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Current status and strategies of rainbow trout farming at the state government trout farm, Shillong, Meghalaya

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Abstract
In the present investigation, the study utilized a mixed-methods approach, integrating both primary and secondary data sources. A questionnaire-based survey and in- depth interview with the supervisor of the trout farm facility 'IF Farm' was conducted to elucidate the incubation, hatching and rearing protocols of eyed-stage eggs sourced from the DCFR Uttarakhand experimental farm. The findings yielded insights into the protocols and scientific techniques, underpinning successful eyed-stage eggs hatching, relevant for the state government trout farm and optimization of trout production in Meghalaya. As for secondary data, the experiment was conducted for the duration of 120 days, at the State Government Trout Farm in Cleve Colony, Shillong, Meghalaya. Two raceway tanks with a water volume of 210 m3 and 170 m3 was stocked with healthy fish specimens having average weight of 75.2±0.73g and average length of 17.3±0.78 cm and was divided into two groups and each raceway tanks was stocked with 9.52 and 5.88 fish/m3 in T_1 and T_2 respectively and were daily fed with commercial floating pelleted feed, Growel-NUTRILA, thrice a day, at the rate of 2-3% body weight. To observe growth patterns in terms of weight and length sampling was done at 20 days interval. In this study length, weight, survival rate, weight gain, condition factor, SGR, FCR and water quality parameters were studied at different intervals *viz*., initial, 20th, 40th, 60th, 80th, 100th and 120th day. During the study period, the physico-chemical parameters of water samples from both the experimental tanks were analyzed and recorded weekly.

Keywords: Eyed-stage eggs, length-weight relationship, survival rate, stocking density

Introduction
Meghalaya state also known as Meghalaya plateau. It is characterized by an elevation range of 150 to 1961 meters above sea-level and is predominantly covered in forested terrain, with approximately one-third of the state comprising of forest cover. The hilly terrains and higher altitude contribute to the state receiving heavy rainfall, particularly during the monsoon season, resulting in cooler temperature throughout the year.

Nature has bestowed Meghalaya with majority of cold-water resources, with a variety of habitats, best suited for cold-water fish farming. The mountainous region endowed with copious amount of highly oxygenated pristine freshwater offers both surface and underground waters with high oxygen levels, ideal for cold-water fishes. Cold-water fish farming particularly, Trout farming in the state has yet to be expanded for the promotion of sustainable fish culture as a suitable income-generating activities, accommodating dietary essentials, promoting fishery sector and tourism of the state. Understanding the potential of trout farming in the state, the Government of Meghalaya (GoM), through the Department of Fishery, have launched a number of initiatives to promote trout farming.

Rainbow trout is most probably the oldest farmed fish in many regions, which its eggs have been available since 1872 and on the other hand this is the only species which eggs have been transferred worldwide. However, a notable revival of rainbow trout farming in Meghalaya is anticipated, owing to the state government's revitalized emphasis on this sector. Furthermore, Farming rainbow trout offers a lucrative alternative to conventional agriculture that can be practice with very limited land. Acknowledging the advantages of this farming system the Government of Meghalaya (GoM) through the Department of Fisheries, along with the

Directorate of Cold-Water Fisheries of India (DCFR) has been actively promoting trout farming among the rural masses as a mean of generating income and ensuring sustainable protein production throughout the state. To support this initiative the State Government Department of Fisheries, has been aiming to provide financial and technical assistance for trout farming, aiming to enhanced livelihoods of rural populations and promote environmentally sustainable practices.

Water quality is one of the key aspects of trout farm management. Water is an essential element for the fish survival. Salmonids, in general and rainbow trout, in particular does not afford much tolerance to the poor water characteristics especially the depletion in dissolved oxygen (DO) and raised level of ammonia. However, the state government trout farm in Meghalaya received water that are either from spring or underground origin. Therefore, the dissolved oxygen level normally does not act as a limiting factor, however seasonal changes in water temperature and rate of water flow may affect the DO levels, following which, the necessary farm intervention might be required.

The first restricted parameter in growing system of trout is the availability of water and the amount of dissolved oxygen. Although the fish can live in low oxygen such as 3 ppm, but for desired farming, the range of oxygen has been advised between 5.8 up to 9.5 mg/L. The second restricted parameter is water temperature which determines the amount of fish production. Another factor is the amount of Ammonia that is produced from discharged metabolic materials which contains protein catabolism (Amino acid), by increasing pH and temperature of which causes the portion of un-ionized ammonia to get higher which is dangerous to fish.

