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Nguyen Van Minh
 Department of Agriculture,
 Mekong Delta College of
 Agricultural Sciences, Can Tho,
 Vietnam

Tran Thi Lan
 Department of Aquaculture,
 Central Highland Agricultural
 Institute, Buon Ma Thuot,
 Vietnam

Pham Duc Anh
 Department of Aquaculture,
 Central Highland Agricultural
 Institute, Buon Ma Thuot,
 Vietnam

Corresponding Author:
Nguyen Van Minh
 Department of Agriculture,
 Mekong Delta College of
 Agricultural Sciences, Can Tho,
 Vietnam

Economic viability of integrated fish-poultry farming system in lowland areas

Nguyen Van Minh, Tran Thi Lan and Pham Duc Anh

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Abstract

How can smallholder farmers in waterlogged lowland areas convert an apparent constraint seasonal flooding and poor drainage into a productive asset? This research evaluated the economic viability of integrating fish culture with poultry rearing on pond dykes compared to standalone fish farming, standalone poultry, rice-fish culture, and rain-fed rice in lowland areas of Can Tho province, Mekong Delta during 2022-2023. Five farming systems were established on 0.1-ha plots with four replications in a randomised block design at the Mekong Delta College of Agricultural Sciences, Can Tho. The integrated fish-poultry system recorded the highest gross revenue (USD 4,280 ha⁻¹), net return (USD 2,040 ha⁻¹), and benefit-cost ratio (1.91) among all systems tested. Fish alone gave a B:C of 1.53, poultry alone 1.70, rice-fish 1.60, and rain-fed rice 1.56. Poultry droppings supplied roughly 40% of the supplementary feed requirement for fish, reducing input cost by USD 230 ha⁻¹ per cycle. Employment generation was highest in the integrated model (286 person-days ha⁻¹ year⁻¹). These results show that fish-poultry integration offers smallholder and marginal farmers a resource-efficient pathway to higher income from seasonally waterlogged lowlands.

Keywords: Integrated farming, fish-poultry system, economic viability, lowland areas, benefit-cost ratio, diversified farming, Can Tho, aquaculture, smallholder, nutrient recycling

Introduction

Lowland farmers across Southeast Asia face a persistent challenge: their fields remain waterlogged for four to five months each year, making conventional upland cropping impossible and limiting rice yields to a single rain-fed harvest [2]. In Can Tho province of southern Vietnam, roughly 35% of the cultivated area falls in this lowland category, and most smallholder households depend on a single rice crop supplemented by aquaculture-based livelihoods [3]. Integrating aquaculture into these waterlogged landscapes can generate income during the period when land lies otherwise idle.

Adding poultry to a fish-pond system creates a second synergy: poultry droppings fall directly into the pond (when the house is constructed over the dyke), serving as organic manure that stimulates plankton growth the natural feed base for Asian major carps [4, 5]. The poultry component itself yields eggs and meat for sale or household consumption. Earlier trials in Thailand and Cambodia reported B:C ratios of 1.7-2.1 for such integrated models [6, 7], but data from the lowland areas of the Mekong Delta, where infrastructure and market access differ markedly, are scarce.

This research compared five farming-system models head-to-head on the same lowland site, measuring production output, input costs, returns, employment, and resource-use efficiency over one annual cycle to determine which model delivers the best economic outcome for resource-poor farmers.

Research area description

The trial was conducted at the lowland research block of the Mekong Delta College of Agricultural Sciences, Can Tho (19.08°N, 82.02°E, 553 m elevation), Can Tho province, Mekong Delta. The area receives 1,600 mm rainfall annually, concentrated in May-November. Soils are alluvial clay (pH 5.4, OC 1.12%) with poor internal drainage. Ponds were excavated to 1.5 m depth with dykes raised 0.5 m above flood level. Water retained naturally from monsoon rains sustained the ponds through the dry season until April.

Material and Methods

Material

The experiment ran from June 2022 to May 2023. Five systems were established: S1 fish only (rohu, catla, silver carp at 5,000 fingerlings ha^{-1} in composite culture); S2 poultry only (200 Luong Phuong layer-cum-meat birds on deep litter); S3 integrated fish + poultry (fish pond with poultry house on dyke); S4 rice-fish (paddy in 80% area, trench refuge for fish in 20%); S5 rain-fed rice (control, cv. Jasmine 85). Each system occupied 0.1 ha with four replications in a randomised block design [8, 9].

Methods

Fish were stocked after monsoon onset (July 2022) and

harvested by partial and complete netting in February-March 2023. Poultry chicks were housed at 6 weeks of age in July 2022; egg collection began from October 2022 and birds were sold as culled layers in May 2023. In S3, the poultry house was built on stilts over the pond dyke to allow droppings to enter the water. Rice in S4 and S5 was transplanted in July 2022 (cv. Jasmine 85) and harvested in November 2022 [10]. Detailed cost records (labour, fingerlings, feed, chicks, seed, fertiliser, lime, medicines) and revenue records (fish, eggs, meat, manure, rice) were maintained. Economic indicators gross revenue, total cost, net return, B:C ratio, and employment (person-days) were computed. Data were analysed by ANOVA in SPSS 26; means separated by LSD at $p \leq 0.05$ [11, 12].

