Integrating fish farming with ducks and poultry in Meghalaya: A case study in a farmer's field

R. N. Mandal[1*], S. Adhikari[1], H. K. De[2], A. Das[1], F. Houque[1], A. Hussan[1], S. Sarkar[1], B. N. Paul[1] and P. K. Sahoo[2]

1. Regional Research Centre, ICAR-CIFA, Rahara, Kolkata 700118, India; 2. ICAR-Central Institute of Freshwater aquaculture, Bhubaneswar, 751002, India. Corresponding author: rnmandal1964@gmail.com

Integrated fish-duck-poultry culture, the combined duck/poultry shed in the background.

The term 'integrated farming' refers to a method of cultivation that combines two or more enterprises at the same time. It may include various combinations, such as crops, horticulture, dairy, livestock, ducks, poultry, fish and vermicompost. In principle, integrated farming means two or more enterprises cultivated together to benefit each other through nutrient cycling and shared resources. It is a farming system that increases productivity, profitability and employment opportunities, and is therefore considered a sustainable practice. It aims to use minimal external inputs, compensated by recycling nutrients and sharing resources within the farm. Ideally, nutrients from one source flow to another, and vice versa.

Integration of fish culture with ducks and poultry has long been practised. Cultivating a single enterprise may not be as beneficial as their integration, in which each enterprise is treated as a sub-system. The sub-systems are interconnected so that wastes or by-products generated from one act as inputs to another. In this way, land and water resources are used efficiently and farming can be sustained with lower cash and labour inputs, while providing substantial output. In practice, integrated fish farming uses wastes generated from ducks or poultry, or both, for fish culture. Such waste is treated as manure, recycled and utilised as nutrients in the pond ecosystem through the trophic food web. Adding organic manures increases the phytoplankton population, which acts as the primary producer and enhances water productivity. Phytoplankton are used as food by a variety of zooplankton. The ideal balance between phytoplankton and zooplankton in the pond ecosystem provides live food for fish.

An increase in phytoplankton due to manuring also has concurrent effects on water quality. During daylight, photosynthesis raises dissolved oxygen and gross primary productivity, and helps to maintain a balanced pH. Levels of free carbon dioxide and un-ionised ammonia may decline. Together, these factors lead to higher fish yields.

In addition, integrated farming offers the following benefits: (i) simultaneous use of land and water for two or more enterprises; (ii) minimal use of external inputs; (iii) recycling of by-products or wastes as manure; (iv) maintenance of enterprise diversity within the same period; (v) a more eco-friendly environment, as negative effects of intensive farming are moderated; and (vi) greater profitability, as diversified outputs reduce the chance of losses across all enterprises at the same time.

Aquaculture development in Meghalaya - the contribution of ICAR-CIFA

For a long time, the Indian Council of Agricultural Research - Central Institute of Freshwater Aquaculture (ICAR-CIFA), Ministry of Agriculture and Farmers' Welfare, Government of India, has been actively engaged in improving and extending aquaculture, as well as developing fishers' livelihoods in Meghalaya, as part of the NEH (North Eastern Hill) region development programme. ICAR-CIFA carries out these activities in collaboration with the Meghalaya State Aquaculture Mission (MSAM). MSAM selects beneficiaries for training, arranges aquaculture inputs, and monitors progress. It also coordinates among farmers and liaises between farmers and scientists to solve problems.

Integrated aquaculture farming: A common practice in Ri Bhoi District, Meghalaya

Meghalaya is one of the eight 'sister' states of north-east India. Its topography is mountainous, with valleys and highland plateaus, as well as plains. It is among the wettest places, with average annual rainfall reaching 12,000 mm in some areas. The population was 2,964,000 at the 2011 Census. In Ri Bhoi district, which adjoins Assam, the terrain is mostly plain and semi-intensive pond aquaculture is common. Many farmers practise integrated aquaculture with ducks and poultry, each as a sub-system. Combining the three components needs proper coordination and monitoring. If one sub-system is mismanaged, the whole integration can be disturbed. An effective integration, run with a sound combination, should maintain the following: (i) the density of each component, appropriate to the overall system; (ii) suitable size and age of the components; (iii) conditioning before release; (iv) health and immunity checks before release; (v) timely feeding; and (vi) close monitoring and surveillance for the first one to two months to ensure the components are compatible and function properly.