In addition to water quality, monitoring the fish growth using length-weight relationship (LWR) are helpful analytical tools for interpreting the field, by collecting primary data in terms of suitable indices, for asserting their overall health and in use of stock assessment model. Trout farming has been traditional practise in a flow-through system to provide the required level of water quality. Hence, successful trout farming requires a deep understanding of management practices to achieve optimal quantities and qualities trout fishes.

Considering the importance of the aforementioned factors in the management of trout species, this study was carried out to determine the changes in growth (length-weight) of trout fishes under farmed condition, to study the management of trout farm, to determine their feed conversion ratio and their production rate.

Brief history of trout farming in Meghalaya

The State Government Trout Farm of Meghalaya situated at Cleve Colony; Shillong was established during the British period, marking the introduction and cultivation of brown trout (Salmo trutta) in the region. The farm's environment and water parameters were conducive to trout cultivation, facilitating successful culture of the species from 1992 to 2002 by utilizing trout seeds sourced from the Government Trout farm, Shergoan, West Kameng, Arunachal Pradesh, although artificial breeding attempts were conducted during 1997-98, they were unsuccessful due to inadequate facilities, highlighting the need for improved infrastructure to support sustainable trout production.

Trout culture was revived through financial assistance of ₹ 45 lakhs under CSS - blue revolution during 2018-19, where reconstruction of the raceways, pipelines etc were carried-out. A fresh consignment of 8000 Nos of trout seeds (Rainbow and Brown trout), were transported from Government Trout farm, Shergoan, West Kameng, Arunachal Pradesh during the month of April, 2022 and although there was a 70% mortality loss during the entire culture period, i.e. right from seed transportation, cannibalism and high turbidity of water during monsoon season. The remaining 30% healthy stock showed good growth and production of 300 kgs was achieved, sold @ 800/- per kg resulting in a revenue of 2.4 lakhs. It is worth mentioning that many hurdles were faced during the culture period, however the dedicated team of officers, supervisors and staff concerned rose to the challenge. Future efforts to artificially breed trout in the state is essential, in order to minimize the production, cost for finally disseminating the technology to others suitable district. The way forward for future success of trout culture is through additional investment in infrastructure. The basic requirement for trout culture is flow through system (raceway), i.e. 30-40 Liters/minute throughout the culture period and optimum water temperature of 0-18˚ Celsius and supplement with feed containing 45% concentration of protein for achieving best growth.

Data collection method

This research employed a mixed-method approach, incorporating both primary and secondary data. Primary data was collected through a structured questionnaire, briefly designed and administered through extensive fieldwork, to contextualize the primary findings and to gather supplementary information, about the incubation, hatching and rearing protocols for rainbow trout, carried at a trout farm facility, 'IF farm', later to be distributed to the Government facility, specifically at the Trout Farm, Cleve Colony, Shillong, Meghalaya.

Additionally secondary data was generated from The Government trout farm, at Cleve colony complemented by in-depth case studies on rainbow trout farming. Specifically, farm observations, hands-on farming operation and case studies were conducted to gather first-hand information on farming practices and experiences.

Material and Method for the collection of primary data

Study area

The primary data were collected directly from a rainbow trout facility 'IF Farm' established by Iatreilang Foundation Multipurpose Cooperative Society Ltd., Nongrum Mawphlang through the Tribal Sub-Plan Program of ICAR-DCFR.

Questionnaire Administration

A single-visit questionnaire survey was conducted to gather data, of the various protocols involved in the hatching of rainbow trout embryos, utilizing a mixed-methods approach that incorporate both open-ended and in-depth discussion with a supervisor of the farm supplemented by a review of their records, to obtain data in order to meet the objectives of the study. Additionally, observational techniques were employed to validate and triangulate the collected data, ensuring accuracy and reliability.

The questionnaire employed was divided into four distinct sections, each targeting specific aspects of the hatching process:

Table 1: Table representing the different sections of the questionnaire employed at 'IF Farm'.

