

Aqua-village in Meghalaya: Linking science, community and sustainable livelihoods

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Meghalaya's subsistence-level fish productivity of 1.5 t/ha/year continues unchanged despite the state's unique water resources endowment and traditional aquaculture practices. This article introduces the Aqua-village approach, a scalable, people-centric aquaculture development strategy tested in the Ri-Bhoi district as part of the ICAR-NEH Region's Tribal Sub-Plan (TSP). The approach combines composite fish farming practices with Indian Major Carps and exotic carps, scientifically designed pellet diets, paddle-wheel aeration systems, and livestock-pond synergies to realise production targets of 3–4 t/ha/year. Value addition and processing expertise are also incorporated to provide secondary livelihood opportunities, especially for women and youth. The Aqua-village approach is founded on knowledge-sharing for development, with synergies across several UN-SDGs, providing a sustainable model for tribal fisheries development in north-eastern India.

Keywords: Composite fish culture, Integrated farming systems, North-eastern India, Sustainable rural livelihoods, Tribal aquaculture

FISH has always meant more than food in the hazy hill country of Meghalaya, where rivers flow through primeval woodland and every house can tell the beat of rain. It is culture, a celebration, the smell of the morning market and the silent pride of a tribal farmer who has worked on his pond as his father and grandfather used to do. But despite all this closeness to water, the fish farmer of Meghalaya is only able to harvest an annual 1.5 t of fish/ha on average nowadays, half the amount that a farmer in the plains can do with the same amount of water and the same sun. With this in mind, the transformative concept of Aqua-village, has been introduced.

Concept of an Aqua-village

Aqua-village is not just the collection of fish ponds. It is a complete system of production, community and sustainability located on water-based farming. It is a living mosaic, with composite fish culture at the centre, duck rearing being done on the pond embankments, vegetables being grown on trellises along the dykes, women working and packing smoked fish to urban markets, and young people being trained in water quality management with a digital tool in their hand. Its idea is based on the ancient wisdom of integrated farming that has been practised by tribal communities

over centuries, and it combines it with modern science such as aeration technology, scientifically developed pellet feeds, species selection guided by ecological compatibility, and evidence-based health management guidelines. It does not lead to the imposition of a foreign technology to a community. It is an old habit taken to a higher level of acquiring knowledge.

The Meghalaya context: Why here, why now?

The geography of Meghalaya is a treasure that is yet to be unwrapped. The country receives one of the greatest rainfalls in the globe. It has hills that are interspersed with streams of perpetual water. It has a temperate climate that allows year round aquaculture without the thermal stress that plagues fish farming in the hot plains. But still over 20,000 individuals reliant on fisheries in this area endure productivity at almost subsistence levels. These causes are historical and structural. In Meghalaya, tribal farmers can access the traditional knowledge of fish rearing, however, scientific contributions such as quality fingerlings, nutrition-balanced feeds, monitoring of water quality, aeration systems, etc. have been mostly inaccessible. There are weak infrastructures, far markets and post-harvest losses whatever profits achieved at the pond level. Skilling does not have any formalities as women



Distribution of inputs and machinery under Aqua-village project

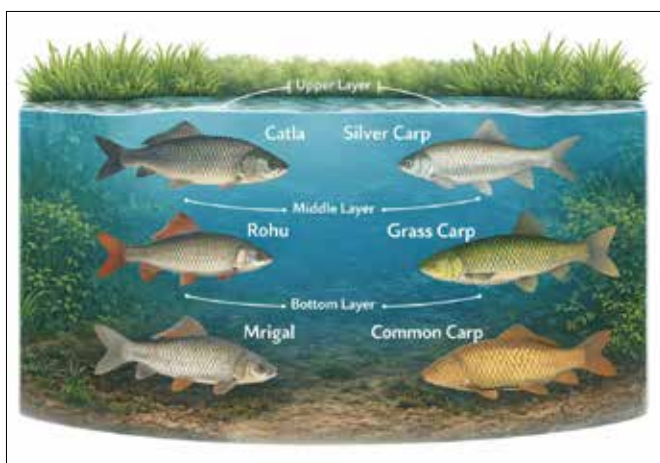
make substantial contribution to drying and selling fish. The young people move to the cities as the pond does not appear promising.

The ICAR Research Complex at Umiam, Meghalaya, has decided to fill this vacuum squarely by coming up with a replicable Aqua-village model in the Tribal Sub Plan (Presently known as Schedule Tribe Component). Ri-Bhoi district was chosen because of its high tribal composition, the tradition of aquaculture already present there, its closeness to the research station where the technical support can be provided at all times, the Self Help Groups (SHGs) and traditional village councils which can serve as the foundation of project sustainability even when the scientists have gone.