Mr Elbert Roni Ramde, of Liarkhla village in Ri Bhoi district, is a progressive fish farmer. He practises integrated farming with fish as the principal component, and ducks and poultry as sub-systems. He is a beneficiary of ICAR-CIFA and has received training in scientific aquaculture. He was provided with aquaculture inputs, including fish seed and feed. Horticultural crops, including bananas and turmeric, are planted on the pond dykes in an integrated manner. Mr Elbert has been technically guided by Krishi Vigyan Kendra (KVK), Ri Bhoi,

Training program conducted by ICAR-CIFA.


Above,below: Elbert receiving fish seeds from CIFA scientists.

under the ICAR Research Complex for the NEH Region, Umiam, Meghalaya. The KVK implements technologies in farmers' fields and gathers feedback to communicate to the concerned scientists.

Mr Elbert manages four ponds for integrated farming. The ponds are constructed almost in a straight line; each pond adjoins the next by a dyke. The first pond is about 0.5 m higher than the second, and the alignment continues to the third and fourth. A narrow channel (150.0 m × 0.5 m depth × 0.5 m width) runs parallel to the four ponds and connects

Turmeric plantation.

to each pond through an inlet. The ponds lie at the foot of a small hill. Run-off from the hill flows into the channel and is the main water source for the ponds. A single iron pipe (4.0 cm diameter) is set in the dyke between ponds so that excess water drains by gravity from the upper pond to the lower one.

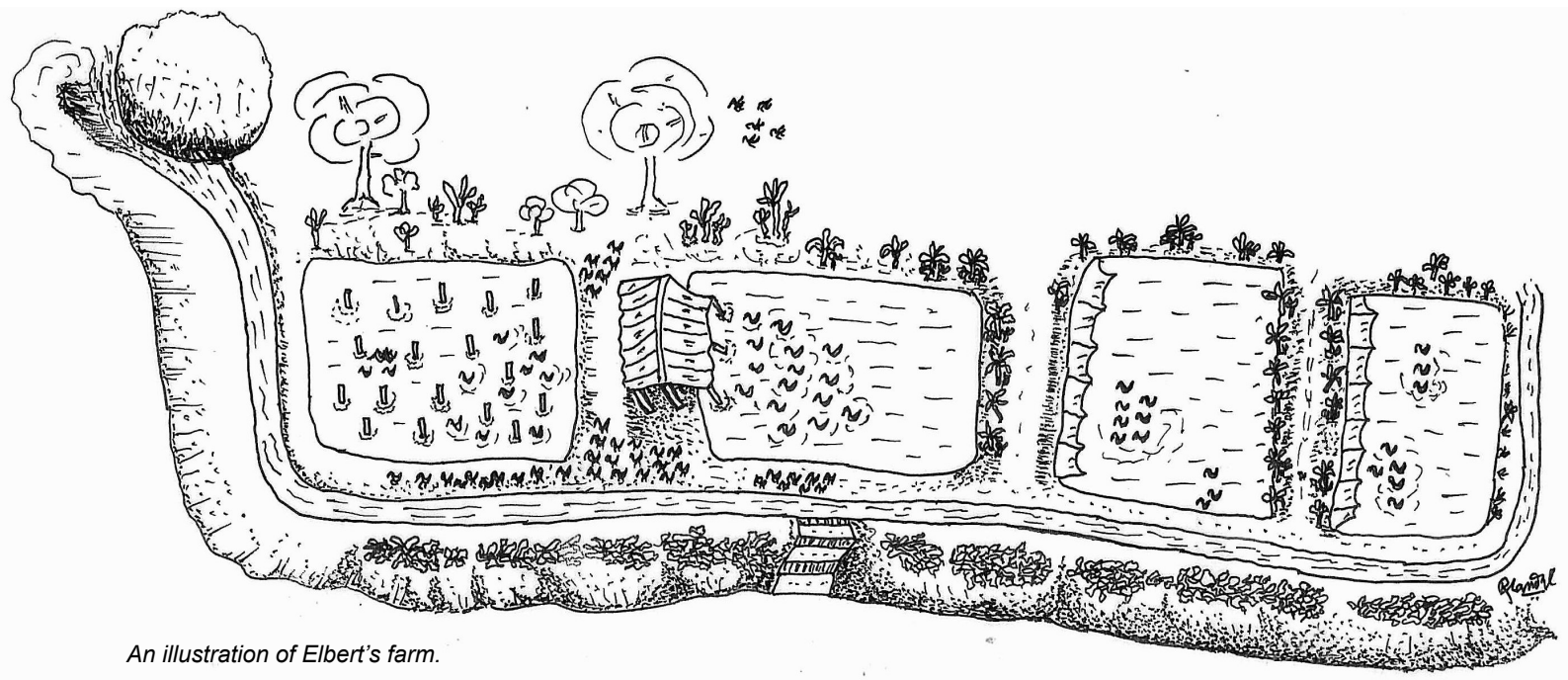
Pond sizes vary. The first, second, third and fourth ponds have areas of 70.0 m^2 (9.2 m × 7.6 m), 93.0 m^2 (12.2 m × 7.6 m), 93.0 m^2 (12.2 m × 7.6 m) and 62.0 m^2 (8.2 m × 7.6 m), respectively. Pond depth ranges from 0.9-1.2 m. Water temperatures range from 10-25°C, and dissolved oxygen from 5-9 ppm (≈ 5-9 mg/L). Lime is applied to maintain pH between 6 and 7.

