Backyard Recirculation Aquaculture System

1. Introduction

Recirculation Aquaculture System (RAS) is a technology wherein water is recycled and reused after filtration and removal of suspended matter and metabolites. The method is used for high-density culture of various species of fish utilizing minimum land area and water.

It is an intensive approach (higher densities and more rigorous management) than other aquaculture production systems. Instead of the traditional method of growing fish outdoors in open ponds and raceways, in this system fish are typically reared in indoor tanks in a "controlled" environment. Recirculating systems filter and clean the water for recycling it back through fish culture tanks. The technology is based on the use of mechanical and biological filters, and the method can in principle be used for any species grown in aquaculture. New water is added to the tanks only to make up for splash out, evaporation and for that used to flush out waste materials. The reconditioned water circulates through the system and no more than 10% of the total water volume of the system is replaced daily. In order to compete economically and to efficiently use the substantial capital investment in the recirculation system, the fish farmer needs to grow as much fish as possible in the inbuilt capacity. However, in order to encourage small-scale fish farmers and entrepreneurs and also to facilitate fish production in urban and peri-urban areas where land and water are scarce, it is proposed to promote Backyard Recirculation Aquaculture Systems.

2. Resources

Land based aquaculture is most commonly undertaken in dugout earthen ponds and often large stretches of fertile agricultural land gets converted into fish ponds for this purpose. Further, a large quantity of water is needed to fill up aquaculture ponds and the used water is often discharged untreated into the open. Given the fact that traditional methods of fish farming in India is able to produce 2–10 tonne/hectare and at the same time uses more than 20 litres of water per kg of fish, Recirculation Aquaculture System may need only $1/8^{th}$ of a hectare and $1/6^{th}$ of water and still would be able to produce up to 60 tonne fish per year. Being highly efficient, utilization of natural resources is very limited and results in conservation of precious natural resources like water, land and environment.

3. Status and Potential

Our country ranks good in freshwater fish production as even traditional methods of fish farming are able to produce anywhere between 2–10 tonne per hectare per year. But, a Recirculation Aquaculture System may produce up to 500 tonne fish per year in same area. Recirculation Aquaculture is a relatively new practice. Establishment of these units will therefore improve the knowledge base of fish farmers about emerging and future technologies in aquaculture.

Operation of these units is more demanding in terms of technology, techniques, biology of cultured fish and stringent water quality parameters. There is deficit of proper knowledge, expertise in technical management of Recirculation Aquaculture Systems (RAS) and entrepreneurial attitude for commercial scale units. The high investment costs may have kept RAS Technology away from our country until now. But there is an amazing potential for it in India and with growing interest RAS Units (big and small) are coming up in Uttar Pradesh, Bihar, Andhra Pradesh and elsewhere. In the next 5 years, these are going to be seen in many places in India for sure and RAS would be the next big thing to happen in Inland Fisheries Sector in the country.

4. Project Location and Implementation

A. Site Selection: Selection of a good site is extremely important, although Recirculation Systems are desirable where only limited water is available for removal of fish wastes out of the production system. Passing water through a treatment unit removes ammonia and other waste products achieving the same effect as a flow-through configuration. Land measuring approximately 100 m^2 is required for the construction of a Backyard RAS Unit.

B. Beneficiaries: Beneficiaries include women SHGs/ fisherman societies/ fish farmers/ entrepreneurs; selection would be based on their interest and awareness. Beneficiary selection is done through a ‘Call for Application’ via newspaper and NFDB Website.

C. Project Implementation:

- Project will be implemented by the beneficiary with technical support from the Designated Technology/Service Provider and Dept. of Fisheries of the State Govt.
- Financial assistance in the form of subsidy will be obtained from Govt. (Central/State) and the remaining amount will have to be borne by the beneficiary through self-finance, bank loan, etc.