Section 1	Focused on incubator setup and water quality management. Aiming to elucidate the standard operating procedures for maintaining optimal water conditions.
Section 2	Investigated egg collection, preparation and handling protocols. Seeking to understand the measures taken to ensure egg quality and viability.
Section 3	Concentrated on incubation parameters and monitoring. Examining the temperature, oxygen levels and other environmental factors crucial for successful incubations.
Section 4	Examined hatching and fry rearing protocols. Exploring the post-hatching care and management practices that facilitate healthy fry development.

Materials and Methods used for the collection of secondary data

Experimental site

The research study was carried out at HV6V+75X, Tripura castle Rd, Risa Colony, Cleve Colony, Malki. State Government Trout Farm, Shillong, Meghalaya - 793003, from August 2024 to January, 2025.

Trout farm management practices

Site selection

When considering trout farming, two crucial factors come to the forefront, the availability of yearly supply of clean water and the climatic features of the area that contribute to the creation and maintenance of cold-water bodies. The 'State Government Trout Farm' in Cleve Colony, Shillong, which has an area of about 4-acre, site an example as an area suitable for rearing of cold-water fishes, for which the farm is situated at higher elevations and experience generally low temperatures throughout the year. Moreover, the existence of the running stream known as the "Wah Dienglieng" serve as the backbone for trout culture at the farm.

System adopted at the state government trout farm of Meghalaya

The State Government Trout farm has many systems adopted to it for enhancing the production of cold-water fishes in the state, The trout fish culture system employed in this study utilized a conventional raceway system, which comprised the following components detailed below:

Filtration Tank: A filtration tank is a pivotal factor for ensuring good quality water for trout culture, the government trout farm at Cleve Colony was envision with a purpose for optimizing water quality to ensure clean and clear water sourced from the stream 'Wah-Dienglieng'. A two-stage filtration system was adopted at the trout farm, to maintain optimal water quality. Each filtration tank was design, wherein water flows sequentially through a three series of chambers containing of sand, stones and gravel media, this design enabled the effective removal of physical and biological impurities.

Overhead Water Storage Tank: The filtered water from the first filtration tank was stored in an overhead tank with a capacity of approximately 75,000-80,000 L. this overhead water storage tank served as a reservoir, supplying water to the system as needed, and ensuring a consistent and reliable source of good-quality water for trout culture.

Raceway ponds: As raceway design and construction serve as a critical element in trout farming, significantly impacting the success of production. The state government trout farm at Cleve Colony has six cemented raceway pond each installed with proper inlet and outlet for water flow. Out of the six raceway ponds, this study focuses on the management of two raceways pond, the two raceway ponds were constructed in series system were water flow from one raceway pond to the other. The first raceway has a maximum dimension of 20m × 7m ×1.5m and has the biggest water capacity with over 210 m3 of water volume, While the 2-raceway pond has a maximum dimension of 17m × 10m × 1m and has the water capacity of 170 m3. This specific design configuration has been shown to provide optimal water flow, oxygenation, and habitat conditions for trout, thereby enhancing their overall growth and survival rates.

Water Pump: In anticipation of water scarcity, a proactive strategy was implemented to mitigate the risk of water shortage, which is exacerbated by the seasonal drying of the 'Wah Dienglieng' stream during the month of January to May. To address this challenge, both an electric water pump and a petroleum water pump is employed, as an emergency backup, ensuring reliable water supply. This innovative approach ensures the survival of the trout species during periods of water scarcity and also during summer season when water level decreases.

Dam construction: The state government trout farm has recently undertaken a small dam construction, creating a water capture system from the stream 'Wah Dienglieng'. The dam's dimension is 5 m in depth and 10 m in width and a length of 29 m, serving as a reliable source for the farm. Interestingly, the dam's design features an environmental flow component, allowing the stream 'Wah Dienglieng' to maintain its natural flow regime. Additionally, the stored water is utilized in a recirculating system, pumping it into the farm's filtration tank and subsequently into the raceway pond demonstrating a closed-loop water management approach.

Netting and materials: A critical component of aquaculture operations, nets and materials play a vital role in efficient management of aquaculture farms. Specifically, various types of nets are employed during grading and harvesting operations including, drag nets, Cast nets, Happa and Hand nets.

Ova-house: The state government trout farm has recently undertaken infrastructure development, with the construction of an ova-house in 2023, funded under a state- sponsored scheme. This facility expected to be operationalized upon the maturation of the broodstock, with anticipated initiation of breeding programs in 2025.

