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# Transformative grassroot innovations for sustainable hill agriculture

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*The Farmer FIRST Programme, implemented in the ICAR Research Complex for NEH Region, Umiam, Meghalaya, has significantly advanced sustainable and inclusive agricultural development in the north eastern hill region of India. Through participatory and location-specific interventions, the programme has promoted both grassroot innovations and transformative technologies that utilize locally available resources to enhance productivity, resilience, and rural livelihoods. Notable grassroots innovations include the use of banana pseudo-stems to protect transplanted seedlings from intense sunlight and rainfall, and the utilization of bamboo for constructing low-cost poultry baskets, feeders, irrigation conduits, and aeration systems for fishponds, demonstrating effective integration of Indigenous Technical Knowledge (ITK) with scientific practices. Complementing these, transformative interventions such as second cropping in rice fallows,* rabi *maize cultivation, orchard establishment, backyard poultry and pig farming, oyster mushroom cultivation, scientific beekeeping, rainwater harvesting, integrated farming systems (IFS), composite fish culture, and farm mechanization through custom hiring centres have enhanced farm productivity, income generation, and resource-use efficiency. Collectively, these efforts have transformed traditional hill farming into a diversified, market-oriented, and environmentally sustainable system, underscoring the vital role of the Farmer FIRST Programme in fostering innovation-driven, climate-resilient, and economically viable rural prosperity in Meghalaya and the broader north eastern region.*

**Keywords:** Farmer FIRST Programme, Hill agriculture, Indigenous technical knowledge, Integrated farming systems

THE north eastern region of India, characterized by hilly terrain, high rainfall, and rich biodiversity, offers unique opportunities for developing sustainable agricultural models suited to fragile ecosystems. However, the region's farmers continue to face multiple constraints such as limited cultivable land, soil erosion, poor mechanization, and low productivity. The rice-based farming system prevalent in Meghalaya often leaves vast stretches of land fallow after harvest, leading to underutilization of resources and reduced farm income.

To address these challenges, the Farmer FIRST Programme (FFP), implemented by the ICAR Research Complex for NEH Region, Umiam, Meghalaya, promotes farmer-centric, participatory, and resource-efficient innovations that combine modern agricultural technologies with Indigenous Technical Knowledge (ITK). The programme focuses on enhancing productivity, diversifying income, and ensuring ecological balance through location-specific interventions. In the Marngar cluster and Mawsiatkhnam villages, farmers adopted a range of grassroot innovations and transformative technologies. The integration of indigenous creativity with scientific technologies under the FFP demonstrates a powerful model for inclusive, climate-resilient, and sustainable hill agriculture, setting a benchmark for rural transformation in the north-eastern region.

## Grassroot innovative technologies

Grassroot innovations involve practical, locally developed solutions that address specific challenges in agriculture and rural livelihoods. The north-eastern region of India, with its rich natural resources and diverse agro-ecological conditions, offers ample opportunities to harness indigenous knowledge for

sustainable farming. The Farmer FIRST Programme (FFP) encourages farmers to experiment with innovative techniques to enhance productivity, reduce costs, and improve resource efficiency. The documented innovative practices in Marngar cluster villages, Meghalaya, focus on the use of banana pseudo-stems and bamboo for agriculture, poultry, aquaculture, and irrigation.

***Banana pseudo-stem for protecting seedlings against sunlight:*** Under FFP, an innovative practice was introduced in the Marngar cluster villages to enhance the survival and growth of transplanted seedlings. The t echnique involves placing banana pseudo-stems around newly transplanted seedlings to shield them from direct sunlight and heavy rainfall. This simple and eco-friendly method helps minimize heat stress, conserve soil moisture, and protect young plants from harsh weather conditions. As the banana stem decomposes, it enriches the soil with organic matter, thereby improving fertility. The intervention has demonstrated how locally available resources can be effectively utilized for sustainable and climate-resilient crop production, aligning traditional wisdom with modern agricultural initiatives under FFP.

Protection of seedings with banana pseudo-stem

***Bamboo for making baskets:*** In the north eastern region of India, where bamboo is exceptionally abundant, accounting for a significant share of India's bamboo area and production, using bamboo baskets for poultry egg laying and also as low-cost poultry feeders is a prime example. These practices leverage the region's rich bamboo resources to provide affordable, locally crafted solutions for poultry management, supporting rural livelihoods and reducing dependence on external inputs. The widespread availability and adaptability of bamboo empower communities to create stundy, biodegradable nesting baskets and durable feeders that fit local poultry rearing systems, reflecting both environmental sustainability and cultural continuity in the region.

