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Baseline survey of Recirculatory Aquaculture System (RAS) farms features and variables in Haryana, India

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ABSTRACT

In the last five years, the state of Haryana has implemented a few high stocking density holding modern fish farming technologies such as Biofloc and Recirculation Aquaculture System (RAS) to boost farmers' fish production. Besides this, RAS technology has the potential to filter water while reducing the danger of environmental contamination and disease outbreaks due to its unique characteristic of filtration systems. The primary goal of this face-to-face interview-based study was to determine the state of various variables, characteristics, RAS employees' skills, farmer engagement, and the role of the Pradhan Mantri Matsya Sampada Yojana (PMMSY) in the overall development of this technology in state of Haryana. The majority of RAS farms in Haryana (55%) employed unskilled employees, 25% employed mixed skilled and unskilled workers, and 20% employed just skilled workers. With the implementation of the Pradhan Mantri Matsya Sampada Yojana (PMMSY), the majority of farmers (90%) received government subsidies for the construction of their high-cost RAS projects, while 5% of farmers built their RAS systems under the Blue Revolution scheme and 5% used their own resources to build the farms without any government assistance. On the other side, majority of RAS farmers (45%) sell their production stock to local district markets, while 30% opted to sell their stock inside and beyond the state, compared to 25% who sold their output within their district and State Haryana. All RAS farmers have single units of RAS for fish farming but only 70% RAS farms have 8-6 production tanks on their RAS farms. Whereas 95% of farmers have a power backup (generator) for the appropriate operation of RAS filtration during emergency hours, 35% of RAS farms have four aerators/units for improved filtration and fish survival under high stocking density technology.

***Key words**: Production tanks, Subsidy, Skills, Stock, PMMSY.*

Introduction

Currently, India accounts for 7.56 percent of worldwide output, providing roughly 1.24 percent to the country's Gross Value Added (GVA) and more than 7.28 percent to agricultural GVA, with fresh water aquaculture playing a significant role. According to the Fisheries Department of the Government of India, export profits from the Fisheries industry were Rs.46, 662.85 crores in 2019-20 (Anonymous, 2021). Around the world, recirculatory aquaculture systems (RAS) are used in fabrications. Significant water inflow governance in RAS can preserve water quality and boost output. There is currently a tremendous opportunity for Recirculatory Aquaculture System (RAS) in India, particularly in Haryana, to increase fish yield. RAS requires a very constrained production area, thus it has superior production tanks, self-cleaning capabilities, and water depth (Losordo *et al*., 1998; Balami, 2021). A recirculating system purifies the water used for fish culture and recycles it back into the tanks (Helfrich and

Libey, 1990). Circular shaped tanks in RAS provide a homogeneous environment for productive culture and allow for a reasonable velocity that optimizes healthy conditions through organic matter removal (Farghally *et al*., 2014; Malone, 2013). Rectangular tanks with round edges are also utilized as production tanks in RAS units (Bregnballe, 2015). The efficiency of the recycling system is determined by the stocking rate, fish production level, water flow rate, recycling rate, daily water replacement, feeding rate, and waste output (Van Gorder, 1994). Moreover, economic feasibility of fish production in a recirculating aquaculture system is partly dependent on reducing the energy consumption of such facilities. RAS need a more sophisticated technological infrastructure than open systems (Singh and Marsh, 1996). Production tank features that are suited for the RAS should have self-cleaning properties, a low particle retention time, oxygen control and regulation, and space utilization. In terms of both water quality and tank design, the fish rearing tank should create an environment that meets the demands of the fish. Size and form, water depth, self-cleaning capabilities, and other criteria must be considered while selecting the best tank design (Bregnballe, 2015). The circular tanks utilized in the RAS system provide consistency of the culture environment and allow for a range of reasonable velocities that maximize the simple removal of settable solids. Circular production tanks with a sloping bottom provide uniform water quality and are ideal for cultivation (Farghally *et al*., 2014; Lee *et al*., 2013). Besides this, selection of a water treatment solution that is compatible with biofilters is critical for optimal operational performance in RAS aquaculture (Jean, 2023). Current research on the factors and characteristics of RAS systems is being undertaken to better understand the trends of RAS farming in the Haryana region.

