Aquaculture Reimagined: Modern Approaches to Sustainable Fish Farming
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Chapter 7

Integrated Fish Farming: Fish and Poultry Integration for Better Income

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Abstract

Integrated livestock and fish farming, particularly the combination of poultry and aquaculture, is a traditional practice in India and many parts of Asia. This method, known as agro-pisciculture, enhances productivity by reducing production costs and utilizing agricultural by-products efficiently. In India, where farm sizes are shrinking, many farmers adopt this mixed farming system to diversify activities and mitigate risks. Poultry farming, in particular, is widely integrated with fish farming due to its economic benefits. Poultry droppings serve as a natural fertilizer for fish ponds, fostering the growth of natural food sources, such as phytoplankton and zooplankton, which fish consume. This practice reduces the need for chemical fertilizers and feed, cutting costs by up to 60%. Moreover, it provides a sustainable solution to the challenge of feed expenses in intensive fish farming. The integration of poultry with aquaculture boosts resource efficiency, enhances labour use and generates multiple products, such as chicken meat, eggs and fish, from the same piece of land. This model promotes food security by increasing the availability of animal protein, improving rural livelihoods and supporting sustainable agriculture. Key considerations for success of this model include selecting resilient fish species and maintaining optimal pond conditions for water retention, soil pH and weed control.

Keywords Aquaculture, Pollution, Remediation, Toxicity

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1. Introduction

Integrating livestock with fish farming is an age-old practice in India and various parts of Asia. Common livestock used in mixed farming systems include ducks, pigs, poultry, cattle, buffalo and goats. As the size of farm holdings continues to decline, many farmers are turning to innovative technologies to enhance productivity. One such method is the mixed farming system, combining livestock and fish, which is particularly widespread in the wetland and watershed regions of the country. Integrated fish farming, commonly known as agropisciculture, seeks to lower production costs while increasing output by merging two or more traditionally separate agricultural systems. This approach allows farmers to make efficient use of agricultural by-products, leading to improved returns per unit of land and higher disposable incomes for farmers. Additionally, it mitigates the risk of production failure by enabling diversification of farming activities. This diversification not only stabilizes income but also enhances food security in rural areas by increasing the availability of animal proteins in local diets, thereby addressing nutritional needs. However, many small-scale farmers in India face challenges in affording the significant quantities of feed necessary for intensive fish farming. Integrated fish farming with livestock offers a practical solution by reducing feed costs in aquaculture. The waste produced by livestock can serve as a nutrient-rich food source for fish, effectively lowering expenses while promoting a sustainable and efficient farming system. Among the various livestock, poultry farming is particularly prevalent in rural communities and its integration with fish farming proves feasible and economically advantageous. Poultry droppings are utilized as organic fertilizer in fish ponds, fostering the development of natural food sources for fish. Furthermore, poultry litter is nutrient-dense, containing 1.6% nitrogen, 1.5% phosphorus, 0.9% potassium and 2.4% calcium, making it an invaluable resource for enhancing fish growth and overall farm productivity (Biswas, 2015). By embracing this integrated approach, farmers can improve their livelihoods and contribute to sustainable agricultural practices that benefit their communities and the environment.

2. Advantages of Fish cum Poultry Integrated Fish Farming

Integrated poultry cum fish farming offers several advantages by allowing the simultaneous operation of poultry and fish farming on the same land area, thereby increasing productivity per unit and ensuring optimal use of available resources. Moreover, this method encourages economic diversification, which typically results in higher overall income for farmers by broadening their range of activities. Additionally, the system provides risk mitigation by serving as a safeguard when one part of the operation may not perform well or fails, thus helping to maintain income stability. Poultry manure serves as a natural fertilizer for fish ponds, promoting bacterial growth and enriching aquatic flora, including phytoplankton and zooplankton. Fish can then consume these organisms, transforming poultry waste into an important source of

animal protein. The system provides substantial savings on fertilizers, as using poultry waste lessens the need for purchased fertilizers, reducing overall production costs.

Additionally, it can lower supplementary feed costs, allowing farmers to save up to 60% on their total feed expenses. Integrated farming improves labour efficiency by requiring less human resources compared to managing poultry and fish farming separately, allowing for a more effective use of available labour. Furthermore, this system enhances resource efficiency, as chickens can obtain water directly from the fish pond. Ultimately, this integrated approach facilitates the simultaneous production of chicken meat, eggs and fish from the same location, maximizing output and profitability.