Stocking of fish seed and rearing

Four species are selected for culture, considering their suitability to the agro-climatic conditions of Ri Bhoi district: rohu, *Labeo rohita*; Amur carp, *Cyprinus carpio haematopterus*; common carp, *Cyprinus carpio*; and grass carp, *Ctenopharyngodon idella*. Fish seed with an average individual weight of 3.5 g are stocked into the four ponds with selective release. The first pond is stocked with 1,000 rohu seed as a monoculture, equivalent to 142,000/ha. The second and third ponds are each stocked with 1,500 seed (500 Amur carp, 500 grass carp and 500 common carp) as mixed culture, equivalent to 160,000/ha. The fourth pond is stocked with 900 seed (300 Amur carp, 300 grass carp and 300 common carp) as mixed culture, equivalent to 150,000/ha.

Selection of ducks and their rearing

Mr Elbert prefers the Indian Runner breed for integration. A total of 100 ducklings, averaging three weeks old, were supplied by Krishi Vigyan Kendra (KVK), Ri Bhoi, under the ICAR Research Complex for the NEH Region, Umiam, Meghalaya. About 5.0 kg of faecal matter is collected daily from the duck shed and applied to the ponds as manure. In addition, 5.0 kg/day of a feed-starter and rice bran mixture is used for feeding; leftovers are added directly to the fish ponds. Ducks swim in the ponds during the day and their droppings fertilise the water. At night they shelter in a roofed shed (75.0 m^2) with five compartments (each 2.0 m × 1.5 m). Three compartments are used for ducks and two for poultry. The shed is built partly on the pond dykes and partly extended over the pond surface.



An illustration of Elbert's farm.

Selection of poultry and their rearing

A total of 50 poultry, averaging three weeks old, mostly Banaraja with a few Rainbow Star, were supplied by KVK, Ri Bhoi, under the ICAR Research Complex for the NEH Region, Umiam, Meghalaya. About 5.0 kg of faecal matter is collected from the poultry shed daily and applied to the ponds as manure. A further 5.0 kg/day of a feed-starter and rice bran mixture is used for feeding; leftovers are added to the ponds.

Benefits of integration: Three crops grown simultaneously in the same unit area

Mr Elbert benefits by harvesting three crops-fish, ducks and poultry-from the same area, which covers 318 m^2 across four ponds, in addition to vegetables and spices grown on the pond dykes. In this system, fish culture is treated as the major sub-system, while ducks and poultry are two minor sub-systems. Fish is considered the major crop because it uses the water area. Ducks and poultry are the minor crops because they mainly fertilise the water body. Their stocking and husbandry are determined by the cultivable water area.

Integrated fish-duck farming: the benefits

Ducks act as “manuring machines”, fertilising the pond with their droppings. Their swimming and light raking of the pond bottom help to aerate the water. The largely self-operating system is efficient, saves labour and is cost-effective. Estimates suggest that duck droppings can reduce the cost of supplementary fish feed by about 60% in traditional pond aquaculture. Duck waste and leftover, partly digested feed are eaten directly by fish. The droppings add essential nutrients, which stimulate the growth of natural foods.

Duck movement also helps break up and distribute droppings and other food particles more evenly across the pond. Ducks keep macrophytes in check and loosen the pond bottom through dabbling, releasing nutrients from the soil and increasing pond productivity. They meet much of their own diet from the pond by eating aquatic weeds, frogs, tadpoles, dragonflies, insects, larvae, earthworms, snails and other aquatic biota, which helps maintain a safe environment for fish. Ducks can obtain around 50-75% of their feed requirement from the pond, while poultry drink from the ponds and take insects, helping to keep water plants in check.

