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Farm-Scale Production Performance of Striped Murrel (*Channa striata*) in a Recirculating Aquaculture System: A one-year case study from Maggi (V), Nizamsagar (M), Telangana, India

S. Saiteja[1], Dr. Malsoor Thirumala[2], Pavan Kumar K.[3], P. Padmavathi[3]

[1]*Student, Government Arts & Science College (A), Kamareddy, Telangana, India.*

[2]*Assistant professor of Zoology, Government Arts & Science College (A), Kamareddy, Telangana, India.*

[3]*Department of Zoology and Aquaculture, Acharya Nagarjuna University, Nagarjuna Nagar-522510, A.P., India*

Abstract

We documented a one-year farm-scale production cycle of striped murrel (Channa striata) in a recirculating aquaculture system (RAS) at Maggi Village, Nizamsagar Mandal, Telangana, India. The culture cycle extended from March 2025 to February 2026. A total of 2,200 fingerlings with an initial mean weight of approximately 20 g were stocked in a 50 m³ culture tank, corresponding to 44 fish m⁻³ and an initial biomass density of 0.88 kg m⁻³. The system incorporated mechanical solids removal, a UV chamber, a 3 hp recirculation pump, and one 2 hp blower distributing air through multiple diffusers; partial water replacement was conducted weekly. Fish received Growel floating pellets containing approximately 42% crude protein three times daily, with pellet size adjusted to fish size. Marketable biomass at the end of the cycle was approximately 1,800 kg, giving a final biomass density of 36 kg m⁻³ and a net biomass gain of 1,756 kg. At the reported apparent feed conversion ratio of 1.30, estimated feed input was 2,282.8 kg. No overt clinical disease outbreak was observed during routine monitoring. At a farm-gate price of ₹320 kg⁻¹, gross sales were approximately ₹576,000 (₹5.76 lakh). The case demonstrates the practical production potential of striped murrel in a compact RAS, while also showing that complete sustainability and profitability claims require verified water-use, energy, survival, feed-ledger, and cost data.

Keywords; Channa striata; recirculating aquaculture system; farm-scale production; feed conversion ratio; biosecurity; Telangana

INTRODUCTION

Recirculating aquaculture systems (RAS) are land-based production units in which culture water is treated and returned to the rearing tank. Compared with flow-through or pond systems, RAS can reduce replacement-water demand, concentrate solids for removal, improve biosecurity, and permit tighter control of temperature, dissolved oxygen, pH, and nitrogenous wastes (Bregnballe, 2015; Martins et al., 2010; Hashmi et al., 2025). These advantages are accompanied by substantial dependence on pumping, aeration, filtration, monitoring, and skilled operation. Consequently, farm-scale evidence is needed to determine whether species-specific RAS designs can deliver reliable production under local operating conditions.

Striped murrel (*Channa striata*) is a high-value freshwater food fish widely consumed in South and Southeast Asia. The species has strong market demand and can accept formulated feeds during grow-out, but intensive culture requires careful control of size variation, cannibalism, feeding response, suspended solids, dissolved oxygen, and nitrogenous metabolites (Kumar et al., 2022; Raizada et al., 2022). Studies have demonstrated that C. striata can be reared in recirculation systems, although performance varies with stocking density, fish size, diet, and system configuration (Saputra et al., 2018; Puspaningsih et al., 2021).

Published Indian evidence on commercial or farm-scale murrel production in tanks remains limited. Vikas et al. (2024) documented high-density production in artificial tanks, while most other work has focused on juveniles or controlled experimental conditions. We therefore analysed one complete production cycle from a commercial farm in Telangana. Our objectives were to describe the RAS configuration and husbandry practices, quantify biomass and feed-use indicators, document observed health status, estimate gross sales value, and identify the additional records required for a complete sustainability assessment.

MATERIALS AND METHODS

Study design, location and duration

We conducted a retrospective longitudinal field case study at a striped murrel farm in Maggi Village, Nizamsagar Mandal, Telangana, India.

Figure 1 location of site

The analysed production cycle extended from March 2025 to February 2026. The study used routine farm records and author observations from one commercial culture unit.

Recirculating aquaculture system

The culture unit contained approximately 50,000 L of water (50 m³). A 3 hp motor-driven pump circulated water through the treatment loop. One 2 hp blower supplied air through a manifold connected to multiple delivery lines and diffusers. A mechanical filter removed visible suspended solids and uneaten feed. A UV chamber was installed, although its model, wattage, hydraulic loading, and delivered UV dose were not available. Partial water replacement was carried out once weekly; the replaced volume was not recorded. The farm description did not confirm the type or capacity of a dedicated biological filter, so the present manuscript does not attribute nitrification performance to a specific biofilter.