3. Fish Species used for Integrated Poultry-cum-Fish Farming

3.1. Species Selection Criteria for Integrated Poultry-cum-Fish Farming

While selecting fish species for integrated fish farming, the following points need to be remembered:

- The ratio of species combinations should be determined based on the expected availability of feed and manure.
- The species must be capable of enduring unfavorable environmental conditions, such as reduced oxygen levels and elevated organic matter in the water.
- The chosen fish should be robust and resistant to common diseases.
- The fish should belong to smaller food chain thus it may take nutrition from natural food available in pond itself.

Commonly cultured species include Rohu, Catla, Mrigal, Silver carp, Grass carp, Common carp, Black carp, Godavari carp, Bata, *Puntius* sp., *etc.* Composite culture of fish along with poultry integration may give desired profit to the farmer.

4. Pond Management for Integrated Poultry-cum-Fish Farming

The pond should be selected on the basis of water retention capacity for a minimum period of 8-9 months and should not be situated in flood-prone area. In integrated farming, the recommended pond water depth typically ranges from 1.5 to 3.0 meters. The pH of the soil is crucial for pond productivity and should ideally range between 6.5 and 7.5. Lime should apply in 3-4 split doses based on water pH. Ideal dosage of lime in accordance to pH is mentioned in table 1. The basal dose of lime and cow dung for each hectare of water bodies is approximately 1,200 kg and 5,000 kg, respectively. The pond should be regularly cleared of aquatic plants, as they often block sunlight from penetrating the water, hinder oxygen flow and provide a habitat for fish predators. Aquatic weeds can be removed manually, mechanically, biologically or chemically. Unwanted fishes can be removed by repeated netting or using mahua oil cake @ 2500 kg ha^{-1}.

After pond preparation, 5-10 cm size fingerlings are stocked @ 600 fingerlings

per 1000 m^2 or 8000-10,000 fingerlings ha^{-1}. Species combination and stocking density may be varied according to local demand and market possibilities. Generally, in integrated farming, a combination of six species is used such as Catla (20%), Silver carp (20%), Rohu (20%), Mrigal (15%), Grass carp (10%) and Common carp (15%), *etc.* Other than that, a combination of four species (Rahu and Catla @ 30% each and Mrigal and Common carp @ 20% each) is also used in many countries like China, Hungary, Germany, Poland and Russia and to a minimal extent in India (Ayyappan *et al.*, 1998). In India, combinations of three species (Catla 40%, Rahu 30% and Mrigal 30%) are used for livestock cum fish farming. The ideal stocking density ratio for composite fish culture integrated with poultry is mentioned in table 2.

Table 1: Dosage of lime application based on soil pH (Handbook of Fisheries and Aquaculture, 2013)

Sl. No.	Soil pH	Application of lime ($kg^{-1}ha\text{-}1yr^{-1}$)
1	4.0-5.0	2000
2	5.1-6.5	1000
3	6.6-7.5	500
4	7.6-8.5	200
5	>8.6	Nil

Table 1: General guidelines on the fish stocking density and species ratio (Prakash et al., 2018)

Trophic niche	Fish species	Stocking ratio (%)
Surface feeder	Silver carp	20
Surface feeder	Catla	20
Mid-water feeders	Rohu	20
Mid-water feeders	Grass carp	10
Bottom feeders	Mrigal	15
Bottom feeders	Common carp	15
Total stocking		100
Expected fish yield ($kg^{-1}acre^{-1}$ $year^{-1}$)		1500

5. Harvesting of Fish

After 7 to 8 months of cultivation, cultured fish attain harvestable size based on market preference. Exotic major carps generally reach 1 kg during this period. Species such as rohu, catla and mrigal require about a year to grow to weigh between 750 g and 1 kg. Once the cultured fish reach a weight of 750 g to 1 kg, they are harvested from the pond. Harvesting can involve removing all cultured fish or selectively harvesting only marketable ones, based on demand. In cases of partial harvesting, the number of fish taken

from the pond is replaced with an equal number of small fish from the farm's nursery ponds. This approach helps to maximize revenue.