5. Project Components

A. Water Quality: Water quality is important and optimum range of certain parameters required for successful fish culture in a Recirculation Aquaculture System is given below:

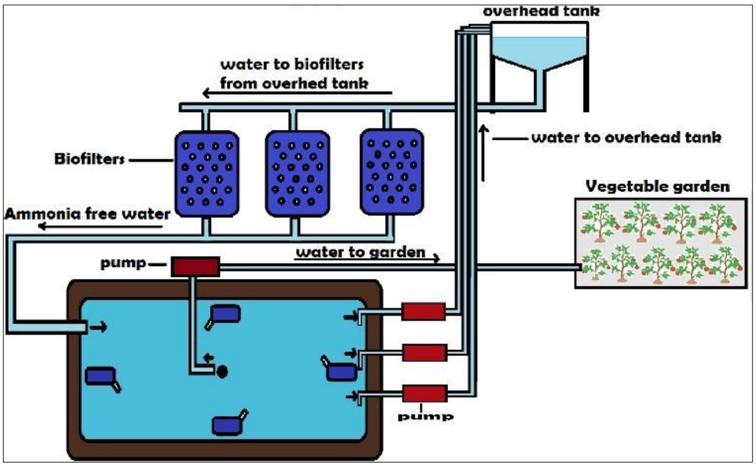
Sl. No.	Water Parameter	Optimum Range
1	Temperature	26 - 30 ^oC
2	Dissolved Oxygen	4 - 6 ppm
3	pH	7 - 8
4	Alkalinity	120 - 150 ppm
5	Ammonia	<0.05 ppm
6	Nitrite	<0.5 ppm
7	Nitrate	<5 ppm

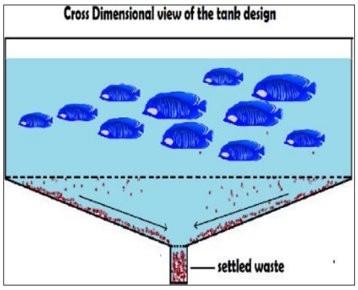
B. Pond/Tank: Area required for construction of the Backyard RAS pond/tank is 44.89 m^2. Fish Tank is constructed with RCC/ brick masonry and lined with HDPE sheet; the dimensions are 6.7 x 6.7 x 2 m, having a water volume of 90 m^3 (90,000 litre); bottom is conical with a slope of 18^o; effective water depth is 2.0 m and maximum depth is 3.3 m (at centre of the tank). Details of design of the Backyard RAS pond/tank is given below:

Sl.No.	Particulars	Unit
1	Total Land Area required	Maximum of 100 m^2
2	Tank Area	44.89 m^2
3	Tank Dimension	6.7 x 6.7 x 2 m
4	Tank Volume	90 m^3 (90,000 litre)
5	Effective Depth	2.0 m
6	Bottom Shape	Conical with a slope of 18^o and a central slurry accumulating pit
7	Maximum Depth	3.3 m (Centre of the tank)
8	Pump	0.5 HP, Centrifugal Pump
9	Venturi Aeration System	0.5 HP, 4 Systems in a tank
10	Bio-filters	Trickling, Nitrifying Bioreactor

C. Floating Cages: Three cages of 30 m^3 each are floated in the 90 m^3 pond/tank, in series. Cages may be free floating or fixed.

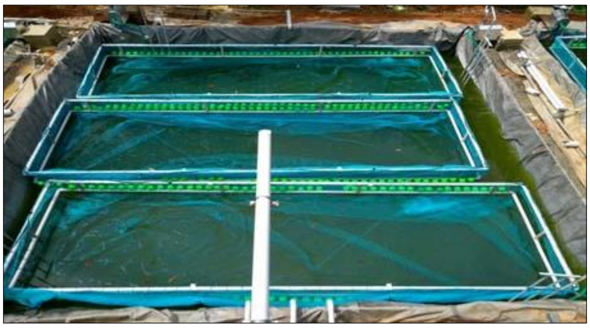
D. Model Backyard RAS Unit: The design of a '*High Density Fish Culture under RAS'* unit developed by CUSAT, Kerala, is given here as an example:





Plan view of 'Backyard RAS Unit' (left) and Cross-Section of Fish Tank Bottom (right)

RAS Fish Tank Setup



Floating Cages Setup in RAS Fish Tank

E. Targeted Fish Species: Monosex Tilapia *(Oreochromis niloticus*), Pearlspot (*Etroplus suratensis*) and Pangasius *(Pangasiandon hypophthalmus***)** are suitable for Backyard RAS.