Live food organisms and a suitable pond environment supported by added manures

Phytoplankton density is high due to organic manure from duck and poultry faeces and duck droppings entering the pond. High phytoplankton supports zooplankton and other benthic communities. The supply of duck droppings, poultry and duck faeces, and leftover feed promotes the growth of live food organisms to an optimal level. Phytoplankton production that supports zooplankton growth helps maintain a balanced proportion of phytoplankton and zooplankton across trophic levels. In addition, duck movements aid oxygenation through surface aeration, increasing dissolved oxygen and helping to reduce ammonia, thus maintaining a healthy environment for fish farming.

A long channel passing alongside the ponds.

Elbert applying lime in his pond.

Elbert stocking fish seed in his pond.

Nutrients management and fish rearing

Of the four ponds, the first is used for monoculture with rohu only. Numerous bamboo poles are placed across the water surface to promote periphyton growth. Faecal matter and leftover feed are added to the first and second ponds, as the duck and poultry shed is located on their shared dyke. Ducks and poultry move frequently in and around these ponds. Rohu are column feeders and browse periphyton growing on the bamboo poles. Duck activity acts as natural aeration and helps distribute added manures evenly through the water, which in turn supports periphyton proliferation.

Excess water, carrying suspended nutrients, flows by gravity through an iron pipe from one pond to the next. This helps spread nutrients uniformly and reduces losses. Continuous flow through the inter-pond pipe also promotes surface oxygenation, improving conditions for fish survival.

The other ponds are used for mixed culture, combining grass carp, common carp and Amur carp. Ponds at the lower tier receive the most nutrient deposition, which stimulates dense plankton blooms and the growth of benthic organisms and macrophytes. Grass carp consume macrophytes and help keep the ponds free of aquatic weeds. Common carp and Amur carp feed mainly near the bottom, exploiting benthic foods and helping to control bottom-dwelling organisms. In this integrated system, manures from ducks and poultry, together with leftover feed, promote the growth of plankton, benthos, periphyton and other organisms, including aquatic macrophytes. These biotic resources are then used as food by the respective fish species. It is estimated that approximately 40-50 kg of organic waste can be converted into 1 kg of fish.

Maintenance of a healthy environment

Nutrient-rich pond water is used to irrigate banana and turmeric, taking advantage of the water resource flowing from the hilltop. Poultry and duck droppings serve as manure and no external manuring is applied. Crops planted on the pond dykes and around the pond margins also provide ground cover, which reduces direct sunlight on the soil. This helps maintain soil moisture and protects soil health. Even in hot weather, the pond environment remains at a favourable temperature, which appears eco-friendly under the integrated farming approach.

Marketable products and earnings from integration

Culture was undertaken for an average of eight months, with multiple harvests. Harvesting begins when fish reach an average weight of about 400 g. Multiple partial harvests gradually reduce stocking density, allowing the remaining fish to grow to larger sizes as space becomes available. The farm-gate price for harvested fish across species is around INR 270.00/kg (about USD 3.10/kg). An adult duck weighing about 2.0 kg fetches around INR 700.00 (about USD 8.04)

Feeding time for ducks and poultry.

per bird, and an adult poultry bird weighing about 1.0 kg fetches around INR 300.00 (about USD 3.45) per bird. It is estimated that Mr Elbert's profit from the integrated system is around INR 450,000 from sales of fish, ducks, poultry and eggs, in addition to income from bananas and turmeric, which are also sold. These farm products are also used for household consumption.

Conclusion

Integration of fish, ducks and poultry is a promising farming system, particularly for resource-poor farmers in rural areas. It has proved sustainable and income-generating, including for unemployed youth. The integrated approach offers a practical route to economic success and helps address issues at the grassroots level, including livelihoods, nutritional security and poverty alleviation. It also encourages ongoing innovation: components can be adjusted or replaced with other sub-systems to improve compatibility and profit under changing climatic conditions.

Mr Elbert's farm demonstrates a replicable model that highlights resource efficiency, productivity and income generation. Such integrated farming can help rural communities meet pressing challenges. It enables multiple crops to be harvested from the same area in a cost-effective way, with modest labour and input needs, to achieve greater overall benefit. The system produces a range of marketable products-fish, meat, eggs, bananas and turmeric-giving farmers several options to reach customers. By combining diverse outputs, integration supports climate-resilient farming and strengthens local food supply.

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