6. Management in Poultry Farming Practices

6.1. Poultry Housing System

The house can be built on the pond itself or on the pond's embankment. The poultry house has a height varying between 2 to 3 meters and can be constructed using materials such as tin, asbestos sheets, tiles, or thatch. The length of the poultry house can vary based on accommodation needs; however, the width should be limited to 9 m to ensure adequate proper ventilation. The birds are kept entirely indoors, with no access to the outside. There are two types of poultry housing systems: deep litter and cage. The litter system is often preferred because it generates more valuable manure. In this system, 250 poultry birds are kept in each pen and the floor is mainly covered with sawdust/dry leaves *etc*. Poultry droppings that fall onto the floor typically mix with the litter through bacterial activity. If the litter becomes wet, lime is applied in sufficient quantity to absorb moisture and also serves as a disinfectant. The litter should be thoroughly stirred throughout the culture period. After 10 to 12 months, it matures into fully developed litter with high manurial value. Before placing chicks in the shed, it should be thoroughly cleaned, disinfected.

6.2. Selection of Birds

In integrated farming systems, dual-purpose birds (for meat and egg production) and egg-laying birds are particularly well-suited. Common dual-purpose breeds include Vanaraja, GramaPriya and Kuroiler, while the White Leghorn is commonly chosen for egg production. Approximately 500-600 birds are recommended per hectare of water spread area for effective integration. Vaccinated chicks aged eight weeks are housed in poultry sheds located close to the pond.

6.3. Feeding of Birds

Birds between 9 and 20 weeks of age are given grower mash at a rate of 50-70 g $bird^{-1}$ daily. After reaching 20 weeks, they receive layer mash at 80-120 g $bird^{-1}$ daily. Feeding is facilitated using feed hoppers to minimize feed waste and a sufficient water supply is provided to all the birds during the rearing period. Layers are fed starter feed from birth until 8 weeks, grower feed from 8 to 20 weeks and layer feed beginning at 20 weeks onward. Conversely, broilers are fed starter feed from 0 to 4 weeks and finisher feed from 4 to 6 weeks. Details proximate content of the commercial feeds is mentioned in table 3.

6.4. Egg Production from the System

Egg production starts at 22 weeks of age and gradually decreases over time. The Vanaraja, Gramapriya and Kuroiler breeds lay approximately 140 to 160 eggs yearly, whereas the White Leghorn produces between 240 and 300 eggs annually.

6.5. Health Care of the Birds

In poultry farming, several key aspects require attention, such as disinfecting the poultry unit and equipment before introducing a new flock. It is important to follow a proper vaccination schedule to protect against various diseases, including infectious bronchitis, laryngotracheitis, Marek's disease, Newcastle disease and fowl pox. Detailed schedule for vaccination for layer and broiler birds are mentioned in table 4 (4.1 & 4.2). Additionally, maintaining proper hygiene is essential for eliminating most bacterial diseases. Fully built-up deep litter is collected and applied to the fish pond at a rate of 50 kg ha^{-1} each morning after sunrise, depending on the pond's productivity.

In poultry, diseases generally spread through various means such as wet litter, contaminated feed and water, close contact among birds, infected equipment and transmission by attendants and visitors. Additionally, airborne diseases, external parasites, free-ranging birds, rodents and flies can also facilitate the spread of infections. So proper precautions should be taken in prior condition to avoid the chances of disease occurrence through these sources considering prevention is better than cure concept. Protocol for maintaining a disease free and healthy poultry culture system is mentioned below.

- Chicklings should be selected from disease free stock.
- Proper hygienic conditions should be maintained throughout the rearing period to avoid disease entry.
- Overcrowding should be avoided for providing a better and stress-free environment.
- Adequate water, feed and floor space for chicks should be provided for better performance and reduction of chances for disease spreading.
- Proper biofencing should be erected to prevent insect and wild bird entry to the poultry house which will eliminate the chances of vector borne diseases.
- Proper vaccination schedule should be followed to eliminate the chances of viral diseases.
- There should be adequate footbaths at the entrance of each shed to promote biosecurity.
- Clean and adequate water supply is necessary to eliminate water borne diseases.
- Dead and diseased birds should be disposed immediately to prevent disease spread.

7. Economic Analysis for 1 Hectare Poultry-cum-Fish Farming Model

In an integrated fish and poultry farming system, one hectare of land can produce around 3,000 to 4,000 kg of fish, 60,000 to 100,000 eggs and more than 3,500 kg of meat annually. Fish production can be increased to 10 tonnes per hectare by cultivating species like tilapia, common carp and murrels. To achieve this, a stocking density of 20,000 fingerlings per

hectare and a chick density of 4,000 chicks per hectare is suggested. This method does not require the use of chemical fertilizers or additional feeds. The combination of fish and poultry allows for efficient use of resources, as the waste from one supports the growth of the other, creating a sustainable farming system. This approach helps farmers increase production while maintaining environmentally friendly practices. Detailed economic analysis of an integrated poultry cum fish farming model is mentioned in table 5 (5.1, 5.2 & 5.3).

