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CMFRI TECHNOLOGY - INTEGRATED MULTI - TROPHIC AQUACULTURE (IMTA)




Prepared by

B. Johnson
Amir Kumar Samal
A.K. Abdul Nazar
R. Jayakumar

ICAR-Central Marine Fisheries Research Institute
Mandapam Regional Centre
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Ramanathapuram District
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PREFACE

The Mandapam Regional Centre of the ICAR-Central Marine Fisheries Research Institute (CMFRI) has developed the technology for breeding, seed production and farming in cages and ponds for selected marine finfishes to meet the need of fisher-folk for carrying out small scale mariculture. It also took initiative and successfully conducted the demonstration of Integrated Multi Trophic Aquaculture (IMTA) under participatory mode with a fishermen group at Munaikadu (Palk Bay), Tamil Nadu by integrating seaweed *Kappaphycus alvarezii* with cage farming of Cobia (*Rachycentron canadum*). By integrating different groups of commercially important species which are having varied feeding habits, increased biomass production can be achieved along with the bio-mitigation. The demonstration were carried out under National Imovations in Climate Resilient Agriculture (NICRA) project. This booklet highlights the economic and environmental benefits of IMTA. I compliment the research team for their efforts in popularizing the IMTA technology.

Dr. A. Gopalakrishnan
Director, ICAR - CMFRI

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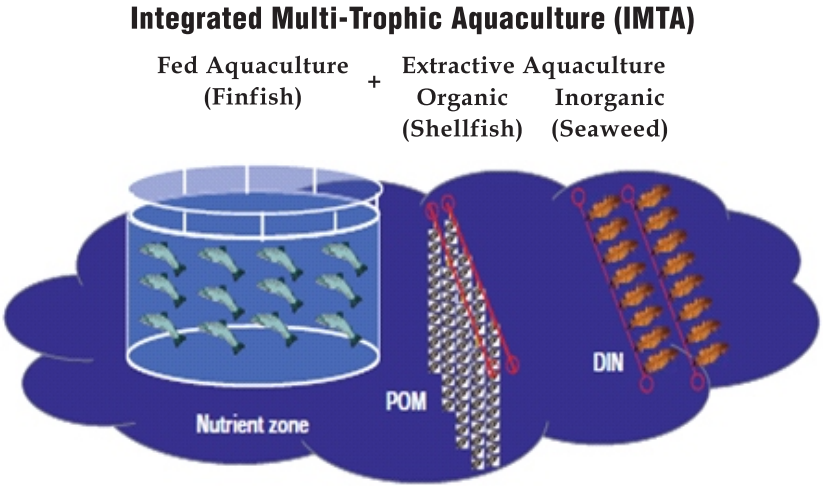
CMFRI Technology - Integrated Multi-Trophic Aquaculture (IMTA)

Introduction

The availability of fish from sea is declining in recent years mainly due to over-exploitation of fish stocks. The demand for fish is increasing year after year, as it is an important source of protein and it provides essential nutrients to the poorer sections of the society. Hence in future years additional sea fish requirement has to be met only by farming in seas namely, mariculture. The Mandapam Regional Centre of Central Marine Fisheries Research Institute (CMFRI) had been developing technologies for the seed production of high value marine finfish and farming techniques such as sea cage farming. This centre was able to standardize seed production and farming technologies of cobia and silver pompano, was also successfully demonstrated. One of the anticipated issues while expanding the sea cage farming is the environmental degradation and consequent disease problems. In this context, the idea of bio-mitigation along with increased biomass production can be achieved by integrating different groups of commercially important aquatic species which are having varied feeding habits. This concept is known as Integrated Multi-Trophic Aquaculture (IMTA) which is gaining importance at global level.

What is IMTA?

Integrated Multi Trophic Aquaculture (IMTA) is the practice which combines in appropriate proportions the cultivation of fed aquaculture species (E.g. fin fish / shrimp) with organic extractive aquaculture species (e.g. shell / herbivorous fish) and inorganic extractive aquaculture species (e.g. seaweed) to create balanced systems for environmental stability (bio-mitigation), economic stability (product diversification and risk reduction) and social acceptability (better management practices).