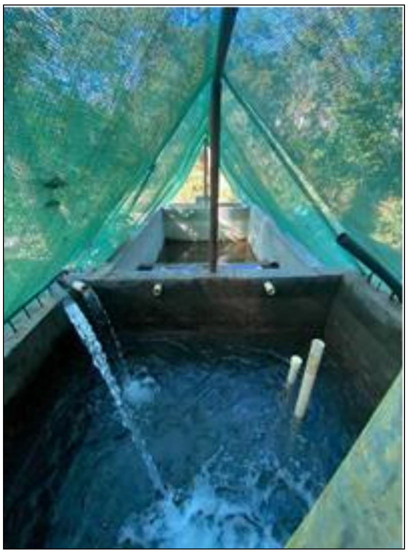

Fig 1: Filtration tank 1

Fig 2: Filtration tank 2

Fig 3: Stocking tank

Fig 4: Raceway tank 1

Fig 5: Raceway tank 2

Fig 6: Water pump

Fig 7: Small Dam

Fig 8: Net and materials

Fig 9: Ova-house

Experimental trial

The culture period at the trout farm had already commenced from May 2024 to January 2025 spanning a duration of 9 months. Initially a total of 3,000 healthy fry were selected and transported from a trout culture facility, 'IF Farm' situated at Mawphlang Nongrum and transported to the State Government Trout farm for rearing purposes.

At the onset of this investigation, the fry had undergone significant growth, reaching advanced fingerlings size, with an Average length and weight of 17.3±0.78 cm and 75.2±0.73 gm respectively. Subsequently, the fingerlings were randomly allocated to two distinct stocking number of 9.52 fish/m3 and

5.88 fish/m3 (Table 2), within two separate raceway tanks (T_1 and T2), Facilitating an examination of the effects of stocking number on growth performance in a controlled raceway system.

Table 2: Varying Stocking Density of Rainbow trout (*Oncorhynchus mykiss)* in Experimental Tank

	Flow through raceway tanks	Stocking Number (fish/m3)	Stocking density (kg/m3)	Total number of fishes
Oncorhynchus mykiss	T_1	9.52	0.72	2,000
	T_2	5.88	0.44	1,000
	TOTAL			3,000

Materials Used for Analyzing Length-Weight Relationship and Condition Factor

Length-Weight Relationship

In this investigation a total of 30 specimens each, from the two raceways tank (T_1 and T_2), of the culture rainbow trout, *Oncorhynchus mykiss*, was randomly selected. This study was carried out for the investigation of the relationship between the length-weight of the farmed rainbow trout between the two raceway ponds, by the use of the allometric formula and its logarithmic transformation proposed by Le-Cren (1951).

W=aLb

Condition Factor

The relation between length and weight for fishes has been used to determine the Fulton's condition factor index using the equation (Fulton, 1904) given below:

$$k = \frac{w \times 10^5}{L^3}$$

Material Used for Monitoring Feeding Patterns

This section of the study, investigated the effect of feed on the cultured rainbow trout (*Oncorhynchus mykiss*). In this study, the fish fingerlings were fed with pelleted floating commercial trout feed, by Growel (NUTRILA- Nutrition for Rainbow Trout). The feed was obtained from a private feed facility.

The experiment consisted the analysis of feed conversion ratios with respect to the growth performance and survival rate. During the experiment, daily water parameters including air and water temperature were frequently being recorded before feeding.

Feed Conversion Ratios

Feed conversion ratio (FCR) is one of the most critical parameters in aquaculture, measuring the efficiency of feed utilization by fish. In rainbow trout (*Oncorhynchus mykiss)* production, FCR is a key factor in determining the sustainability and profitability of farming operations. In this investigation, sampling of fish body weight was initiated at the start of the study and then the recorded data on weight were used for the calculation of feed conversion ratio (FCR). The FCR was calculated according to Ricker (1979) represented as follows:

$$\text{FCR} = \frac{\text{Feed given (dry weight)}}{\text{Weight gain (wet weight)}}$$

Materials Used for Assessing the Growth Performance, Survival Rate and marketing strategies

Growth Performance

The present study initiated with the recording of initial biometric parameters, specifically mean length and weight of advanced fingerling rainbow trout. Subsequently, the fish were randomly allocated to two distinct raceway ponds, each characterized by distinct stocking densities. This investigation aimed to assess the impacts of differential stocking densities on the growth efficiency, survival percentage and mortality rate of the farmed rainbow trout.

