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To Assess the Current Status of Trout Farms in Kullu And Mandi Districts of Himachal Pradesh

Meenakshi Sharma[1*] • Rohit[1] • Mansi Sihotra[1] • Ishita Rathore[1]
[1]*Department of Zoology, Sri Sai University, Palampur, Himachal Pradesh, India*

*Corresponding Author Email: msharmahpkv1983@gmail.com

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Abstract: Trout fishing in Himachal Pradesh was introduced to attract tourists, featuring two species: Oncorhynchus mykiss and Salmo trutta fario. These fish thrive in the upper reaches of snow-fed rivers like Beas, Sutlej and Ravi. Commercialization began in 1990 with rainbow trout breeding in hatcheries. However, recent observations revealed a decline in wild trout populations due to human activities, pollution, and climate change. The rainbow trout (*Oncorhynchus mykiss*) holds significant importance in aquaculture, both in India and globally. In India, rainbow trout production has steadily increased, especially in regions with favorable environmental conditions, such as Himachal Pradesh. In the present survey, trout farms in the Kullu and Mandi districts were investigated, where various individuals were interviewed using questionnaires distributed among farm owners and their staff. The collected data were thoroughly analyzed, revealing challenges such as limited fish seed availability, transportation issues, environmental factors, topographical constraints, socio-economic challenges, and a lack of awareness among farmers. The necessity of addressing these challenges to fully harnessing the potential of trout culture in Himachal Pradesh was highlighted. A comprehensive survey was conducted to assess the maintenance, care practices, operational efficiency, and infrastructure of trout farms, revealed insights into farm management practices. The study concluded with recommendations for improvements to enhance productivity and sustainability in trout farming in the region.

Keywords: Trout farms • Oncorhynchus mykiss • Salmo trutta fario • Himachal Pradesh • Environmental challenges

Introduction

Himachal Pradesh is located in the Northwestern Himalayas, between 30°22' and 33°12' north latitude and 75°47' and 79°4' east longitude, at an elevation ranging from 320 to 7000 meters above mean sea level. The fishery potential within the Himalayan region remains largely untapped due to the remote location of its cold-water resources. The water bodies in the Himalayan region harbour a diverse array of fish species. The abundant fishery resources in the Himalayan region encompass around 258 fish species, including native Mahseer, Snow Trout, Exotic Trout, and Common Carp (Singh *et al.*, 2014). Out of a total of 1,300 fish species, approximately 36 freshwater fish species are unique to the Himalayan region (Ghosh 1997). Trout, initially introduced for amusement in certain rivers and streams of the mountains, has succeeded in establishing self-reproducing populations and has later been embraced as a commercial pursuit in the region (Petr and Swar, 2002).

Trout culture has recently been initiated in the state of Himachal Pradesh. Among European Salmonids, Brown Trout (*Salmo trutta fario*) was historically the primary fish artificially bred and reared. However, the current focus has shifted towards the farming of Rainbow Trout (*Oncorhynchus mykiss*), the only species among cold-water fishes being reared on a commercial scale. Rainbow Trout originates from the Sacrament River region, while Brown Trout is native to the mountain waters of Central and Western Europe. Both fish species belong to the family Salmonidae and order Isospondyli (Pushpa *et al.*, 2018).

Rainbow Trout is deemed suitable for commercial farming due to its easy acceptance of artificial feed, ability to withstand temperature fluctuations, shorter incubation period, faster growth, and higher disease resistance (Pushpa *et al.*, 2018) The rainbow trout (*O. mykiss*) also has productivity benefits as it possess number of characteristics that make it extremely versatile and appropriate for aquaculture in a variety of settings. Rainbow trout has short incubation period where faster growth rate reduces production costs and enhances yield, while the species' adaptability to diverse water conditions and environments further simplifies farming (Henryon *et al.*, 2005; D'Agaro *et al.*, 2022).

Present communication focused on the status of rainbow trout, specifically in Mandi and Kullu districts. These areas have plenty of farms and cold, running water from streams and rivers, creating ideal conditions for rainbow trout. The aim of our study was to evaluate the current status of trout farms in the districts of Kullu and Mandi of Himachal Pradesh. Objectives of this study included evaluating the maintenance and care practices implemented in trout farms in Mandi and Kullu districts to ensure proper handling of the fish stock, assessing the efficiency of current operations to identify any areas for improvement or optimization in farm management practices, and investigating opportunities for upgrading infrastructure and technologies to increase productivity and sustainability of trout farming in the region. The information of trout survey regarding global production farming has been investigated in the past. As per the literature surveyed to design the current problem, it has been observed that reports regarding the survey of trout farms in Kullu and Mandi districts are lacking. To fill this gap, the present study has been planned to access the current status of trout. This research aims to provide comprehensive insights into the production practices, challenges faced by farmers, and the overall economic impact of trout farming in Kullu and Mandi.