POM: Particulate Organic Matter; DIN: Dissolved Inorganic Nutrients
Source: Chopin, 2006

Successful demonstration of CMFRI technology - Integrated Multi-Trophic Aquaculture (IMTA)

The CMFRI has successfully conducted demonstration of Integrated Multi Trophic Aquaculture (IMTA) under participatory mode with a fishermen group at Munaikadu (Palk Bay), Ramanathapuram district, Tamil Nadu by integrating seaweed *Kappaphycus alvarezii* with cage farming of Cobia (*Rachycentron canadum*).

IMTA Design

A total of 16 bamboo rafts (12 × 12 feet) with 75 kg of seaweed per raft were integrated for a span of 4 cycles along with one of the cobia cages. A GI cage of 6 m diameter and 3.5 m depth with 750 cobia fingerlings was integrated with the above seaweed raft system. One complete cycle of seaweed extends for an average of 45 days duration and four such cycles were performed in a row. As a control, a separate set of rafts of the same number were grown in a distant location without any integration with the cages.

Seaweed rafts (16 Nos.) integrated with cobia cage

Cobia cage without integration of seaweed rafts

Seaweed rafts – without integration

Economic benefit through increased seaweed production under IMTA

The total seaweed production of the integrated rafts after 4 cycles was 1280 kg, while that of non-integrated rafts was only 576 kg. So, an additional yield of 704 kg of seaweed was achieved due to the integration with cobia cage farming.

Comparison of seaweed rafts - both integrated (with cobia cage) and non-integrated

Comparison of cost and returns of seaweed cultivation with and without IMTA (16 rafts/ one cage/4 cycle)

Particulars	With IMTA	Without IMTA
Dried seaweed production (for 4 cycle, 16 rafts)	1280 kg	576 kg
Price of dried seaweed (Rs.per kg)	37.50	37.50
Revenue (Rs.)	48,000	21,600
Costs (Rs.)	16,000	16,000
Net Profit (Rs.)	32,000	5,600
Profit Margin (%)	67	26

Moreover there was an increased number (average 90-100 nos.) of newly emerged apical portion/tips in a bunch of harvested seaweed from the rafts integrated with the cobia cages, whereas the same was less (average 30- 40 nos) from the rafts which were not integrated. The bunches having more numbers of newly emerged apical portion/tips, when used for replanting, will be ready for harvest within 40 days, whereas the seaweed with less numbers of newly emerged apical portion/tips, if used as seed, will be ready for harvest only after 54 days.

Comparison of a bunch of seaweed taken from integrated and non-integrated raft

More numbers of newly emerged apical portion /tips from integrated rafts

Although the operational costs of rafts in either case were the same, there was an additional revenue generation/additional net profit of Rs. 26,400 realized with an increased profit margin of 41 per cent through integration of seaweed rafts with cobia cages.

View of portion of harvested seaweed *Kappaphycus alvarezii* from the integrated raft

Economic benefit through increased cobia production under IMTA

The integration of the cage with seaweed also generated favorable returns for the farmers with respect to the finfish production.

In a six month production cycle of cage farming of cobia (along with 4 cycles for the integrated seaweed), an average yield of 1,220 kg was achieved with the integrated system in contrast to the non-integrated one where the cobia yield was only 960 kg. The gross revenue generated from the yield (with an average weight of 2.2 kg/ fish and at the rate of Rs. 290/ kg) was Rs. 3,53,800 for

Comparison of economics of sea cage farming of cobia with and without IMTA (for one cage & one crop of 6 months duration)

No.	Particulars	With IMTA (Rs)	Without IMTA (Rs.)	Difference
	750 cobia seeds were stocked in a 6m dia and 3.5m depth GI cage			
1	Fixed cost (one cage)	61,600	61,600	0
2	Total Operating cost	1,30,000	1,30,000	0
3	Total cost of production (Six months)	1,91,600	1,91,600	0
4	Yield of farmed fish (in kg) (in six months ave. wt. 2.2 kg)	1220	960	260 kg
5	Gross revenue in Rs. (@ Rs. 290 per kg)	3,53,800	2,78,400	75,400
6	Net income	1,62,200	86,800	75,400
7	Net operating income (Income over operating cost)	2,23,800	1,48,400	75,400
8	Price realized	290.00	290.00	0
9	Capital Productivity (Operating ratio)	0.37	0.47	-
10	Cost of production per kg	157	199	42
	Profit Margin (%)	85	45	40