Total mean weight gain (g)

$$\text{Total mean weight gain (g)} = \frac{\text{Final mean weight (g)} - \text{initial mean weight (g)}}{\text{Total mean percentage weight gain (g)}}$$

$$\text{Total mean percentage of weight gain (\%)} = \frac{\text{Final mean weight (g)} - \text{initial mean weight (g)}}{\text{Initial mean weight (g)}} \times 100$$

Specific growth rate (SGR)

The specific growth rate was calculated using the following formula:

$$\text{SGR} = \frac{\text{ln final weight (g)} - \text{ln initial weight (g)}}{\text{period}} \times 100 \text{ time}$$

$$\text{Daily mean growth rate (g/day)} = \frac{\text{Final mean w eight (g)} - \text{initial mean weight (g)}}{\text{Time period}}$$

Determination of Survival Rate and Mortality rate

Following a 6 months period of continuous monitoring, the survival and mortality rates of cultured fish in the raceway ponds were calculated using the following formula:

$$\text{Survival rate (\%)} = \frac{\text{Number of fishes survived/harvested at the end of the study}}{\text{Initial number of fish stocked}} \times 100$$

Harvesting

The initial batch of the cultured rainbow trout (*Oncorhynchus mykiss*) underwent harvest from January to February. The harvesting protocol employed a combination of gear types, including cast nets, happas and hand nets, to ensure efficient and safe collection of the fish. Additionally, safety precaution measures were also implemented to minimize handling stress and prevent injury to the fish during harvesting process.

Market and Trade

The state government trout farm, has been operating with a simple yet effective marketing strategy. Currently, the farm relies on advertisement programs through local newspapers and social media platforms to reach potential customers. This approach has been successful in attracting a massive local consumer to visit the farm directly and purchase live fish. The state government trout farm, marketing and trading practices play a crucial role in its overall performance and sustainability. The current market structure targets local communities, home stay, hotels and restaurants and is looking forward in expanding its market and increase sales, through alternative marketing strategies and consider value-added products.

Analysis of physio-chemical parameters of water

This study emphasizes the importance of rigorous water quality management practices to ensure the sustainability and productivity of trout farming operations. A comprehensive analysis of crucial water quality parameters was conducted throughout the trout farming cycle. Specifically, this study investigated the following key water characteristics such as, water flow rates, temperature, Dissolved Oxygen, Alkalinity, pH, and ammonia levels, which are deemed essential for trout culture. This investigation sought to determine the fluctuation and interrelations of these water quality variables and their consequence for trout health, growth and productivity.

Results and discussion

Collection and Analysis of primary data

Section 1: incubator setup and water quality management

The VS-8 vertical incubator, a specialized equipment designed for optimal egg incubation was employed at the 'IF Farm', a farm facility recognized as the first rainbow trout production facility in Meghalaya to have successfully hatched rainbow trout eggs, the incubator had a size dimension of 58×64×84 cm, it features 8-trays and egg capacity of approximately 8 liters. Prior to incubation, the supervisor of the IF Farm reported, various water parameters in the incubator including, water oxygenation for hatching trout eggs was maintained at saturation level; by monitoring the water flow rate at 5 L/min, pH was kept at an optimum level of 6.5-7

Section 2: Egg collection, preparation and handling

In this section of the investigation, the respondent reported that approximately 50,000-10,000 trout eggs, measuring approximately 0.3 mm in size, were sourced from the experimental farm of the Directorate of Coldwater Fisheries (DCFR) Uttarakhand, the eggs were typically collected in February and transported in a sterilized, enclosed box equipped with ice flakes in multiple layers to maintain cold temperatures at 5˚C during transit. Upon receipt, the eggs were carefully handled, with ice flakes replaced before transportation to the farm. At the farm the eggs are subjected to a series of procedures prior to incubation. Gentle handling and minimal stress were prioritized to prevent damage. A gradual acclimatization methodology was employed to facilitate the eggs adaptation to the farm's environmental conditions. This involved measuring the water temperature at the farm (12˚C) and the packaging environment (5˚C) and subsequently raising the temperature by 2˚C increments until reaching the existing farm water temperature.