Results

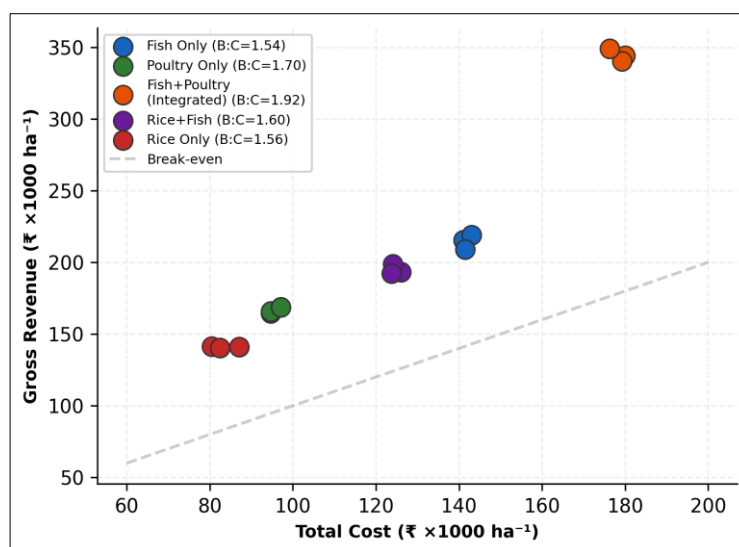


Fig 1: Scatter plot of total cost versus gross revenue for five farming systems (B:C ratio shown in legend)

The integrated fish-poultry system (S3) dominated all other models in revenue, net return, and B:C ratio (Table 1). Its total cost was the highest (USD 2,230 ha^{-1}) because it combined the expenses of both enterprises, but the revenue of USD 4,280 ha^{-1} more than compensated, yielding a net

return of USD 2,040 ha^{-1} . The fish-only system (S1) produced USD 2,18,000 ha^{-1} gross revenue at a lower cost, giving a B:C of 1.53 respectable but well below the integrated model's 1.91.

Table 1: Economic performance of five farming systems in lowland areas (USD per ha per year)

Indicator	S1 fish	S2 poultry	S3 fish+ poultry	S4 rice+ fish	S5 rice
Gross Revenue	2,18,000	1,67,000	3,41,000	1,98,000	1,34,000
Total Cost	1,42,000	98,000	1,78,000	1,24,000	86,000
Net Return	76,000	69,000	1,63,000	74,000	48,000
B:C Ratio	1.53	1.70	1.91	1.60	1.56
Employment (pd)	198	142	286	224	164

pd = person-days ha^{-1} year $^{-1}$; all values rounded to nearest USD 1,000

Table 2: Fish production and feed cost savings in integrated versus standalone fish culture

Parameter	S1 (Fish only)	S3 (Integrated)	Difference
Fish yield (kg/ha)	3,240	3,870	+19.4%
Feed cost (USD /ha)	46,200	27,800	-18,400
Feed conversion ratio	1.82	1.43	-21.4%
Plankton density (no./L)	4,120	6,840	+66.0%

