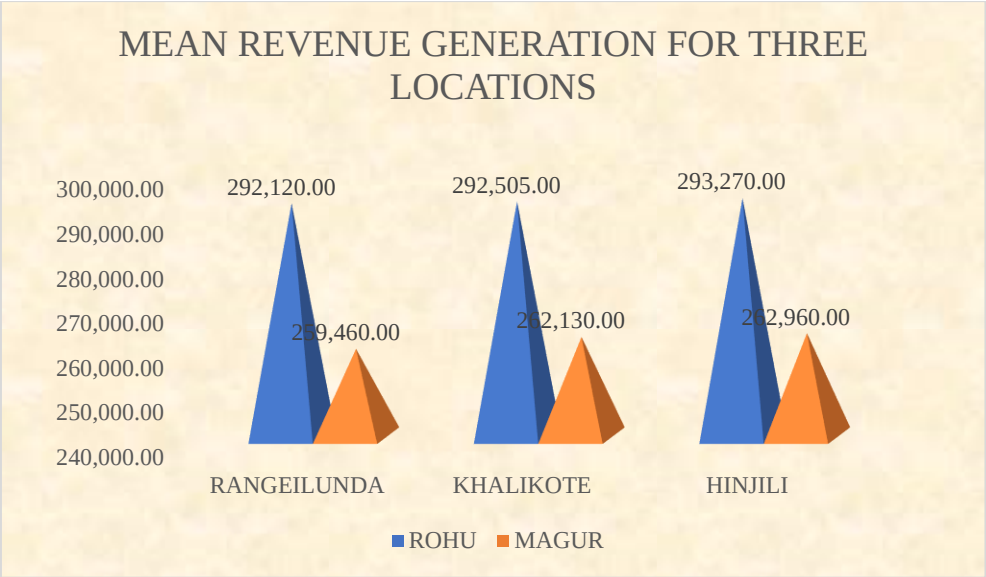

Fig. 14 Mean revenue generation for three location

Interpretation:

It is observed that A_1 is statistically significant with A_3 at the 1 percent level of significance whereas A_2 are not statistically significant.

It is observed that A_2 is statistically significant with A_1, A_3 are not statistically significant.

It is observed that A_3 is statistically significant with A_1 at the 1 percent level of significance whereas A_2 are not statistically significant.

It is observed that B_1 is statistically significant with B_2 at the 1 percent level of significance.

It is observed that B_2 is statistically significant with B_1 at the 1 percent level of significance.

The ANOVA results indicate that there is no significant difference among Interaction means at 5 % level of significance.

Table 22. Two Factor RCBD Analysis of Variance table for variable/Character Profit

Source of Variation	D.F.	Sum of Square	Mean Squares	F-value	p-value	CD (1%)	CD (5%)
Replication	2	4,818,915,700.000	2,409,457,850.000				
Treatments	5	4,378,768,262.500	875,753,652.500	585.555	0.000		
Factor A	2	16,749,775.000	8,374,887.500	5.600	0.023	N/A	1,573.217
Factor B	1	4,356,644,512.500	4,356,644,512.500	2,912.984	0.000	1,827.092	1,284.526
A X B	2	5,373,975.000	2,686,987.500	1.797	0.215	N/A	N/A
Error	10	14,955,950.000	1,495,595.000				
Total	17	9,212,639,912.500					

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Table 23. Two-way Mean Table of Location and Fish for Profit

A/B Levels	B_1	B_2	Mean A
A1	163,120.000	130,460.000	146,790.000
A2	163,505.000	133,130.000	148,317.500
A3	164,270.000	133,960.000	149,115.000
Mean	163,631.667	132,516.667	148,074.167