8. Success Story of an Integrated Poultry-cum-Fish Farmer in Bihar

8.1. Name of the Entrepreneur: Mr. Umesh Sahu (Figure 1)

Figure 1: Mr. Umesh Sahu

8.2. Age: 60 years

8.3. Address: Jasauli Kata, Nearby Motipur, Muzaffarpur district, Bihar (843 141), India.

8.4. Background: Mr. Sahu was previously engaged in brick manufacturing industry and later on slowly converted into integrated poultry cum fish farmer.

8.5. Technical Guidance: He got training from ICAR-CIFE, Motipur in 2021 and started working in the sector with proper technical handholding and technical support (Figure 2).

8.6. Land Area: 65 acres total farm area and 45 acres water area.

8.7. Culture Practice Adopted

The farm is entirely operated in integrated model where waste and excreta of poultry farm is utilized as a fertilizer in fish ponds for enhancing pond

Figure 2: Mr. Umesh Sahu with training participants

productivity thus the waste is being recycled and cost of feed is minimized at a very high level. The farmer is operating a total number of 21 ponds in 65 acre area where Indian major carps and Exotic major carps are cultured (Figure 3 and 8). Stocking density is maintained at 4000 no. acre^{-1} and average weight of fishes ranges between 20-50 g. Among poultry Kadaknath and Sonali birds are cultured for both meat and egg production purposes due to their popularity and demand in local market (Figure 4 and 5). Total 20,000 numbers of birds are cultured and sold in a year. The litter generated from poultry is enriched with nutrients which are mostly used as fertilizer in fish ponds (Figure 6). For enhancing pond productivity, a mixture of ingredients used which includes 1200 kg cow dung and poultry litter, 50 kg Urea, 50 kg SSP, 10 kg Molasses, 10 kg Salt, 1 kg Yeast, 200 kg Mustard oil cake and 200 kg Rice bran (Figure 7). The mixture is used at the rate of 30 kg ha^{-1} 15 days^{-1} to promote plankton growth which is essential for fishes with short food chain *i.e.*, herbivore or herbi-omnivore fishes. No supplementary feeding is given to the fishes but commercial feed is given to the poultry at the rate of 1-2% of body weight. Fishes are cultured for a period of 6-8 months to achieve 700 g to 1 kg weight whereas poultry is being ready to be sold within 3-4 months (1 kg). Investment for production of poultry is around Rs. 120.00 kg^{-1} and for fish is around Rs. 80.00 kg^{-1} which is being sold at Rs. 180.00-200.00 and Rs. 240.00-280.00, respectively. With this venture the farmer is currently earning around Rs. 15-20 lac year^{-1}.

Due to higher stocking density and high organic loading, there are several occasions of Dissolved oxygen and water quality issues noticed which are most commonly solved by water exchange and installing surface aerator *i.e.*, paddle wheel aerator.

8.8. Future Directions

The farmer is willing to adopt natural fish farming system along with

integration by poultry to provide high quality meat and fish to the consumer. Also, he is planning to start a hatchery with an aim to supply good quality fish seeds to the farmers.

Figure 3: Farm area of Mr. Umesh Sahu

Figure 4: Chicken shade

Figure 5: Chicken shade

Figure 6: Sun-drying of poultry litter

Figure 7: Mixture of poultry litter with fertilizers

Figure 8: Portion of pond area

Table 3: Proximate composition of different commercially available poultry/duck feed (Ofori *et al.*, 2019)

Feed	Moisture (%)	Protein (%)	Lipid (%)	Carbs (%)	Ash (%)
Broiler Starter feed	10.4	20.9	3.6	56.3	8.6
Grower Mash Feed	9.7	16.8	2.7	53.7	17.1
Layer Mash Feed	9.4	16.2	2.7	56.8	14.85

Table 4: Vaccination schedule for the poultry (AHVD, Government of Meghalaya)