Table 1. Technical configuration and operating characteristics of the culture system.

Component	Specification
Culture volume	50,000 L (50 m³)
Recirculation pump	3 hp motor-driven pump
Aeration	One 2 hp blower; multiple diffuser lines
Solids removal	Mechanical filter
UV treatment	Installed
Water replacement	Partial replacement once weekly
Culture period	March 2025–February 2026

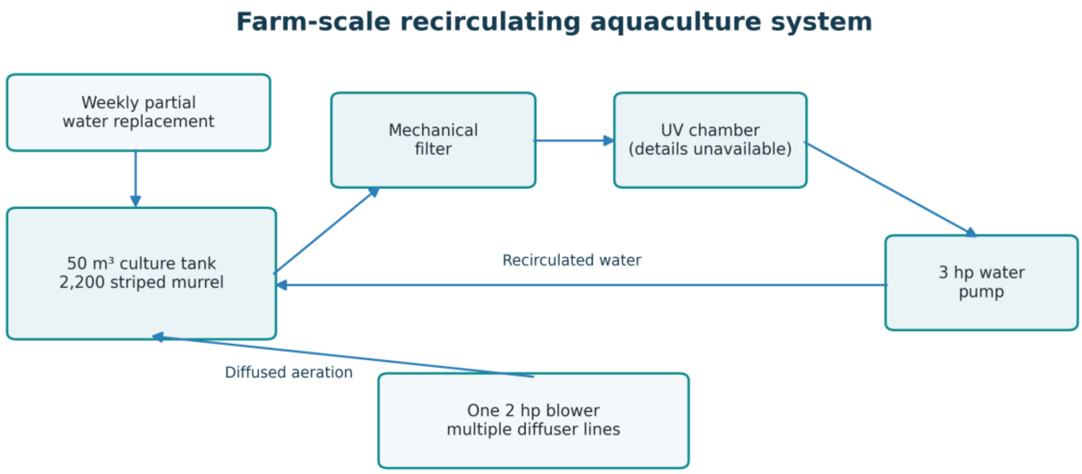

Figure 2 Schematic representation of the farm-scale RAS. Component dimensions, UV dose, flow rate and biological-filter specifications were unavailable.

Fish stocking and husbandry

We stocked 2,200 striped murrel fingerlings with an initial mean weight of approximately 20 g fish^{-1}. Initial standing biomass was calculated as 44 kg. The numerical stocking density was 44 fish m^{-3} and the initial biomass density was 0.88 kg m^{-3}. The final fish count and individual harvest-weight distribution were not recorded separately; consequently, survival, mean final weight, specific growth rate, and size uniformity could not be calculated.

Figure 3 Fish stocking tank

Water-quality and biosecurity management

The farm used routine operating targets for dissolved oxygen, pH, temperature, alkalinity, total ammonia nitrogen (TAN), nitrite, and nitrate (Table 2). These values are management targets and not a statistical summary of measured time-series data. Fish were observed for feeding response, swimming behaviour, surface gasping, skin lesions, excessive mucus, fin damage, and mortality. Equipment was cleaned as part of routine farm management, external access was controlled, and weekly partial water replacement was practiced. No laboratory pathogen screening was undertaken.

Table 2. Water-quality operating targets used for routine farm management.

Parameter	Farm operating target
Dissolved oxygen	>4.5 mg L^{-1}
pH	6.8–8.0
Temperature	28–30 °C
Total alkalinity	>150 mg L^{-1} as $CaCO_3$
TAN	<1.0 mg L^{-1}
Nitrite	<1.0 mg L^{-1}
Nitrate	0.5–2.0 mg L^{-1}; analytical form not recorded

Production and economic calculations

Production indicators were calculated from the recorded stocking number, initial mean weight, culture volume, final marketable biomass, reported FCR, and farm-gate price. Initial biomass was the product of fish number and initial mean weight. Net biomass gain was final marketable biomass minus initial biomass. Density-based indicators were calculated per cubic metre of culture water. Estimated feed input was calculated as reported FCR multiplied by net biomass gain. Gross sales value was marketable biomass multiplied by farm-gate price. Feed conversion efficiency was expressed as 100/FCR. Net profit and benefit–cost ratio were not calculated because itemised costs were unavailable.