Section 3: Incubation Parameters and Monitoring

In this section of the study, the respondent reported that initial hatching rates were approximately 50% during their first trial. However, through experience and optimization, hatching rates improved significantly, reaching 80-90%. To assess egg viability and hatching success, the respondent relied on the use of a feather and bamboo forceps to helps distribute the eggs for proper visual observation noting that viable eggs exhibited an orange-yellowish coloration, whereas non-viable eggs turned opaque and whitish. The respondent also highlighted challenges associated with using the VS-8 vertical incubator, particularly during monitoring of egg viability and spoilage. The incubator's design, where water flows through a series of egg trays, requires the egg tray to be pulled forward for inspection, temporarily disrupting water flow and potentially stressing the eggs, this design limitation poses challenges for accurate monitoring and maintenance of optimal incubation conditions.

Section 4: Hatching and Fry Rearing Protocols

According to the respondent, the anticipated timeline for egg hatching in their incubator is approximately 300 degree-days. Following hatching, the newly emerged alevins undergo a series of standardized handling and care procedures. Initially, the alevins are transferred to nursery tank with a dimension of 8 × 1.5 × 1 feet, for monitoring their feeding habits, once their yolk sacs have been fully absorbed, the alevins are initiated on a commercial feed of die size of 0.3 mm. and a protein content of 48%. The feeding regime during larval rearing consists of 8 feedings per-day ensuring optimal nutrition and growth.

Growth characterization of Rainbow trout by length - weight relationship

Initially the average length and weight of the farmed rainbow trout on the onset of the experiment, were 17.3±0.78 cm and 75.2±0.73g respectively. Subsequent growth assessment revealed that the fish reared in Raceway (T2) demonstrated a significantly higher growth rate compared to those in Raceway (T1), in the length and weight among the two different stocking number. 30 Sampled fish species were randomly selected from each raceway tank, (T1) and (T2) and the biometrics parameters of length and weight were measured for studying length- weight relationship. The result of length-weight relationship is presented in the (Table 3) and Chart 1 - Chart 2. it was observed that a positive correlation was established between the length and weight of the fish species sampled in the study.

Table 3: Length-weight relationship of Rainbow trout (*Oncorhynchus mykiss)*

Flow through raceway tanks		Relationship parameters			Log W = log a + b log L
	N	a	b	r2	
T_1	30	0.016	3.02	0.97	Log W = log0.016 + 3.02 log L
T_2	30	0.012	3.12	0.98	Log W = log0.012 + 3.12 log L

N - Total number of samples taken; a - intercept; b - slope; r2 - coefficient of determination.

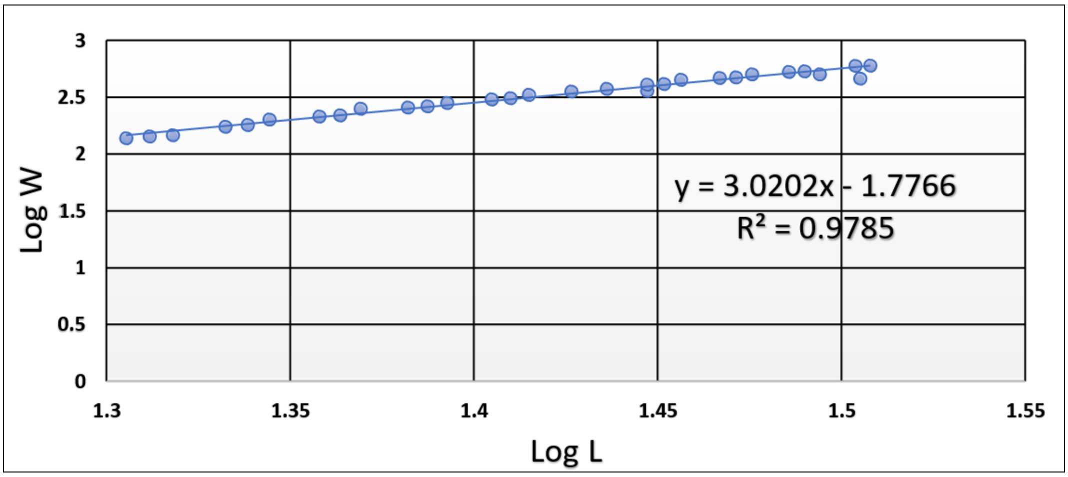

Chart 1: Length - Weight Relationship of Rainbow Trout (*Oncorhynchus mykiss*) in Raceway Pond (T_1)