Material and Methods

The study was carried out in the Kullu and Mandi districts of Himachal Pradesh which relies on current primary data collected from various government and private trout farms. To accomplish the objective of the present study, a survey instrument (questionnaire) was prepared drawing inspiration from the work of Kousar *et al.* (2019) aimed at effectively fulfilling the research objectives. Extensive fieldwork was undertaken across diverse farms situated in the Kullu and Mandi districts, providing valuable insights into the intricate processes involved in fish farming, spanning from the initial stages of egg incubation to the nurturing of fully matured adult fish. Throughout these visits, the survey questionnaires were distributed among both farm proprietors and their diligent workers, with personalized assistance extended to ensure accurate and thorough completion of the questionnaire forms. Farms which were surveyed in Kullu and Mandi District are outlined below

Kullu- Rose Garden Trout Fish Farm Fozal (Private; L1), Trout Fish Farm Patlikuhal Kullu (Government; L2)

Mandi- Thakur Trout Farm Barot (Private; L3), Rajkumar Trout Barot (Private; L4), Rajendar Kumar Trout Fish Farm Barot (Private; L5), Khundu Ram Trout Fish Farm Barot (Private; L6), Amar Singh Trout Fish Farm Barot (Private; L7), Trout Farm Barot (Government; L8), Salt Valley Trout Fish Farm Gumma (Private; L9), Jaswal Trout Fish Farm Shanan (Private; L10).

Results

The findings were presented in terms of years in operation, employee count, production tanks, annual production, annual income, fish species, disease found, preventive measures, water source and quality, training, feeding schedules, challenges, and future plans across different farm locations.

As per the information provided by the officials of different farms, L8 has been operating the longest at 66 years, followed by L2 with 35.5 years and L10 with 22 years. The remaining farms range from 6 to 15 years, with L9 at 9 years and L1 at 10 years.

Table 1: No. of employees and production tanks in different trout farms

Farms	No. of Employees	Production Tanks
Rose garden trout fish farm, Fozal (L1)	5	10
Trout fish farm, Patlikuhal (L2)	33	17
Thakur Trout farm, Barot (L3)	2	5
Rajkumar Trout fish farm, Barot (L4)	1	3
Rajendar Kumar Trout fish farm, Barot (L5)	1	3
Khundu Ram trout Fish farm, Barot (L6)	1	3
Amar Singh Trout Farm, Barot (L7)	1	3
Trout fish farm, Barot (L8)	10	6
Salt Valley Trout Fish Farm, Gumma (L9)	1	3
Jaswal Trout Fish Farm, Shanan (L10)	2	15

The data in Table 1 revealed that maximum number of employees were found in trout farm at Patlikuhal with highest (17) production tanks. In addition, Trout fish farm at Patlikuhal (L2) had highest annual production of 3800 kg and income of 38-39 lakh (Table 2).

Table 2: Annual production and annual income of different trout farms

Farms	Annual Production (in kg)	Annual income (in lakhs approx.)
Rose garden trout fish farm, Fozal (L1)	25000	1.5-2.0
Trout fish farm, Patlikuhal (L2)	38000	38-39
Thakur trout farm, Barot (L3)	3000	3.0-3.5
Rajkumar trout fish farm, Barot (L4)	1500	1.20-2.20
Rajendar Kumar Trout fish farm, Barot (L5)	1300	1.15-2.40
Khundu Ram trout Fish farm, Barot (L6)	1500	1.25-2.0
Amar Singh Trout Farm, Barot (L7)	1600	1.30-2.20
Trout fish farm, Barot (L8)	3500	19-20
Salt Valley Trout Fish Farm, Gumma (L9)	2500	1.15-2.50
Jaswal Trout Fish Farm, Shanan (L10)	23000	36-37

As per information provided by the officials of different trout farms, in most of the farms rainbow trout was cultivated while brown trout was seen only in two farms (L8 and L10). The cultivated Rainbow trout in most farms showed a rapid growth rate of 200-300 g per year, outperforming the slower-growing Brown trout. This growth was supported by optimal conditions such as cold temperatures, clean water, and favourable climatic factors. The choice to cultivate these species was driven by market demand, adaptability, profitability, and resource availability. These elements together ensured successful trout farming in the regions.