Data analysis

We used descriptive analysis only. Values are reported as recorded or calculated quantities, ratios, and density-based indicators. No inferential statistics were performed because the dataset represented one farm unit and lacked independent replication and digitised monthly observations.

Figure 4 Data collection

RESULTS

Biomass production

The initial biomass was 44 kg and the final marketable biomass was approximately 1,800 kg. Net biomass gain was therefore 1,756 kg. Final biomass density reached 36.0 kg m^{-3}, compared with an initial biomass density of 0.88 kg m^{-3}. Net biomass gain per unit culture volume was 35.12 kg m^{-3}, and final biomass was 40.9-fold the initial standing biomass. Harvest biomass per fish initially stocked was 0.818 kg. This ratio should not be interpreted as mean final fish weight because the number of fish harvested was not recorded separately.

Feed use and apparent conversion

At the reported apparent FCR of 1.30, estimated feed input was 2,282.8 kg (2.28 t). This was equivalent to an average of 6.25 kg day^{-1} over the full cycle and 1.04 kg feed per fish initially stocked. The corresponding feed conversion efficiency was 76.9%. Because feed input was back-calculated from FCR rather than independently summed from daily feed records, it is reported as an estimate.

System operation and health observations

The 3 hp circulation pump, mechanical filter, UV chamber, and 2 hp blower with multiple diffuser lines formed the routine operating system throughout the cycle.

Partial water replacement was conducted weekly. We did not observe an overt clinical disease outbreak during routine farm monitoring. This observation indicates absence of a visible outbreak, not confirmed absence of pathogens, because laboratory testing was not conducted.

Gross sales value

At the reported farm-gate price of ₹320 kg^{-1}, the 1,800 kg marketable biomass represented gross sales of ₹576,000 (₹5.76 lakh). Gross sales were equivalent to ₹11,520 m^{-3} of culture volume. These values represent revenue before deduction of seed, feed, labour, electricity, maintenance, depreciation, transport, and marketing costs.

Table 3. Production and economic indicators derived from the farm records.

Indicator	Value	Basis
Fish stocked	2,200	Recorded
Initial mean weight	20 g fish^{-1}	Recorded approximate value
Initial biomass	44 kg	Calculated
Stocking density	44 fish m^{-3}	Calculated
Initial biomass density	0.88 kg m^{-3}	Calculated
Final marketable biomass	1,800 kg	Recorded approximate value
Net biomass gain	1,756 kg	Calculated
Final biomass density	36.0 kg m^{-3}	Calculated
Reported apparent FCR	1.30	Recorded
Estimated feed input	2,282.8 kg	Back-calculated from FCR
Farm-gate price	₹320 kg^{-1}	Recorded
Gross sales	₹576,000 (₹5.76 lakh)	Calculated

Derived descriptive statistics and sensitivity analysis

Derived performance indicators showed a biomass multiplication factor of 40.91 and a relative biomass increase of 3990.9% over the initial standing biomass. Average net biomass gain was 4.81 kg d^{-1}, equivalent to 0.096 kg m^{-3} d^{-1}. Estimated feed input averaged 6.25 kg d^{-1} or 0.125 kg m^{-3} d^{-1}, and apparent feed conversion efficiency was 76.9%. Gross sales averaged ₹1,578 d^{-1}, ₹11,520 m^{-3} per production cycle, and ₹261.82 per fish initially stocked (Table 4).

Table 4. Derived descriptive performance indicators from the one-year production cycle.

Indicator	Value	Calculation or interpretation
Culture duration	365 d	March 2025–February 2026
Relative biomass increase	3990.9%	Net biomass gain/initial biomass × 100
Average net biomass gain	4.81 kg d^{-1}	1,756 kg/365 d
Volumetric net productivity	0.096 kg m^{-3} d^{-1}	Net gain per culture volume and day
Net biomass gain per cycle	35.12 kg m^{-3}	1,756 kg/50 m^3
Apparent feed conversion efficiency	76.9%	100/FCR
Average estimated feed input	6.25 kg d^{-1}	2,282.8 kg/365 d
Harvest biomass per fish initially stocked	0.818 kg	1,800 kg/2,200 fish; not mean final weight
Gross sales intensity	₹11,520 m^{-3} cycle^{-1}	₹576,000/50 m^3
Gross sales rate	₹1,578 d^{-1}	₹576,000/365 d
Gross sales per fish initially stocked	₹261.82 fish^{-1}	₹576,000/2,200 fish

Each 0.10 increase in apparent FCR increased estimated feed requirement by 175.6 kg for the same biomass gain. Across FCR values of 1.20–1.50, estimated feed requirement ranged from 2,107.2 to 2,634.0 kg. Each ₹10 kg^{-1} change in farm-gate price changed cycle gross sales by ₹18,000. Across prices of ₹280–₹360 kg^{-1}, gross sales ranged from ₹5.04 to ₹6.48 lakh (Fig. 2). Under hypothetical final survival of 85–100%, the implied mean harvest weight would range from 818.2 to 962.6 g fish^{-1}. These are deterministic scenario outputs rather than measured estimates of variability.