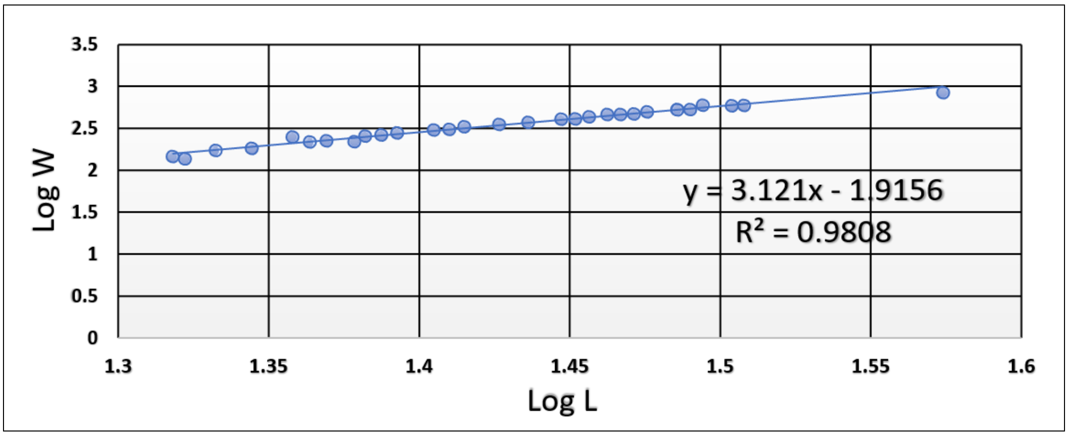

Chart 2: Length - Weight Relationship of Rainbow Trout (*Oncorhynchus mykiss*) in Raceway Pond (T_2)

Condition Factor

The mean value of condition factor (K) for all the length group of farmed rainbow trout from T_1 and T_2, was calculated and the data is depicted in (Table 4). The average condition factor was 1.00±0.06 in tank T_1, and 1.01±0.06 in tank T_2 respectively. The value of condition factor for the different stocking densities of the farmed rainbow trout showed both stocking densities had value being 1.00 and 1.01 from each raceway tank T_1 and T_2.

Table 4: Condition factor (K) of rainbow trout (*Oncorhynchus mykiss)* in different experimental tanks

S. No	Raceway	N	Condition Factor (K)	St dev
1	T_1	30	1.00	0.06
2	T_2	30	1.01	0.06

N - Total number of samples taken; St dev - standard deviation.

Feed Conversion Ratio (FCR)

The present research examines the impact of commercial pelleted feed on the feed conversion ratio (FCR) of rainbow trout, a key indicator of animal efficiency in converting feed into biomass gain. The FCR among the different stocking densities of rainbow trout between the two treatments (Table 5) revealed**,** lower FCR (1.12) was found in T_2. while T_1 showed higher results of (1.19). suggesting that feed utilization efficiency is influenced by stocking density.

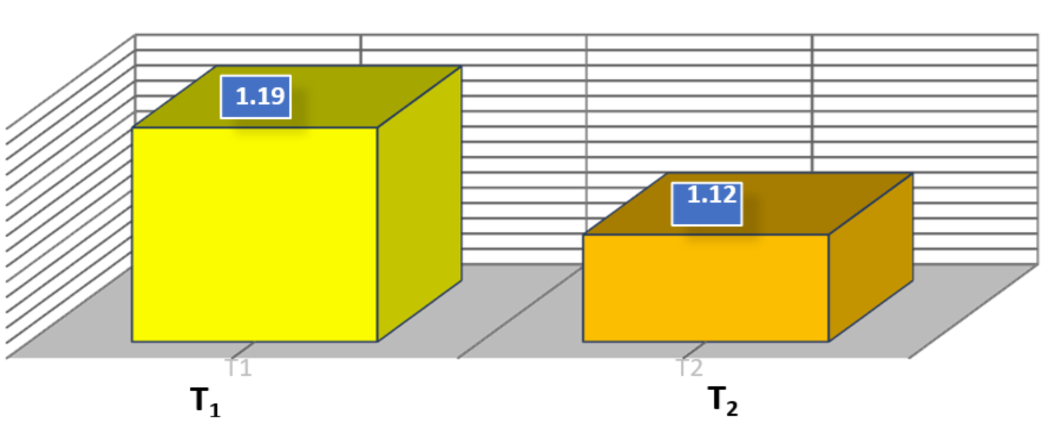

Chart 3: Feed conversion ratio in different experimental tanks (T_1 and T_2)

Growth Performance

The growth (total mean weight gain, total mean percentage of weight gain, daily mean growth rate, specific growth rate (SGR) survival and mortality rate) for each stocking densities (T_1 and T_2) were calculated to ascertain the growth rate and biomass yield of the farmed rainbow trout.