Bamboo based feeder for poutlry

Bamboo basket for nesting

***Bamboo-based aeration for fishponds:*** Shri Gumbir Syiem, an innovative farmer from Margnar village, addressed the challenge of insufficient aeration in his fishponds by developing a low-cost, environment-friendly aeration system using locally available bamboo. Instead of using expensive PVC pipes or motorized aerators, he utilized a rare indigenous bamboo species known locally as 'doluba,' which is long (about 42 feet) and durable. Each bamboo, costing about ₹100, can cover up to three-fourths of a pond, making this method highly cost-effective. The bamboo aerator harnesses water from a nearby stream, ensuring adequate oxygen supply for fish and improving water quality. This solution not only reduces operational costs but also avoids environmental harm associated with plastic and electric alternatives, demonstrating how traditional, sustainable resources can address modern aquaculture needs efficiently.

***Bamboo for irrigation of vegetables:*** Bamboo can be effectively used instead of PVC pipes for irrigating vegetables. In many regions, especially where bamboo is abundant, farmers use hollow bamboo stems to transport water directly to their crops. This method is both cost-effective and environmentally friendly, providing a sustainable alternative to plastic pipes.


Bamboo based aeration system in fish ponds

Using bamboo for irrigation takes advantage of natural resources and helps ensure a steady supply of water to vegetable fields.

Bamboo irrigation channel

## Transformative technologies

Hill farmers in the north-eastern region of India often face constraints such as limited cultivable land, low productivity, and inadequate access to modern agricultural technologies. The rice-based farming system prevalent in Meghalaya leaves substantial post-harvest fallow areas that remain underutilized, resulting in reduced farm income and livelihood vulnerability. The Farmer FIRST Programme (FFP), implemented in ICAR-RC NEH Region, Umiam, aims to address these challenges by promoting participatory, location-specific interventions that combine modern agricultural innovations with locally available resources and Indigenous Technical Knowledge (ITK). By leveraging both scientific and traditional practices, the FFP initiative provides a sustainable pathway for improving rural livelihoods, promoting resource-efficient farming, and enabling market-oriented agriculture in the hilly terrains of Meghalaya.

***Enhancing productivity through* rabi *vegetable cultivation in rice fallow lands:*** To utilize fallow land after paddy harvest, trainings-cum-demonstrations on scientific *rabi* vegetable cultivation were conducted in Marngar cluster and Mawsiatkhnam village. Training focused on improved practices like variety selection, sowing time, nursery management, mulching, irrigation, and use of banana pseudostem and bamboo for seedling protection and irrigation. Quality seeds were distributed to 147 farmer. Thirteen growers cultivated vegetables over 31.1-acre, broccoli covered 12.7 acre (yield: 21.1 tonnes), followed by capsicum (5.3 acre) and cabbage (3.6 acre). Net income was highest in broccoli (₹3.8 lakh), capsicum (₹2.3 lakh), and peas (₹0.4 lakh), with benefit-cost ratios of 1.8 and 1.6 in broccoli and peas, respectively.

***Intervention of* rabi *maize variety in paddy fallow:*** To utilize unproductive paddy fallow, *rabi* maize cultivation was introduced for the first time in Lalumpam, Borgang, Borkhatsari, and Purangang villages through demonstrations held on 2 and 12 November, and 10 and 23 December 2021. Quality seeds (120 g/packet) of maize varieties RCM1-76 and RCM1-61 were distributed to 30 farmers (21 with RCM1-76, 9 with RCM1-61). Technical guidance on cultivation and land management was provided. Field monitoring on 09th February 2022 showed slow growth but good vegetative performance, with crops at cob formation stage.

***Establishment of orchard of fruit, spices and plantation crops:*** To enhance long-term farm income, orchards of fruit, spice, and plantation crops were established covering Khasi mandarin (0.60 ha, 250 trees), Guava (0.85 ha, 350 trees), Assam lemon (0.70 ha, 200 plants), Arecanut (3.00 ha, 900 plants), and Black pepper (0.70 ha, 200 plants). Currently, 40 Khasi mandarin trees yield 1.8 kg/plant, 60 guava trees yield 1.4 kg/plant, and Assam lemon plants bear 10–20 fruits each, while arecanut and Black pepper remain in the vegetative stage.

***Backyard poultry farming:*** Improved backyard poultry and pig farming (33 Hampshire crossbred pigs to 33 farmers) were introduced to enhance rural livelihoods. Poultry income from 20 birds sold averaged ₹49,000 with a net profit of ₹21,800 (B:C-1.80). A pig breeding cluster of three farmers sold 38 piglets and 5 adult pigs, earning ₹2,54,300 with a B:C ratio of 1.74, including Shri Mrinal Sohkhwai's net profit of ₹33,700 from 10 piglets and 2 adults (B:C-1.76).