Table 4.1: Vaccination schedule for Layer birds

Age	Name of the vaccine	Route
5-7th day	Lasota	I/R or I/O
14-16th day	Infectious Bursal Disease (I.B.D.)	I/O or D/W
24-26th day	I.B.D. (booster)	D/W
30th day	Lasota (booster)	D/W
7th week	Fowl pox	I/M
9th week	Deworming	-
10th week	R2B	I/M
15th week	Debeaking	D/W
17th week	Lasota	-

[*Note: I/N - Intra Nasal; I/O - Intra Occular; D/W - Drinking water; I/M - Intra Muscular]

Table 4.2: Vaccination schedule for Broiler birds

Age	Name of the vaccine	Route
3-5th day	Lasota	I/O or I/N
7-9th day	I.B.D.	I/O or D/W
16-18th day	I.B.D. (booster)	D/W
24-26th day	Lasota (booster)	D/W

[*Note: I/N - Intra Nasal; I/O - Intra Occular; D/W - Drinking water; I/M - Intra Muscular]

Table 5: Economic analysis of integrated poultry-cum-fish farming for 1 ha area

Table 5.1: Initial investment costs

Item	Cost (INR)
Land preparation (1 ha) and lease value	60,000.00
Fish pond preparation (ploughing, fertilizers, liming, *etc.*)	1,00,000.00
Poultry housing	1,00,000.00
Equipment (feed hoppers, nets, *etc.*)	50,000.00
Stocking fingerlings (15,000 @ Rs. 10 piece^{-1})	1,50,000.00
Purchasing chicks (4,000 @ Rs. 50 piece^{-1})	2,00,000.00
Miscellaneous (biofencing, *etc.*)	20,000.00
Total Initial Investment	6,80,000.00

Table 5.2: Operational costs (Annual)

Item	Cost (INR)
Feed for fish (5 kg day-1 for 12 months = 1800 kg) @ Rs. 50 kg^{-1}	90,000.00
Feed for poultry	90,000.00
Vaccinations (poultry)	15,000.00
Labour (2 workers, 10,000 labour-1$month^{-1}$)	2,40,000.00
Utilities (water, electricity)	30,000.00
Miscellaneous (maintenance, *etc.*)	10,000.00
Total operational costs	4,75,000.00

Table 5.3: Revenue generation (Annual)

Product	Quantity	Price (INR kg^{-1})	Total Revenue (INR)
Fish assume 50% mortality (7500 *1.0 kg = 7500 kg) along with 1.0 kg growth $year^{-1}$	7500	150	11,25,000
Eggs (80,000 eggs)	80,000	10	8,00,000
Meat (3,500 kg)	3500	200	7,00,000
Total Revenue			26,25,000
Annual profit	Total Revenue - (Total Operational Costs + Initial Investment Costs)		Rs. 26,25,000 - (4,75,000 + 6,80,000) = Rs. 14,70,000 $year^{-1}$

9. Conclusion

In conclusion, integrating poultry with fish farming offers a sustainable, cost-effective and efficient approach to enhancing agricultural productivity. By utilizing poultry waste as organic fertilizer, farmers can reduce feed and fertilizer costs while promoting natural fish food sources. This integrated system maximizes resource use, improves labour efficiency and enables the production of multiple outputs, such as fish, chicken meat and eggs, from the same land. It provides a practical solution for small-scale farmers facing rising feed costs contributing to income diversification, food security and environmental sustainability in rural communities. With proper species selection and pond management, integrated poultry-cum-fish farming holds great potential for improving livelihoods and promoting sustainable agricultural practices.

10. References

Ayyappan, S., Kumar, K., Jena, J.K., 1998. Integrated fish farming practices and potentials. *Fishing Chimes* 18(1), 15-18.

Ayyappan, S., Jena, J.K., Gopalakrishnan., Pandey, A.K., 2013. *Handbook of Fisheries and Aquaculture*. Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research, New Delhi, India. p. 1116.

Bhanu Prakash, C.H., Khairnar, S.O., Mandal, A., Kumar, A., Kumar, B., 2018. Composite fish farming: A review on economic enterprise for rural empowerment and livelihood generation. *International Journal of Fisheries and Aquatic Studies* 6(4), 545-550.

Biswas, A., 2015. *Fish Duck Integrated Farming*. Available at: https://www.researchgate.net/publication/287595864_Fish_Duck_Integrated_Farming.

Ofori, H., Amoah, F., Arah, I., Krampah, E.K., 2019. Proximate analysis and metabolizable energy of poultry feeds. *ARPN Journal of Engineering and Applied Sciences* 14(5), 1026-1032.