The farmed rainbow trout fingerling stocked in a lower stocking density (0.44 Kg/m3) showed appreciable increase in growth, measure in terms of weight gain and lower feed conversion ratio, than the raceway system with a much higher stocking density (0.72 Kg/m3). The weight gain recorded in raceway tank (T_1) and (T_2) were 359.3 and 373.3 grams, respectively.

The data on daily weight gain is also given in (table 5) better growth (31.92%) was obtained in the raceway system (T_2) with a stocking density of 0.44 Kg/m3 compared to the raceway system (T_1) with a stocking density of 0.72 Kg/m3, which clearly indicates that stocking density or stocking number has significant impact on the growth rate of the stocked species.

Table 5: Growth performance of *Oncorhynchus mykiss* between two stocking densities.

Parameters	Raceway tank	
	T_1	T_2
Initial length (cm)	17.3±0.78	17.3±0.78
Final length (cm)	26.55±0.94	27.01±0.18
Initial weight (g)	75.2±0.73	75.2±0.73
Final weight (g)	359.3±0.90	377.3±0.35
Weight gain (%)	30.68±17.91	31.92±19.32
Daily weight gain (g/day)	0.52±0.07	0.55±0.04
SGR	0.21±0.1	0.22±0.1
FCR	1.19	1.12

Fig 11: Weight measurement of *O. mykiss*

Fig 12: Length measurement of *O. mykiss*

Water Quality Analysis

Various physio-chemical parameters like water flow rate, water Temperature was found to be in the range of 19 ˚C - 12.1˚C. pH of water was found to be in the range (7.3-8.05). Dissolved oxygen was estimated within the range of (6.61-10.07 mg/l). Total alkalinity was found to be in the range of (54.7-65.4 mg/l). Total ammonia nitrogen was found to be in the range (0.04- 0.01).

Table 6: Physio-chemical parameters of water throughout the experiment. (Mean±SD)

Parameters	T_1	T_2
Temperature	16.28±2.46	16.2±2.44
pH	7.62±0.18	7.51±0.19
Dissolved Oxygen (mg/L)	8.29±0.84	8.78±0.78
Total Alkalinity (mg/L)	59.9±3.26	59.7±3.26
Total Ammonia Nitrogen (TAN) ppm	0.02±0.01	0.01±0.009

Conclusion

It is evidenced from the present study that the growth performance of the cultured rainbow trout at the state government trout farm, from the two raceway tanks each showed isometric growth, indicating the cultured fish species grows proportionally in length and weight, with a condition factor of average or normal weight for its length, and that there was a positive correlation between length and weight of the experimental fish. Moreover, the utilization of the commercial floating pelleted feed of variable protein concentration, can be used as an important means for better production of fish. This study although was conducted for a period of 120 days, it also provided an insight on the role of water quality parameters, that was sourced from the 'Wah Dienglieng' stream, on the growth and survival of the species. Furthermore, the state government trout farm at Cleve Colony has optimized itself in necessitating vigilant monitoring of fish health status to ensure early detection and rapid response. A comprehensive monitoring protocol employed at the state government trout farm typically encompasses, observation of symptomatic behavior, clinical sign assessment and water quality monitoring and control. The finding underscores the importance of daily monitoring of water parameters to prevent disease and stress of the cultured species, thereby improving their growth and survival. It is inferred from the results that the adoption of the different systems at the trout farm proved beneficial for optimizing water quality and trout production, highlighting the feasibility of culturing of rainbow trout, *O. mykiss* in raceway tanks with a water volume of 210 m3 and 170 m3. The results suggest that this culture system will be beneficial to the farmers and entrepreneurs of India in general, particularly in Meghalaya, where the climate and water resources are conducive to trout farming.

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