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Constraints and challenges of fish farmers with a recirculatory aquaculture system (RAS) in Haryana State, India

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ABSTRACT

The present study was conducted with the aim of examining the most relevant constraints, challenges, and experiences of RAS fish farmers in the state of Haryana state of India. Over the course of a year, extensive surveys were conducted among 20 RAS farms in various districts of the Haryana Region, i.e., Ambala, Bhiwani, Fatehabad, Gurgaon, Hisar, Jind, Kaithal, Karnal, Rohtak, Rewari, and Sonipat. These farmers were interviewed face to face using a questionnaire that combined closed- and open-ended questions to gather valuable insight. The results revealed several common constraints faced by RAS farmers in Haryana. The most significant challenges that farmers faced included disease outbreaks (50%), seed quality issues (45%), lack of knowledge about RAS (35%), and misguidance (5%). Additionally, farmers reported difficulties in seed transportation (10%), and approximately 70% of the farmers emphasized the critical need for specialized training in RAS operations. Moreover, 50% of the farmers considered the lack of information regarding suitable fish species for RAS to be a major problem. In terms of RAS equipment, drum filters (35%) and MBBR media (30%) were the most common malfunctioning components for fish farmers, while 55% of the farmers experienced no default in their RAS systems. Moreover, this research revealed that Haryana farmers are interested in the adoption of RAS technology and are interested in a prototype farm with professional guidance to promote its adoption.

Introduction

Aquaculture contributes 52% of the total human fish consumption worldwide (FAO, 2020). Its output is predicted to climb by 60-100 percent by the end of the century to keep up with population expansion and rising per capita fish consumption. Future food production must be integrated (Tyson *et al*., 2011) and intensified (Rockström *et al*., 2013) to fulfill these needs. The use of intensive recirculating aquaculture systems (RAS) to produce aquaculture species is regarded as one of the most sustainable and environmentally friendly farming systems for acquiring animal protein per unit area (Badiola *et al*., 2012; Martin *et al*., 2010). Furthermore, RAS have the advantages of indefinite extension, environmental friendliness (they use 90% less water and occupy less than 1% of the land area than conventional aquaculture systems), and ensuring safe quality fish output (Ebeling and Timmons, 2012). The primary limits, on the other hand, include significant capital and operational expenditures, as well as the need for very careful management and difficulty in treating illnesses (Schneider *et al*., 2006). Furthermore, having water in continuous reuse necessitates ongoing pumping of additional intake water, resulting in increased electrical expenses, i.e., the greater the water reuse is, the

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greater the costs (Shepherd and Bromage, 1988). RAS facilities are often energy demanding, with large investment expenditures that must be monitored and maintained by a skilled team (Anonymous, 2021a). The economic feasibility of fish production in a recirculating aquaculture system is partly dependent on reducing the energy consumption of such facilities. Because RAS require more technological infrastructure than open pond systems, the energy costs of RAS have previously been identified as important restraints that may prevent this technology from being widely used (Singh and Marsh, 1996). Benjamin *et al*. 2022 reported that it is critical to have access to appropriate equipment and inputs, as well as energy for the recirculating system. Moreover, the Indian government intends to develop 1178 recirculatory aquaculture system units by 2025, with a focus on Uttar Pradesh, Andhra Pradesh, Haryana, and Punjab (Anonymous, 2020). In Haryana, the Department of Fisheries plans to build 16 new RAS units at a cost of Rs 50 lakh Avenue, with a 50% subsidy (Anonymous, 2021b). On the other hand, the rapidly expanding aquaculture business in the state of Haryana is also a significant economic generator, offering a high-quality, low-cost protein diet. Haryana is second in the country in terms of average annual fish output per unit area. Compared to the national average of 2900 kg, the state produces 7000 kg of fish per acre per year (Anonymous, 2021b). This RAS system will be able to generate 40 tons of fish per acre, doubling the revenue of fish farmers. The primary goal of this research is to examine the most relevant constraints, challenges and experiences of RAS fish farmers in Haryana State, India. This comprehensive picture will assist in determining where changes may be made to benefit complete aquaculture farming by using RAS in the fisheries sector.