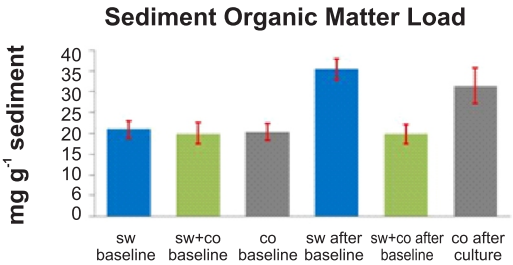
the integrated and Rs. 2,78,400 for the non-integrated cages. So, an additional net operating income of Rs. 75,400 was realized from the integrated cage. The decrease in operating ratio from Rs.0.47 to Rs.0.37 and cost of production per kg from Rs. 199 to Rs. 157 for non-integrated and integrated cages respectively augments the marginal profit percentage by an additional 40 per cent.

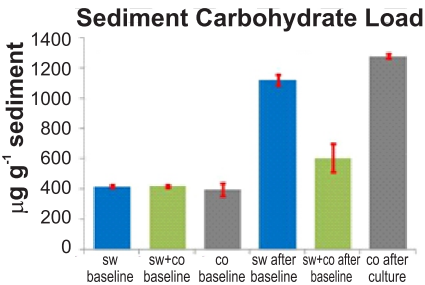
Environmental benefits under IMTA

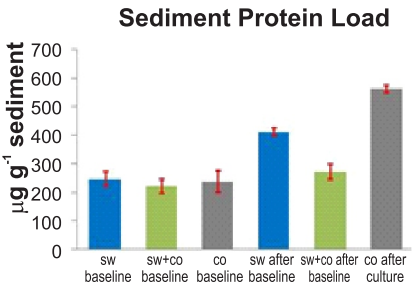
It was found that the organic waste mitigation of integrated system of *Kappaphycus* farming is more efficient than the non-integrated system of farming. Biochemical analysis of

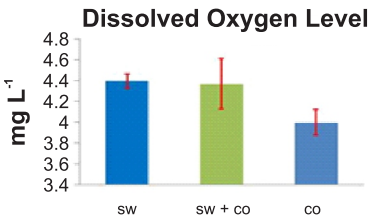
View of harvested cage farmed cobia fishes from the integrated cages

water and sediments from the experimental rafts and cages (figures) indicated a mutual beneficial effect of seaweeds and cobia in the integrated aquaculture system. The analyses for organic matter load and water quality parameters indicated that the organic wastes from the feed waste and excreta of fish were sequestered by the integrated seaweed. While the sequestration of the organic waste by seaweed acts as a fertilizer for itself, it decreases the organic pollution and helps the fish to save and minimize its energy expenditure towards warding off environmental stress, thus helping it to have better growth rate over its counterpart cultured in non-integrated manner.

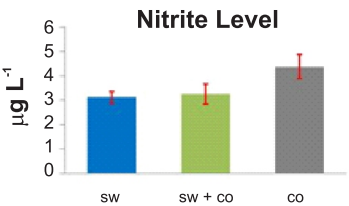








DO of co group is significantly lower (α=0.001) than the sw and sw + co group



Nitrite level of co group is significantly (α=0.015) higher than the sw and sw + co

The total amount of CO_2 sequestered into the cultivated seaweed (*Kappaphycus alvarezii*) in the integrated and non-integrated rafts was estimated to be 223 kg and 100 kg respectively. Hence there is an addition of 113 kg carbon credit due to integration of 16 seaweed rafts (4 cycles) with one cobia cage (one crop).

Comparison of carbon sequestration potential of seaweed cultivation with and without IMTA

No.	Particulars	With IMTA	Without IMTA
1	Fresh seaweed production (for 4 cycle, 16 rafts)	12800 kg	5760 kg
2	Average dry weight percentage of the harvested sea-weed (%)	8.75	8.75
3	Average carbon content (%)	19.92	19.92
4	Total amount of carbon sequestered (1)× (2)× (3)	223 kg	100 kg

Conclusion

It can be concluded that, integration of seaweed with cobia cages favourably generates additional revenue through increased yields of both cobia and seaweed. This is evident from the increased profit percentages in either case. A total of 25 fishers from Munaikadu village, Ramanathapuram district, Tamil Nadu are being benefited through this technology and they are perpetually adopting this technology with their own investment.