		
GIFT Tilapia (*Oreochromis niloticus*)	Pearlspot (*Etroplus suratensis*)	Pangasius (*Pangasiandon hypophthalmus*)

F. Stocking and Yield: Although stocking densities should be determined by species requirements and operational considerations, the influence of stocking densities on growth and production has been determined empirically. The indicative stocking and harvest details are as follows:

Sl.No.	Component	Salient Feature
1	Floating Cages Unit	3 nos. (30 m^3 each)
2	Targeted Species	GIFT Tilapia (*Oreochromis niloticus*), Pearlspot (*Etroplus suratensis*) and Pangasius (*Pangasiandon hypophthalmus*)
3	Fingerling stocking rate	1500 nos./Cage; 4500 nos./ 3 Cages
4	Culture period	5-6 months
5	Survival	80% (3600 nos.)
6	Average body weight	450 g
7	Expected yield/unit/cycle	540 kg/cage x 3 cages =1620 kg/ 6 months
8	Total Production per year	1.62 tonne x 2 = 3.24 tonne per year

6. Probable Project Cost

Sl. No.	Components	Unit Cost (Rs. in lakh)
A	***Setup Cost***	
1	Fish Tank Construction	1.0
2	Procurement & installation of Cages, floats, pumps, filters, aerators, pipes, valves, etc.	4.6
	Sub-Total (A)	**5.6**
B	***Inputs Cost***	
1	Seed (4500 fingerlings @ Rs.6/each)	0.27
2	Feed (28-30% protein; floating pellets)	0.72
3	Transportation	0.06
4	Probiotics	0.15
5	Electricity	0.08
6	Others including Service Delivery	0.12
	Sub-Total (B)	**1.40**
	Total Cost (A+B)	**7.0**

7. Estimated Project Costs & Returns

Sl.No.	Particulars	Amount/ Quantity
1	Culture period for fish	5-6 months
2	Fish fingerlings stocked (@ 50/m^3)	4500 nos./unit
3	Expected Survival (%)	80%
4	Total Fish Survived (nos.)	3600 nos.
5	Average Size at harvest (g)	450 g
6	Production (kg/cycle/unit)	1620 kg
	Total Production/unit/year (2 cycles)	3240 kg
7	Sale Price (Rs/kg)	Rs. 150/-
8	Gross Income/year (Rs)	Rs.4,86,000/-

8. Comparison of GIFT Monoculture in Conventional Earthen Pond vs. Backyard RAS

Component	Conventional Earthen Pond	Backyard RAS
Stocking Density (Monosex)	20,000/ha (2-3/m^3)	50/m^3
Culture Duration	4-5 months	4-5 months
Feeding Rate (% Av. body wt.)	3.5 - 1%	8 - 2%
Feed Type (commercial, pellet)	25-32% CP	25-32% CP
Feed Cost	Rs. 28-30/kg	Rs. 28-30/kg
Harvest Size	500-600 g	500-600 g
Farm-gate Price	Rs. 75/kg	Rs. 75/kg (Rs.100-150/kg if sold live)
Total Production/ha area	8.0 - 9.5 t/ha	150 - 160 t/ha
Productivity for Semi-intensive System	10-20 t/ha/yr.	300-320 t/ha/yr.
Commonly Practiced in	TN, Kerala, AP	Kerala
Potential	In all tropical regions	In all tropical regions

9. Project Monitoring Unit (PMU)

A Project Monitoring Unit (PMU) comprising representative of the Designated Technology/ Service Provider, Dept. of Fisheries of the State Govt. and the NFDB would be constituted to monitor the implementation and progress of the Project.

10. Further Reading

Jacob Bregnballe, 2015. *A Guide to Recirculation Aquaculture: An introduction to the new environmentally friendly and highly productive closed fish farming systems*. Published by FAO and EUROFISH International Organisation, 2015, pages 1-100.

Ravindranath, K., 2017. Tilapias – the most amenable fishes Introduced and Farmed Worldwide. NFDB Newsletter *Matsya Bharat*, Vol. 8, Issue 5, January-March 2017, pages 26-38.