Materials and Methods

Based on discussions and accessible research, a survey questionnaire was designed with the greatest numbers of closed and open-ended questions were included. It was divided into 2 different surveys based proforma. Proforma I included RAS farms features and variables and Performa II depicted worker profile and innovation in RAS respectively. One year face to face survey was conducted to understand the RAS farm features, variables and innovation status in Haryana. The study encompassed 20 RAS farms situated in different districts of Haryana. The majority of these farms established their units under the Pradhan Mantrimatsaya Sampada Yojana (PMMSY). Fatehabad district of Haryana contributed three RAS farmers, while Jind, Karnal, Gurgaon, Sonipat and Rohtak each had two representatives. In addition, one RAS farmer was included from Ambala and one from Karnal. Standard statistical methods such as frequency distribution and percentage were employed to analyze data collected in various trials.

Material used for tanks	
Material used for floor construction	
Material used for shed construction	
RAS components material	
Material used local or branded	
Purchasing company	
Installation company	
Number of Water quality kits	
Company of water quality kits	
Disinfectants use	
Manure using or not	
Source of water	
Any other material using	
Year of starting	
Time of construction	

Farm labour	Self/ Hired
Number of labour	
Qualification of labour	
Skilled or unskilled	
Job type	Temporary/ Permanent
Annual electricity charges (Rs.)	
Annual fuel composition (Rs.)	
Inputs & export services	
Training & Literature	
Cleaning & repair/Renovation	
Any taxes or other expenses	

Fig. 1. Representation of the survey Performa I and II

Results and Discussion

RAS farms features and variables in Haryana

With the onset of the Pradhan Mantri Matsya Sampda Yojana (PMMSY), majority of the farmers (90%) got benefited from the government subsidy for the construction of their high-cost RAS projects while 5 percent farmers constructed their RAS system under the Blue Revolution scheme and 5percent used their own resources to construct the farms without any government aid (Table 1). Survey data revealed that the 90 percent farmer's utilized underground water as main source of water for their recirculatory aquaculture system, but 5 percent farmers preferred to take river water for their RAS farms in Haryana region. Olaoye *et al.* (2013) also reported that 61.7 percent fish farmers of their study depended directly on river water as major source, 25.2 percent on deep well water and 13.1 percent on borehole for their fish farm respectively. The regular check on the requirement of water exchange and cleaning prevents disease outbreak and control fluctuations in water quality parameters (Meliko *et al.*, 2021).Mostly farmers (85%) preferred to construct closed type shed (Figure 1) followed by (15%) semi closed shed (Figure 1) for their recirculatory aquaculture systems. Olaoye *et al.* (2013) also reported that fish farmers (44.1%) used both concrete and earthen ponds, 27.5 percent used concrete pond, 26.1 percent earthen pond, while 2.3 percent used fish trough/ holding/rearing structure for their fish farming. In a separate study, Omeje *et al*. (2021) reported that 80 percent of the fish farmers adopted the earthen pond system and 20 percent use flow-through system for their fish farming.