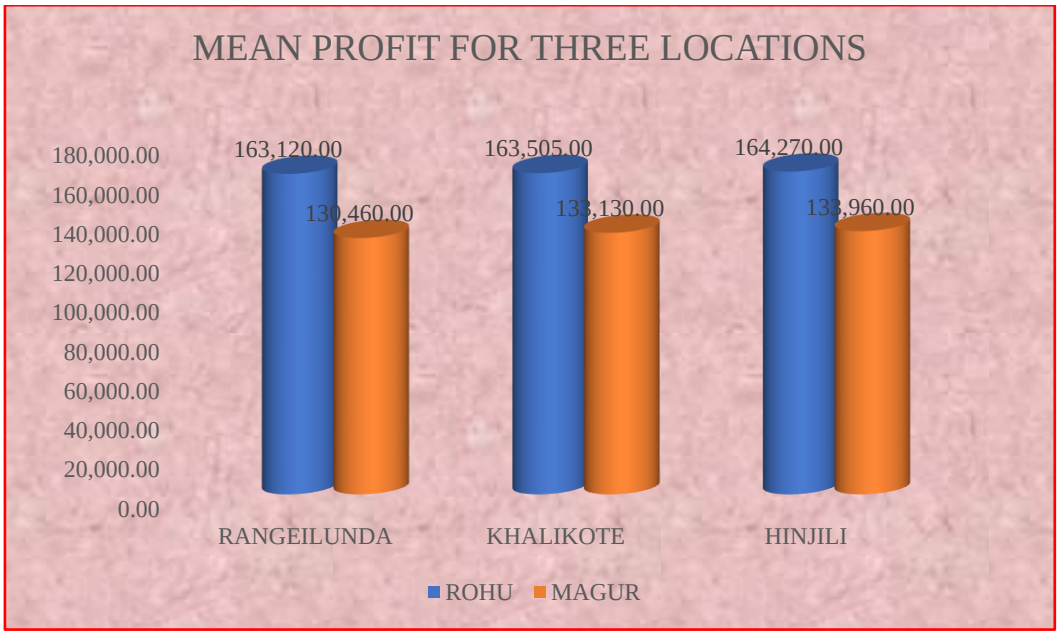

Fig. 15 Mean profit for three locations

Interpretation:
It is observed that A_1 is statistically significant with A_3 at the 1 percent level of significance whereas A_2 are not statistically significant.
It is observed that A_2 is statistically significant with A_1, A_3 are not statistically significant.
It is observed that A_3 is statistically significant with A_1 at the 1 percent level of significance whereas A_2 are not statistically significant.
It is observed that B_1 is statistically significant with B_2 at the 1 percent level of significance.
It is observed that B_2 is statistically significant with B_1 at the 1 percent level of significance.
The ANOVA results indicate that there is no significant difference among Interaction means at 5 % level of significance.

Conclusion

The water deficient or drier areas (low average annual precipitation) of Ganjam district adopting the bio-floc technology with the use of minimal water resources. Due to government initiative and subsidy provision fish farmers are doing fish culture with the inclusion of bio-floc technology. Major fish introduced are *Rohu*,*Catla*, *Clarias* and *Anabas.* Production had generated revenue and profit generated boosting their livelihood. Data regarding production, revenue generation and profit incurred from Rohu and Magur fish cultivation from three different location was subjected to statistical analysis by using ANOVA one factor and two factors analysis. It is evident from the table and figure that, there is significant difference in production of Rohu fish per year in three different location i.e. Rangeilunda, Khallikote and Hinjili, respectively. The mean production of *Rohu* and *Catla* fish for Rangeilunda, Khallikote and Hinjili was 1947.46±17.67 kg, 1950.03±17.19 kg and 1955.13±19.76 kg, respectively. The difference in mean production for three location was found to be statistically significant (p<0.05). Same trend was observed for revenue generation and profit incurred from Rohu cultivation, respectively. The mean revenue generation for all the three locations was Rs. 292120.00±2651.42, Rs.292505.00±2579.16 and Rs. 293270.00±2964.19, respectively. Likewise, the mean profit was Rs. 163120.00±11136.87, 163505.00±11105.72 and 164270.00±11404.44, respectively. But in Magur cultivation no significant

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difference was observed among the means of three different locations. But there is a gap in the production level due less technical knowledge of knowledge poor fish farmers. This can be improved by proper training to them.