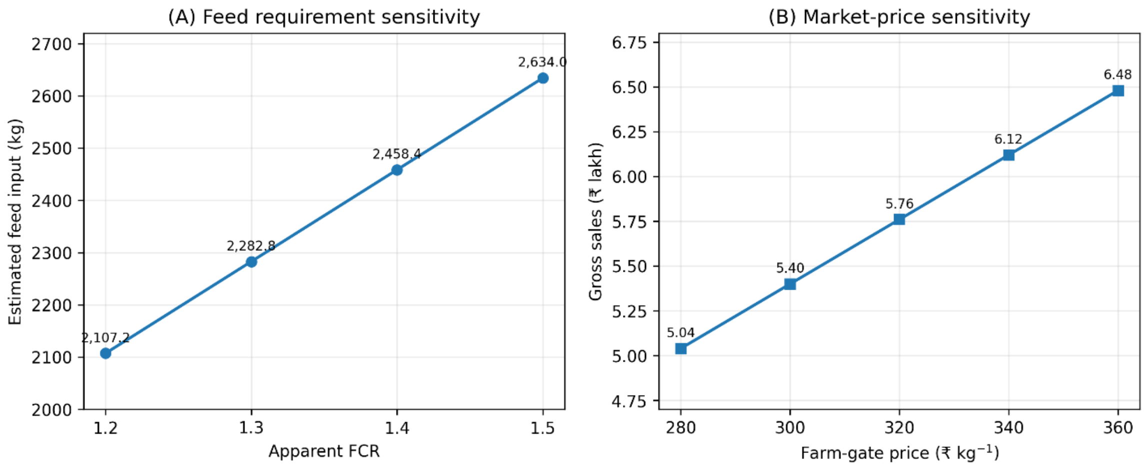

Figure 5 Deterministic sensitivity of (A) estimated feed requirement to apparent FCR and (B) gross sales to farm-gate market price. The analyses hold net biomass gain (1,756 kg) and marketable biomass (1,800 kg), respectively, constant.

DISCUSSION

Farm-scale production performance

The cycle produced approximately 1,800 kg of marketable striped murrel in a 50 m³ culture unit. The final biomass density of 36 kg m^{-3} indicates that substantial biomass can be produced in a compact system under the reported management conditions. This value is an end-of-cycle biomass loading and should not be treated as a universally optimal stocking density. Carrying capacity depends on oxygen transfer, water circulation, solids removal, nitrogen conversion, feed loading, fish size, and the reliability of emergency support systems.

Vikas et al. (2024) reported 2,235.5 kg of striped murrel from artificial tanks over 250 days, with an average final weight of approximately 420 g, 97% survival, and an FCR of 1.8. Our study documented lower total marketable biomass but a defined culture volume and a lower reported FCR. Direct performance ranking is inappropriate because the studies differed in tank configuration, water depth, stocking pattern, fish size, duration, feed, filtration, and survival records. The present work is most useful as a field implementation case rather than a replicated comparison.

Feed management and apparent efficiency

Feed conversion strongly affects both production cost and nutrient loading in RAS. The reported apparent FCR of 1.30 corresponds to an estimated conversion efficiency of 76.9%. This value is favourable compared with the 1.8 reported by Vikas et al. (2024), but it must be interpreted cautiously because the present feed quantity was back-calculated rather than verified against a complete feed ledger and closing inventory. Future cycles should reconcile daily feed issue, feed returns, mortalities, grading removals, and final biomass.

The farm used floating pellets containing approximately 42% crude protein. Dietary protein requirements in *C. striata* vary with life stage, ingredient quality, digestible energy, and feeding regime. Mohanty and Samantaray (1996) observed strong protein effects in fry, while Hua et al. (2019) showed that growth and nutrient utilization depend jointly on protein and lipid. The present result supports the practical use of a 42% protein commercial diet during grow-out, but does not establish a universal optimum.