Advanced RAS with closed shed **Advanced RAS with semi closed shed**

Fig. 1. RAS farms with different types of sheds

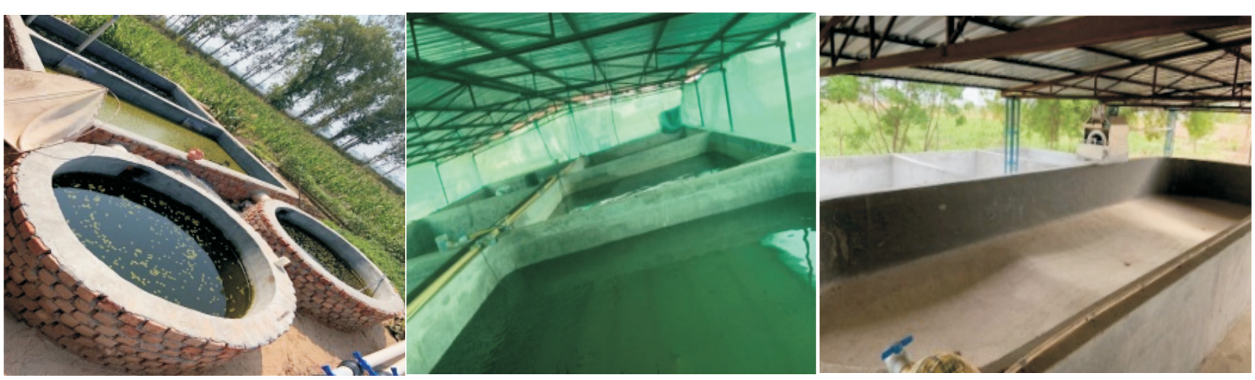
Among the 20 RAS farms, 55 percent farmers were using 2 aerators/unit followed by 35 percent who were using 4 aerators/unit. Out of the total RAS farms, 5 percent each were using 5 and 8 aerators per unit (Table 1). In Punjab, 100 percent shrimp farmers installed 10 wheel aerators in one ha pond to keep the ponds well aerated with water depth between 4-5 feet (Brar *et al.,* 2022). Besides this, all the farms have generator facility for proper functioning of RAS unit, 95 percent of the farms were using one generator whereas, 5 percent farms had 2 generators.

Only five percent RAS farmers in Haryana prefer to manure their recirculatory aquaculture system before starting the production cycle.

When inquired about fish market preference, it was clear that majority (45% farmers) preferred to sell their production stock to local district market and 30 percent preferred to sell their stock within and outside the state as compared to 25 percent who were selling their produce within their district and state (Haryana) (Table 1). During survey it was observed that the 85 percent farmers preferred to construct advanced recirculatory aquaculture systems (RAS) for fish farming and only 15 percent farmers preferred to construct backyard or integrated recirculatory aquaculture systems (Low-cost RAS). The 40 percent farms had 8 tanks/ RAS unit followed by 10 tanks/ RAS unit in 30 percent farms, 12 tanks/ unit in 25 percent farms and 14 tanks/ unit in 5 percent farms. Majority of RAS farmers (75%) preferred to construct circular shape RAS production tanks than square (20%) and rectangular (5%) tanks (Figure 2). During the study it was noted that RAS tanks with water holding capacity of 50,000 liters were more preferred (90%) than tanks with 80,000 (5%) and 1,00,000 (5%) liters capacity. Edet *et al.* (2018) observed that 53.4 percent fish farmer's preferred small size of operational ponds (less than 5 in numbers) on their production sites, 33.3 percent had 5 to 10 production ponds and 13.3 percent had more than 10 ponds. Maximum number of RAS farmers (75%) brought fish seed by air and road in comparison to 25 percent who preferred only road transport.

Worker profile and innovation in RAS units of Haryana

Maximum number of farmers preferred permanent labour employed on their farms for management instead of the contractual labourer in Haryana region. According to number of workers on RAS



RAS with circular tanks at Fatehabad RAS with square tanks at Jind Rectangular cemented tanks in RAS