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References

[1] Agrawal A. Enchantment and Disenchantment: The Role of Community in Natural Resource. World Development, Elsevier Science Ltd. 1999; 27(4):629-649.
[2] Ahmed, N., Thompson, S. the blue dimensions of aquaculture: A global synthesis Science of the Total Environment, 652 (2019), pp. 851-861, 10.1016/j.scitotenv.2018.10.163
[3] Berkes F. Evolution of co-management: role of knowledge generation, bridging organizations and social learning. Journal of Environmental Management. 2009; 90:1692-1702. j. jenvman.2008.12.001.
[4] Berkes F. Cross-scale institutional linkages: perspectives from the bottom up. E. Ostrom, T. Dietz, N. Dolsak, P. C. Stern, S. Stonich, and E. U. Weber, editors. The drama of the commons. National Academy, Washington, D.C., USA, 2002, 293-321.
[5] Berkes F, Mathias J, Kislalioglu M, Fast H. The Canadian Arctic and the Oceans Act: the development of participatory environmental research and management. Ocean & Coastal Management. 2001; 44(3):451-469.
[6] Craig, Steven & Helfrich, Louis. (2002). Understanding Fish Nutrition, Feeds, and Feeding Understanding Fish Nutrition, Feeds, and Feeding. Virginia Cooperation Extension.
[7] M. Emerenciano, G. Gaxiola, G. Cuzon Biofloc technology (BFT): A review for aquaculture application and animal food industry M.D. Matovic (Ed.), Biomass now—cultivation and utilization, INTECH (2013), pp. 301-328, 10.5772/53902
[8] FAO. (2022). The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation. Rome, FAO. https://doi.org/10.4060/cc0461en
[9] FAO. 2020. The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome. https://doi.org/10.4060/ca9229en
[10] Fishery statistics (2024) Government of Odisha, https://fisheries.odisha.gov.in/statistics-fisheries-1/
[11] Jacob, B., 2015. A guide to recirculation aquaculture: an introduction to the new environmentally friendly and highly productive closed fish farming systems. FAO, EUROFISH,100 p
[12] M.H. Khanjani, M. SharifiniaBiofloc technology as a promising tool to improve aquaculture productionReviews in Aquaculture, 12 (3) (2020), Article 12412, 10.1111/raq.12412
[13] Martinez-Cordova, L. Rafael A preliminary evaluation of an integrated aquaculture-agriculture systems (tilapia and peppers) at mesocosm scale Journal of Aquaculture & Marine Biology, 9 (1) (2020), pp. 19-22, 10.15406/JAMB.2020.09.00272
[14] Naylor, R.L., Hardy,R.W., Buschmann,A.H., Bush,S.R., Cao,L., Klinger, D.H..A 20-year retrospective review of global aquaculture Nature, 591 (7851) (2021), pp. 551-563, 10.1038/s41586-021-03308-6
[15] Sultana, T, Haque M.M., Salam MA, Alam MM (2016) Effect of aeration on growth and production of fi sh in intensive aquaculture system in earthen ponds. MS Thesis, Department of Aquaculture, Bangladesh Agricultural University, Mymensingh. Link: https://bit.ly/39VBsCM
[16] Tacon, A.G.J., Metian, M., 2015. Feed matters: satisfying the feed demand of aquaculture. Rev. Fish. Sci. Aquac.23,1–10(Online:http://www.tandfonline.com/doi/abs/10. 1080/23308249.2014.987209?journalCode=brfs21).
[17] Tacon, A.G., Hasan, M.R., Metian, M., 2011. Demand and Supply of Feed Ingredients for Farmed Fish and Crustaceans (Rome). (Online: http://www.fao.org/docrep/015/ ba0002e/ba0002e00.htm)
[18] Younis T. Bottom-up implementation after Rio: Rural community participation in Scottish forestry. Community Development Journal. 1997; 32(4):299-311.

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