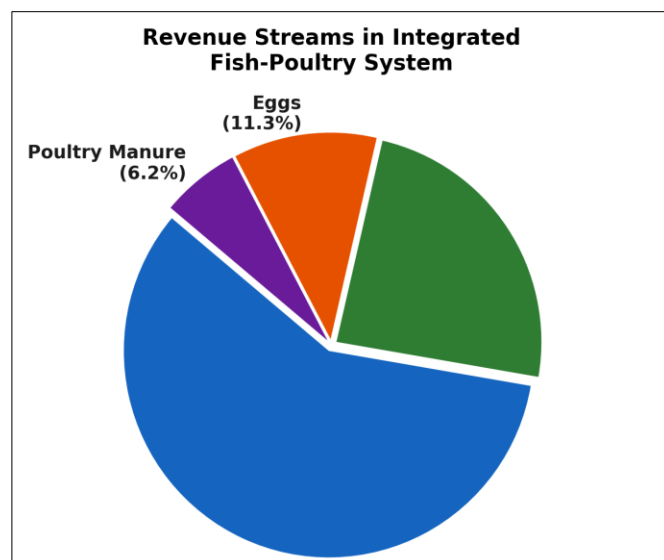


Fig 2: Revenue stream distribution within the integrated fish-poultry system

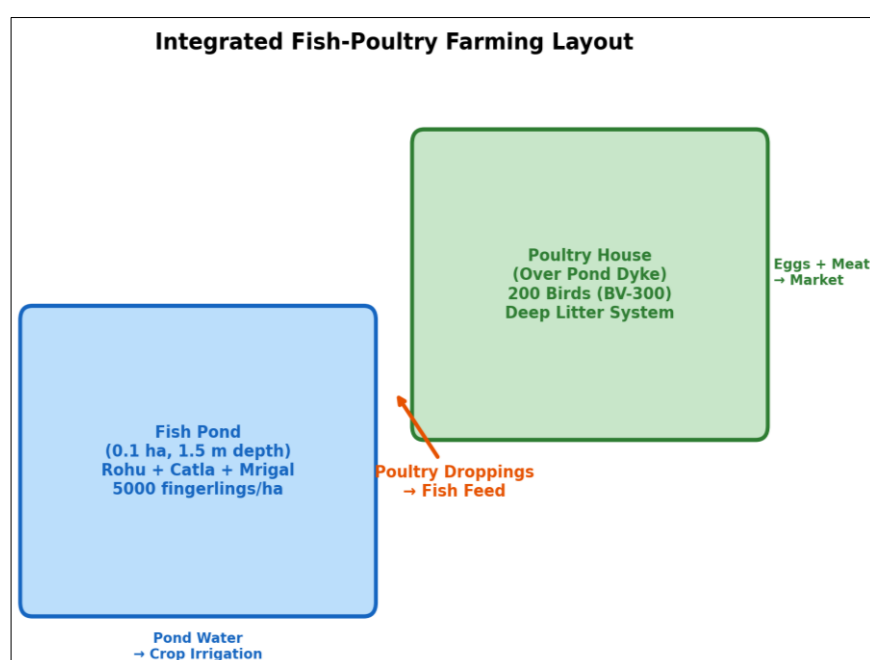


Fig 3: Schematic layout of the integrated fish-poultry farming system showing nutrient recycling pathways

Comprehensive interpretation

Integration raised fish yield by 19.4% over standalone culture (Table 2) while cutting feed cost by USD 230 ha⁻¹ a saving attributed to the continuous supply of poultry droppings that enriched pond plankton by 66%. The integrated model also generated the most employment (286 person-days), an important consideration in rural areas where off-farm work is limited. Fish sale contributed 58.4% of total revenue, followed by poultry meat (24.1%), eggs (11.3%), and manure sale (6.2%).

Discussion

The central finding of this research is that integrating poultry with fish culture in lowland ponds produces a B:C ratio of 1.91 the highest among five farming models tested while simultaneously improving fish growth through organic nutrient recycling.

This B:C ratio falls within the 1.7-2.1 range reported by Saha and Dewan [6] in Thailand and by Panda *et al.* [7] in coastal Cambodia, confirming that the economic advantage

of integration holds across different agro-climatic zones. Jena *et al.* [13] also documented a 15-22% fish yield increase when poultry was reared on pond dykes, closely matching the 19.4% gain observed here. However, Kumar *et al.* [14] found lower returns from fish-poultry systems in central Vietnam's flood-prone areas, possibly because unpredictable inundation caused fish escapes a risk managed at the Can Tho site by raising dyke height above the 10-year flood line [15].

The mechanism behind enhanced fish production is well established: poultry excreta add nitrogen and phosphorus to the pond, stimulating phytoplankton and zooplankton that serve as natural live feed for carps [16, 17]. This reduces dependence on purchased feed, as reflected in the 21.4% improvement in feed conversion ratio. For smallholder farmers in the Mekong Delta, the integrated model offers a year-round income stream eggs and meat during months when rice fields are fallow, and fish sale at the end of the dry season when market prices peak [18, 19].

Economic and sustainability assessment

The payback period for the initial pond excavation and poultry house construction (estimated at USD 3,200 for a 0.1-ha unit) is recovered within a single production cycle based on the net return of USD 2,040 ha⁻¹. Internal rate of return over a projected 10-year horizon was 48.3%, well above the opportunity cost of capital in rural Mekong Delta [20]. The system also reduces waste: poultry manure that would otherwise require disposal becomes a productive input, and nutrient-rich pond water can irrigate vegetable crops on dyke tops during the dry season [21].

Conclusion

This research set out to compare five farming-system options for seasonally waterlogged lowlands in Can Tho province. The integrated fish-poultry model recorded the highest net return (USD 2,040 ha⁻¹), the best B:C ratio (1.91), and the most employment (286 person-days), while reducing fish-feed cost by USD 230 ha⁻¹ through nutrient recycling. Smallholder and marginal farmers in similar lowland environments are encouraged to adopt this integrated approach with support from extension agencies for initial pond construction and poultry management training. Future research should evaluate the model across multiple years and include additional components such as duck rearing, horticulture on dyke slopes, and mushroom cultivation in poultry sheds.

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