Fig. 2. RAS farms with different shapes of tanks

Table 1. Frequency distribution of RAS farms features and variables in Haryana

Profile information	Type of funding		Profile information	Fish market preference	
	Frequency	Percentage		Frequency	Percentage
PMMSY Scheme	18	90	Within district	9	45
Blue revolution scheme	1	5	Within district + state	5	25
Owned	1	5	Within state +Other state	6	30
Total	20	100	Total	20	100
	Type of RAS shed			Type of water source	
Semi Closed	3	15	Underground water (Bore well)	18	90
Closed	17	85	River water	1	5
Total	20	100	Both	1	5
	Number of aerators/ units		Total	20	100
2	11	55		Number of generators	
4	7	35	1	19	95
5	1	5	2	1	5
8	1	5	Total	20	100
Total	20	100		Seed mode of transportation	
	Manure application		By road	5	25
Yes	1	5	By air+ road	15	75
No	19	95	Total	20	100
Total	20	100			
	Type of RAS units			Number of RAS units/ farm	
Advance	17	85	Single unit	20	100
Backyard/Integrated (Low cost RAS)	3	15	Double unit	0	0
Total	20	100	Total	20	100
	Production tank shape			Production tank capacity	
Rectangular	1	5	50,000 litres	18	90
Square	4	20	80,000 litres	1	5
Circular	15	75	1,00,000 litres	1	5
Total	20	100	Total	20	100
Number of tanks/ RAS unit					
8	8	40	12	5	25
10	6	30	14	1	5
		Total: 20 (100)			

farms 45 and 40 percent farms preferred to hire 2 and 1 worker, respectively on their farms as compared to 3 workers by 10 percent farms and 5 workers by 5 percent farms (Table 2). Besides this, 65 percent RAS farms in Haryana are providing Rs. 10,000 per month as salary to their working labour and only 10 percent RAS farmers are giving highest salary (Rs.14,000/-) to their workers in addition to boarding-lodging. Three RAS farms were giving Rs. 11000-12500/-salary to their workers and two RAS farm owners were distributing Rs. 8000/- as salary per month to their workers. Majority of RAS farms (55%) in Haryana employed unskilled workers, 25 percent employed both skilled and unskilled workers whereas 20 percent farms had only skilled workers on their farms. Brar *et al*. (2022) reported that 76.7 percent shrimp farms preferred to hire permanent labour and 10 percent hired contractual labour on their shrimp farms. Out of these, 86.7 percent shrimp farmers of Punjab have skilled labour and 13.3 percent have unskilled labour on their farms. Among the RAS farmers, only one farmer in Haryana introduced innovation in his RAS unit and is now establishing his innovation units in other farms also. One RAS farmer received prestigious Padam Shree award from Government of India for his outstanding work in fish farming (Table 2).

Table 2. RAS farms worker profile and innovation status in Haryana

Profile information	Number of workers employed		Profile information	Type of workers	
	Frequency	Percentage		Frequency	Percentage
Permanent	18	90	Skilled	4	20
Temporary	2	10	Unskilled	11	55
Total	20	100			
	Avg. per worker salary (Rs.)		Both	5	25
		Total	20	100	
8000	2	10		Number of workers/RAS	
10000	13	65	1	8	40
11000	1	5	2	9	45
12000	1	5	3	2	10
12500	1	5	5	1	5
14000	2	10			
Total	20	100	Total	20	100
	Innovative RAS farmers			Award winners	
Yes	1	5	Yes	1	5
No	19	95	No	19	95
Total	20	100	Total	20	100

Conclusion

With the establishment of the Pradhan Mantri Matsya Sampada Yojana (PMMSY), the majority of farmers obtained government subsidies for the building of their high-cost RAS projects with the goal of doubling their revenue from fish farming using advanced RAS technology. The preceding remark indicates that PMMSY had a significant influence in the formation of this advanced technology in the state of Haryana. Aside from that, a few farmers used their own money to establish the farms without the help of the government. In contrast to experienced staff, it is obvious that the bulk of RAS farms in Haryana used unskilled labor for overall RAS farm upkeep. Furthermore, on their RAS farms, most RAS farmers have closed RAS units with circular production tanks with a capacity of 50,000 litres of water. Furthermore, research is required on the working efficiency and overall cost benefit analysis of fish farming under RAS systems in Haryana require to understand the farmer's setback behind their overall production, development and growth by implementing this advance technology.

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