Five pillars of the aqua-village

Composite fish culture with high-yielding varieties:

Composite fish culture (CFC) is the basis of the aqua-village, in which several species compatible, which in this case are Indian Major Carps (IMCs) such as *Catla*, *Rohu*, and *Mrigal*, and exotic carps such as Silver Carp, Grass Carp and common carp are stocked in one pond. The species inhabit ecologically distinct niches in the water column and have different sources of natural food, so that all the productive potential of the pond ecosystem can be utilised at once. The demonstration ponds in Ri-Bhoi are aiming at 3–4 t/ha/yr with scientific stocking densities, quality fingerlings, and the use of



Composite fish culture utilising complementary feeding niches



Fish productivity enhancement through composite fish culture

Supplementary feeding has long been the most reliable lever for increasing fish production. The aqua-village model demonstrates the use of nutritionally formulated pellet feeds that provide balanced protein, energy, vitamins, and minerals through the growth cycle. Unlike traditional farming that relies entirely on natural pond productivity, feed-based aquaculture breaks the ceiling on production. Demonstrated farmers receive training on scientific feeding schedules, feed conversion ratio (FCR) monitoring, and cost-benefit analysis so that they can independently manage their feeding programme with confidence.



Formulating supplementary fish feed from locally available ingredients at the farm level

Aerator-based systems and water quality management: One of the most common causes of sudden fish mortality in fish ponds is dissolved oxygen depletion, particularly during morning hours or after heavy algal blooms. The Aqua-village introduces paddle wheel aerators (1 HP units that mechanically circulate pond water and drive oxygen exchange at the surface) as standard practice in demonstration units. Alongside aeration, farmers are trained in regular monitoring of water parameters including pH, dissolved oxygen, ammonia, and turbidity using simple field testing kits. When a farmer can read his pond's condition, he is no longer at the mercy of invisible disasters.

Integration of livestock and pond farming: The most noticeable thing about the Aqua-village model is the incorporation of duck rearing with fish culture. Insects, weeds, and algae are natural foods of ducks



Aerator-based aquaculture production system

foraging in fish ponds, so they can be used as effective biological controllers of pests without the use of chemical inputs. Their excreta are high in nitrogen (N) and phosphorus (P) and therefore, fertilise the pond water and induce production of plankton which is the foundation of aquatic food chain and production of fish. Moreover, ducks increase water aeration as a result of dabbling and swimming, thus, they are commonly called the 'biological aerators'. Farm produce on pond embankments enjoys the fruitful silt and the pond water as life saving irrigation source to produce more food and generate more income without the need to have more land. This circular model of bio-economy represents ecological intensification, i.e. generating more with the same natural resource base and less reliance on outside inputs.

Value addition and secondary livelihoods for women and youth: Any fish that is not sold is a loss. A fish which is sold on the spot receives a lower price than the fish which has been smoked, dried, or packed into a labeled package to an urban supermarket shelf. The Aqua-village model has a strategic investment



Integrated duck with fish farming

in the post-harvest economy and women and the young entrepreneurs are provided with skills in fish processing, hygiene management, products development, packaging, and market connection. The drying, pickling and ready-to-eat fish product development training programmes are undertaken on intensive training module. The packaging equipment, sealing equipment, and labelling materials are also given so that micro-enterprises can be able to maintain themselves commercially.



Value-added fish product development

Environmental sustainability at the core

Aqua-village model is one of the actions to environmental crisis of our times. All of its components promote the United Nations Sustainable Development Goals (UN-SDGs) directly. The circularity of fish, duck and vegetable farming eradicates waste streams and resembles natural ecosystems leading to SDG 12 (Responsible Consumption and Production). The reliance on organic pond fertilization by livestock integration decreases synthetic fertiliser and chemical inputs to preserve the health of watersheds and promote SDG 15 (Life on Land). Community-based water body management develops local institutions that have an ability to manage resources collectively, which promotes SDG 6 (Clean Water and Sanitation). Value addition incomes diversify vulnerability to climate change and market shocks and helps to achieve SDG 1 (No Poverty) and SDG 2 (Zero Hunger). And, the inclusive approach of consideration of women and youth as main economic participants of the Aqua-village model directly addresses SDG 5 (Gender Equality) and SDG 8 (Decent Work and Economic Growth).

Aerators, though electrically powered, significantly decline instances of fish deaths which would otherwise result in total wastage of biological capital. With prudent application of the paddle wheel aerators, the management of dissolved oxygen is maximised and when combined with solar-powered alternatives in further expansion, it can be transferred to SDG 7

(Affordable and Clean Energy). The pond system with water recycling and low fresh water extraction relative to open channel irrigation systems makes the model have a much smaller water footprint than the terrestrial crop agriculture.

Community at the centre

Tribal farmers in Meghalaya are not blank slates to be filled by the scientists. They are professionals whose ecological expertise is several generations old. Aqua-village model is intended to justify and uphold that knowledge rather than substituting it. The implementation of scientific interventions is done through demonstration, conversation and participatory monitoring, where farmers receive information of not only what to do but also why it works. Self Help Groups (SHGs) and traditional village councils are not peripheral stakeholders, they are the institutional underpinning therein the model will built upon.



Participant farmers of Aqua-village project

SUMMARY

The Aqua-village project that was created in the Ri-Bhoi district of Meghalaya is specifically designed as a project that can be replicated. The knowledge has been carried forward through its documentation, training manuals, video material, and field guides to spread across the eight states that make the Northeast, where the conditions of tribal demography, hill topography, water abundance and underperformance in aquaculture are similar. The network of regional centres, Krishi Vigyan Kendras (KVKs) and state fisheries departments, which are the foundation of this scaling by ICAR, do not recreate the wheel at every scale. Aqua-village is not a local experiment, but a national example of how sustainable, inclusive, and ecologically smart aquaculture can appear.

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