Material and Methods

An extensive survey was carried out for one year, March 2021 to March 2022, and the major goal of this study was to present the findings to RAS fish farmers at the start of the survey program to ensure their cooperation. Contact information for RAS farmers was obtained with the assistance of the State Fisheries Department and local aquaculture specialists. Out of a total of 35 RAS farmers in Haryana, 20 agreed to enable us to visit important locations for face-to-face interview-based surveys. Various farmers, encompassing both seasoned practitioners and newcomers, were subjected to observation to discern the challenges encountered during cultivation. The experienced farmers, already proficient in their practices, requested uninterrupted cultivation to showcase their methods and asked us to visit their farms during their whole culture period. However, for the newcomers, they wanted to complete their 1st and 2nd crops, focusing on unraveling the specific constraints and challenges confronted by recirculating aquaculture system (RAS) farmers throughout their cultivation cycles. These farmers were from the Haryana districts of Ambala, Bhiwani, Fatehabad, Gurgaon, Hisar, Jind, Kaithal, Karnal, Rohtak, Rewari, and Sonipat. A questionnaire was created by using the literature and was discussed with fish farmers and academics at the College of Fisheries Science, CCSHAU, Hisar. Based on discussions and previous accessible research, the greatest numbers of closed- and open-ended questions were included in this questionnaire. Frequency count- and percentage-based methods were applied to this survey program.

Results and Discussion

Common constraints of RAS farms in Haryana

During the survey program in Haryana State, India, the most common reasons for poor growth performance in fish cultivated in recirculatory aquaculture systems were disease outbreaks (50%) and poor seed quality (45%), but 35% of the farmers were also concerned about a lack of knowledge about RASs (Table 1). These three concerns are major reasons for the poor growth of fish stocks. Aich *et al*. (2020) reported that after pathogens have infiltrated the RAS, their potential impact on the stock is influenced not only by the quality of the system design but also by the knowledge and experience of the RAS manager. Approximately 5% of the farmers also reported that misinformation about RAS farming contributed to the poor development of their fish stock under the RAS system. There is prevalent misinformation among farmers who have been misled into thinking that merely introducing fish culture into a recirculating aquaculture system (RAS) will guarantee success. Unfortunately, many lack awareness of the

Table 1: Frequency distribution of common constraints of RAS farms in Haryana

Profile in formation	Most common reason for poor growth (n=20)		Profile information	Most common problem in RAS (n=20)	
	Frequency	Percentage		Frequency	Percentage
Seed quality	9	45	**High cost of investment**	4	20
Disease outbreak	10	50	**Intensive management and cost**	16	80
			Total	**20**	**100**
Lack of knowledge	7	35		**Bad Seed quality**	
Misguidance	1	5	**Yes**	17	85
Seed transportation issue	2	10	**No**	3	15
			Total	**20**	**100**
Most common default component(n=20)			**Most common suggestions of farmers(n=20)**		
Drum filter	7	35	**Training required**	14	70
MBBR media	6	30	**Lack of knowledge regarding RAS**	15	75
UV system	1	5	**Proto type farm**	11	55
No	11	55	**Lack of information regarding sustainable fish species**	10	50