Water treatment and operational resilience

The treatment loop combined mechanical solids removal, UV treatment, water circulation, and diffused aeration. Mechanical removal of faeces and uneaten feed is essential because retained solids consume oxygen and release dissolved nutrients. In conventional RAS, a biological filter is normally used to oxidize ammonia and nitrite (Bregnballe, 2015; Martins et al., 2010). Because the type and capacity of a dedicated biofilter were not recorded, the system should be described only by its confirmed components. The water-quality values available for this study were operating targets, not measured monthly statistics; therefore, water-quality stability cannot be quantified.

The farm replaced water once weekly, but the volume was not recorded. Consequently, water use per kilogram of fish could not be calculated. Similarly, the 3 hp pump and 2 hp blower indicate a rated installed capacity of 5 hp, but actual energy intensity depends on operating hours, motor loading, efficiency, and electricity source. Current RAS reviews emphasize that hydrodynamics, filtration, energy demand, monitoring, and waste valorization must be evaluated together when sustainability is claimed (Hashmi et al., 2025).

Biosecurity and observed fish health

No overt clinical disease outbreak was observed during the one-year cycle. Controlled water entry, routine cleaning, mechanical filtration, UV treatment, and continuous aeration may have reduced health risks. Nevertheless, UV effectiveness depends on dose, transmittance, exposure time, and solids loading, none of which were available. In addition, visual observation cannot detect subclinical infections. The health outcome should therefore be reported as absence of an observed outbreak rather than evidence that the stock was pathogen-free.

Striped murrel culture also requires attention to size variation and cannibalism, especially during juvenile phases (Raizada et al., 2022). The present records did not quantify grading frequency, cannibalism, or cause-specific mortality. Recording these variables would improve interpretation of survival and production efficiency.

Economic and sustainability implications

Gross sales of approximately ₹5.76 lakh demonstrate that the cycle produced a substantial marketable output. Gross revenue is not equivalent to profit. Feed, seed, electricity, labour, maintenance, replacement water, depreciation, transport, and marketing costs must be deducted before economic viability can be assessed. Because feed is normally a major variable cost, verified feed-purchase and feed-issue data would allow calculation of feed cost per kilogram of biomass and contribution margin.

The farm reused water, concentrated production in a small culture volume, and applied controlled aeration and solids removal. These practices indicate resource-efficiency potential, but they are insufficient for a complete sustainability claim. Future assessment should report replacement water in L kg^{-1} fish, electricity in kWh kg^{-1} fish, sludge production, nutrient discharge, mortality, carbon intensity, and itemised costs. The paper title therefore emphasizes production performance rather than asserting quantified environmental sustainability.

Study limitations

- The study involved one commercial production unit without a control or independent replication.
- Final fish count and individual harvest weights were unavailable, preventing calculation of survival, mean final weight, specific growth rate, and size uniformity.
- Estimated feed input was derived from the reported FCR rather than independently verified from a complete feed ledger.
- Water-quality information consisted of operating targets rather than a digitised time series.
- Replacement-water volume, pump and blower operating hours, electricity use, UV dose, flow rate, and biological-filter characteristics were not available.
- No laboratory disease screening was conducted.
- Itemised production costs were unavailable, preventing calculation of net profit and benefit–cost ratio.

CONCLUSIONS

We documented a one-year farm-scale striped murrel production cycle in a 50 m^3 RAS in Telangana. Stocking 2,200 fingerlings at approximately 20 g $fish^{-1}$ yielded about 1,800 kg of marketable biomass. Final biomass density was 36 kg m^{-3} and net biomass gain was 1,756 kg. The reported apparent FCR was 1.30, corresponding to an estimated feed input of 2.28 t. No overt clinical disease outbreak was observed during routine monitoring, and gross sales were approximately ₹5.76 lakh at ₹320 kg^{-1}. These findings support the practical production potential of *C. striata* in a compact recirculating system. A stronger evaluation of survival, water and energy use, fish welfare, environmental performance, and net profitability requires prospective recording of daily feed, mortality, water quality, replacement water, power consumption, and itemised costs.

Declaration of generative AI and AI-assisted technologies

During preparation of this manuscript, the authors used AI-assisted language and formatting support to improve clarity and presentation. The authors reviewed and edited the manuscript, verified the

calculations and references, and take full responsibility for the final content. This statement should be retained or modified truthfully in accordance with the target journal's policy.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper

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