The survey revealed a consistent issue of fin rot across many trout farms, notably in L1, L2, and several in Mandi, including L10, L8, L3, L9, and L4. Increased aggression during breeding seasons led to injuries, providing entry points for infections. Additionally, serious diseases such as Infectious Pancreatic Necrosis (IPN) and whirling disease were noted, particularly in government-run farms. Environmental stressors like low rainfall and poor water quality, along with inadequate net disinfection and rough handling, further exacerbated health issues. Mortality rates were reported at 10-15%, with government assistance and expert support being crucial in managing these outbreaks. Farm owners and workers at both private and government facilities implemented various treatments to maintain trout health, including using potassium permanganate, salt baths, oxytetracycline, and chloromint-T. In cases of severe infection, infected fish was removed to prevent the spread of diseases such as fin rot, which was particularly problematic in L2 (Patlikuhal), and whirling disease, noted in L8 (Barot). Nets protected fingerlings from predators, and regular health monitoring varied by location: monthly at L1 (Fozal) and L2, bimonthly at L3 (Barot), daily at government farms in L8 and L10 (Shanan), and trimonthly at L4, L5, L6, and L7 (Barot). Dedicated staff or owners managed these checks, including water quality monitoring and quarantining new fish before introduction into tanks.

The main water source for most farms was running water from streams, and water quality was regularly monitored. Despite these efforts, many farms faced water quality issues that negatively impacted fish health, with poor water quality being closely linked to disease outbreaks. Filtration tanks were utilized to improve water quality in the farms. Farm owners wanted to expand rapidly and were found to be interested in collaborations with academic institutions or research centres to improve illness management.

Discussion

This research offers a comprehensive analysis of the structure and operations of both private and government trout farms in the specified regions, expanding upon insights from previous studies. Blair *et al.* (2013) found that climate and human impacts affected trout growth, with increased productivity and temperatures harming shallower lake habitats more than deeper ones. Our study similarly highlighted the need for continuous water quality monitoring and management to maintain trout health in varying conditions. Hajiesmaeili *et al.* (2014) highlighted the importance of physical habitat conditions, like hydraulic parameters, on trout health, aligning with our findings on the important role of water quality management. Acquiring best management practices and innovations (BMP&I) was advised to address these environmental challenges. Kovach *et al.* (2016) highlighted the lack of empirical data on how temperature and streamflow variations affect trout in freshwater habitats. Despite limited data, they found a positive link between summer streamflow and trout growth, suggesting the need for better data collection and understanding of trout resilience. Similarly, our study examined the impact of weather extremes and temperature fluctuations on trout farming in Kullu and Mandi. Both studies stressed the importance of addressing environmental issues to enhance the sustainability and productivity of trout farming.

Pushpa *et al.* (2018) noted that rainbow trout is ideal for commercial farming due to their acceptance of artificial feed, tolerance to temperature changes, shorter incubation, faster growth, and higher disease resistance. Our study observed that farm owners in Kullu and Mandi districts favour rainbow trout for their high market demand, faster growth compared to brown trout, disease resistance, and ease of feeding. The popularity of trout among locals and tourists also significantly boosts the local economy which was also shown by Sharma (2018) where tourism was boosted by trout fishery.

It is noted that there is a frequent bacterial infections like fin rot in trout farms due to aggressive fish behaviour and poor net cleaning. This corroborates with the observations of Kousar *et al.* (2019) who found harmful bacterial strains in all hatchery water sources and recommended regular water checks, good practices, vaccination, pest management, and careful handling... Treatments included potassium permanganate, salt baths, and oxytetracycline, with an emphasis on regular health monitoring. Duman *et al.* (2023) analysed 150 studies on bacterial infections in global rainbow trout aquaculture, identifying new pathogens like *Lactococcus* and *Weissella*, and highlighting risks from stress, water quality, and fish density. Similarly, our study in Kullu and Mandi districts found bacterial infections like fin rot, caused by environmental stress and poor practices. Both studies emphasized the need for improved disease management to sustain trout aquaculture.

Our investigation recommends integrating recirculating aquaculture systems (RAS) is especially beneficial in regions with frequent climatic disruptions (Singh, 2020). Implementing RAS can mitigate climate change effects by providing a controlled environment for trout farming, ensuring consistent growth rates, and reducing disease outbreaks. This study aligned with Vasdravanidis *et al.* (2022), who identified rainbow trout as a good candidate for aquaponics to mitigate climate change impacts on fish culture.

It has been concluded that climatic and environmental factors in the given region were factors that had affected the production of trout farming. Due to variations in quality and temperature of water, the health and growth of the trout was affected. This ensured that the farming practices need resilient measures in trout farming. This study also established that there is need to train farmers on best management practices and innovation (BMP&I) so as to improve production and efficiency. This also included suggestion such as advanced technologies like recirculating aquaculture systems (RAS) which can increase production and sustainability of trout farming. In some farms diseases like fin rot, Infectious Pancreatic necrosis (IPN), Infectious Hematopoietic Necrosis (IHN), saprolegnia, whirling disease were found which highlighted the need for awareness of proper handling and management of fish. The government also implemented financial assistance programs, offering subsidies to the farms to kickstart their business. Hence, the study underscores the critical need for proactive measures to safeguard the trout farming industry in Kullu and Mandi districts.

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