fundamental principles and operations of RAS. Their understanding is limited to the presence of tanks, and they assume that placing fish in these tanks is sufficient for successful cultivation. The RAS functions as an integrated system, necessitating a comprehensive understanding of each filtration system's operation and specifications. Farmers must grasp the intricacies of filtration processes for effective implementation. Furthermore, 10% of the RAS farmers stated that seed transportation was a major factor in their poor growth rate, while 85% of the farmers experienced poor seed quality during stocking (Table 1). When selecting seeds, farmers are advised to choose locally available, healthy seeds from certified hatcheries. It is crucial to prioritize health conditions and select seeds that result from a controlled breeding process. Farmers should take measures to avoid inbreeding seeds for optimal results. Maintaining a successful recirculating aquaculture system (RAS) farm poses significant challenges, with low feed quality and concerns related to fecal matter emerging as two key issues (The Fish Site, 2019). During the whole cultivation period, the most common defaulting components of RAS units observed by RAS farmers were drum filters (35%; Figure 1) and MBBR media (30%), whereas 55% of the farmers experienced no default in their RAS systems. On his/her RAS farm, one farmer also encountered issues with the UV filtration system (Table 1). According to the study conducted by Badiol *et al.* (2012), the most difficult device to manage within the RAS is a biofilter (44%). During the study, 75% of the farmers said that they lacked specialized information about the operation of recirculatory aquaculture systems (Table 1). The challenges faced by recirculating aquaculture system (RAS) farmers primarily result from a shortage of skilled personnel who are willing to take responsibility for issues related to water quality and mechanical problems, as reported by Badiola *et al.* (2012). Seventy percent of the Haryana farmers wanted specific training to ensure the success of their recirculatory aquaculture systems. Approximately 55% of Haryana farmers stated that a prototype farm based on a recirculatory aquaculture system with expert researchers and scientists would be extremely beneficial to the development of this advanced technology in the state (Table 1). According to McKinsey *et al.* (2006), a comprehensive understanding of the limitations of

Figure 1: Representation of malfunctioning of the working drum filter

each system necessitates the delineation of issues related to physical, environmental, production, and social carrying capacity. Furthermore, in the present survey, 35% of the Haryana RAS farmers surveyed noted that the common reasons for poor growth performance were lack of knowledge about working in the RAS system, lack of specific professional training in RAS, better seed quality, prototype fish farms on RAS and misguidance regarding RAS farming, which contributed to the poor growth of fish. The primary challenges include inadequate system design, since many had been updated after a prior method proved ineffective, and poor administration, owing mostly to a lack of competent individuals assuming responsibility for water quality and mechanical problems. Moreover, Pandey and De (2015) also reported that 68.89% of fish farmers had a medium level of knowledge regarding improved practices for scientific fish farming. Devi *et al*. (2014) noted that the number of problems faced by fish farmers in their fish production cycle were a lack of drainage facilities during the rainy season, lack of training facilities related to new technology, nonavailability of funds from institutional sources, scarcity and untimely availability of fingerlings and high cost. The development and adoption of aquaculture can provide benefits for livelihood improvement, food security and poverty alleviation through income generation, employment, diversification of farm practices and trade to both farmers and the nation (Bondad Reantaso *et al*., 2005; Kaminski *et al*., 2020).

Conclusion

This surveillance was intended to express valuable information regarding the constraints and challenges of RAS technology for fish farmers.

Undoubtedly, recirculating aquaculture systems (RASs) offer significant benefits for farmers, but they encounter various challenges:

- Lack of proper knowledge or expertise.
- The absence of a prototype RAS farm.
- Inadequate selection of candidate species.
- Poor seed quality.

Running an RAS system without adequate guidance is challenging. Given that it is an integrated system with diverse filtration components, farmers require skilled hands, professional training, and guidance from scientists, experts, and professionals during the initial phases (1-2 years) to learn and install the system effectively. While RASs hold immense potential for the future of fish farming, their success depends on farmers being exposed to prototype farms under expert guidance during their initial cultivation cycles. From the perspective of the economics of RAS farming, the farmers shared that they are facing the problem that the establishment of RAS itself is a very costly process; moreover, RAS requires intensive monitoring, which in turn has an impact on increasing costs, and they also suggested having a cost-effective low-investment RAS setup, which can be beneficial for every fish farmer. RASs are characterized by intensive cost management, necessitating a continuous supply of electricity to operate various systems. Providing electric subsidies could alleviate the initiation cost and reduce the economic burden on farmers. If farmers successfully address these challenges, they could significantly increase fish production in RASs. In addition, Haryana RAS fish farmers have a demand for scientific and expert support in terms of RAS component selection, design and operation with the help of proto-type RAS excellence farms in the state of Haryana.

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Conflict of interest

The authors declare that they have no conflicts of interest.