***Development of pig breeding cluster in village:*** A pig breeding cluster using improved Hampshire crossbred pigs was established with three farmers Shri Mrinal Sohkhwai, Shri Dominick Syiem, and Shri Jiten Sohkhwai-who collectively sold 38 piglets and 5 adult pigs, earning ₹2,54,300 with a B:C ratio of 1.74. Individually, Shri Mrinal earned ₹33,700 (B:C-1.76), Jiten ₹48,650 (B:C-1.75), and Dominick ₹26,100 (B:C-1.71)

as net profits from their sales. This cluster enhanced organized breeding and improved farmer incomes.

***Oyster mushroom cultivation:*** The demonstrated technology involved the distribution of oyster mushroom spawn to various beneficiaries from adopted villages. A total of 100 spawn packets (weighing 40 kg) were distributed, resulting in a yield of 90 kg of fresh oyster mushrooms. These mushrooms were sold in local markets at a rate of ₹ 200–250/kg, generating a total income of ₹ 15,800. The cost of production was ₹ 6,320.00, leading to a net profit of ₹ 9,840 and a B:C- 2.5.

***Scientific beekeeping:*** The demonstrated technology involved scientific beekeeping practiced by 8 farmers from adopted villages using 15 bee colonies received in previous year. A total of 53 L of honey was harvested, resulting in a net profit of ₹ 31,800.

***Construction of low cost rainwater harvesting structure,* Jalkund:** The demonstrated technology involved the construction of 35 low-cost rainwater harvesting structures *(jalkunds)* measuring 5 m × 4 m × 1.5 m each, built before the onset of the monsoon. The stored water is utilized for irrigating crops, cleaning livestock sheds, and fish rearing.

***Establishment of integrated farming systems:*** In Nalapara village (1.6 ha), Shri Jiten Sohkhwai's IFS generated ₹7,21,500.00 income from fishery (2 ponds, 1000 $m^2$ each), crops (1 acre paddy, 0.8 acre vegetables), piggery (26 piglets born, 24 sold, 1 adult sold), dairy (8 adult cows sold), duckery (70 ducks received, 50 sold, 510 eggs sold), goatery (2 kids sold), and rabbitery (13 offspring). Expenditure was ₹3,16,850 net profit ₹4,04,650; B:C ratio 2.28.

In Joigang village (1.5 ha), Shri M. Raja's IFS earned ₹3,27,366.00 from fishery (0.75 acre angling), crops (2 acres paddy, 0.7 acre broccoli), poultry (80 birds, 30 sold, 12 trays eggs), piggery (7 adults, 3 sold, 8 piglets), duckery (107 ducks, 30 sold, 17 trays eggs), and goatery (10 goats, 2 males sold). Expenditure was ₹1,59,112.00; net profit ₹1,68,254.00; B:C of 2.06.

***Composite fish culture:*** To address low farm income in the adopted villages, composite fish culture was demonstrated using *Rohu*, *Mrigal*, Grass carp, Common carp, Silver carp, and *catla*. Three beneficiaries achieved a total yield of 480 kg, sold at ₹ 250.00–300.00/kg, generating an income of ₹ 1,14,800.00 with a B:C of 3.1.

***Farm mechanization through custom hiring centres:*** To reduce the cost of cultivation, a farm mechanization module was implemented through the establishment of three custom hiring centres at marngar cluster (2) and Mawsiatkhnam village (1). These Custom Hiring Centres are well equipped with modern farm machineries. Over 389 farmers registered and around 200 farmers utilized the implements, generating total revenue of ₹ 27,780 in 2021–22, which was used for maintenance and repair. Investment in new machinery is also planned.

## SUMMARY

The Farmer FIRST Programme (FFP) implemented by ICAR Research Complex for NEH Region, Umiam, Meghalaya, has successfully demonstrated the convergence of grassroots innovations and modern agricultural technologies to enhance hill farmer livelihoods. Innovative, low-cost practices such as using banana pseudo-stems for seedling protection and bamboo-based systems for poultry housing, irrigation, and fishpond aeration effectively integrated indigenous technical knowledge with scientific approaches. Transformative technologies including *rabi* maize and vegetable cultivation, orchard establishment, livestock improvement, mushroom cultivation, beekeeping, integrated farming systems, and mechanization through custom hiring centres significantly improved productivity and income. Farmers like Shri Gumbir Syiem, Shri Jiten Sohkhwai, and others exemplify innovation-led transformation towards sustainable, diversified, and climate-resilient hill agriculture in Meghalaya.

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