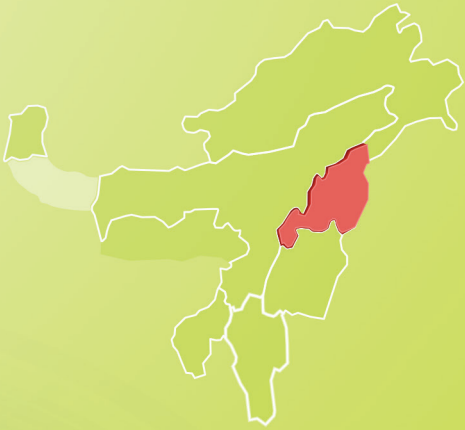
50 Golden Jubilee Celebration

AGRICULTURAL TECHNOLOGIES
TO TRANSFORM RURAL LIVELIHOODS IN
NAGALAND





ICAR Research Complex for NEH Region
Nagaland Centre
Medzipehma-797106, Nagaland

AGRICULTURAL TECHNOLOGIES TO TRANSFORM RURAL LIVELIHOODS IN NAGALAND

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2024

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Agricultural Technologies to Transform Rural Livelihoods in Nagaland

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La. Ganesan
Governor of Nagaland

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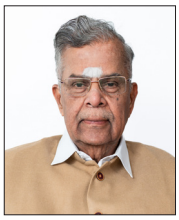

November 21, 2024

MESSAGE

I take great pride in congratulating ICAR, Research Complex for NEH Region, Umiam, Meghalaya on celebrating its Golden Jubilee on the 9th of January, 2025.

This Institute has served the farmers of Nagaland and Northeast Hill Region of India by developing several useful farming technologies and guided them through its various outreach and development activities. The Institute has also played a major role in conserving the highly diverse and unique ecosystem of the hill region. It was enlightening to know that the souvenir being published on this occasion will give an in-depth picture of the work done for Northeast Hill Region in last 50 years and indeed heartening to know that ICAR Research Complex for NEH Region has made noteworthy progress in the area of hill agriculture. I am certain that the Institute in its upgraded capacity will continue to be instrumental in agriculture, horticulture and livestock research and development of the Northeastern hill region of India and assure you the support of the government and people of Nagaland in its future endeavours.

I extend my hearty greetings and congratulate the members and staff of the Institute on this joyous Golden Jubilee occasion and wish them all success in their future endeavours.

(La Ganesan)

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UNITY
GOVERNMENT OF NAGALAND

CHIEF MINISTER
NAGALAND
KOHIMA

12th November, 2024



MESSAGE

On this momentous occasion of the Golden Jubilee of the ICAR Research Centre Complex for NEH Region, Umiam, Meghalaya, I extend my congratulations to the entire ICAR family, distinguished scientists, researchers, and staff who have contributed immensely to the center's growth over the past five decades.

The ICAR Research Centre at Umiam has been instrumental in advancing agricultural research and innovation in the challenging terrains of Northeast India. Through dedicated efforts and pioneering research, this institution has empowered our farmers, enriched regional biodiversity, and fostered sustainable agricultural practices across the Northeast. It is a true testament to the Centre's unwavering commitment to the prosperity of this unique region.

As we celebrate fifty years of excellence, may this occasion inspire renewed dedication towards transforming agriculture in the Northeast, advancing scientific research, and addressing the evolving challenges of the agricultural sector. I am confident that ICAR will continue to play a pivotal role in enhancing food security, livelihoods, and environmental sustainability in our region.

Warm wishes for a memorable celebration and continued success in the years to come.

12/11

(NEIPHIU RIO)

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Date: 10/11/2024

MESSAGE

It is indeed a moment of great pride that the ICAR Research Complex for NEH Region, Umiam, Meghalaya, is celebrating its Golden Jubilee on 9th January 2025, marking five decades of dedicated service to the agricultural landscape of the Northeast Hill Region. I extend my heartfelt congratulations to the Institute for its sustained commitment and significant contributions in advancing agriculture and improving the livelihoods of farmers across this unique and challenging terrain.

Over the past five decades, the Institute has been at the forefront of addressing key challenges specific to the hilly regions, such as the impacts of climate change, soil degradation, erosion, difficult terrain, and limited access to markets and post-harvest infrastructure. Agriculture in the North Eastern Hill Region requires region-specific, resilient approaches, including development of crop varieties suited to the local environment, environmentally safe technological applications, farm mechanization, and infrastructure support, all to foster a more resilient and sustainable agricultural ecosystem. The efforts of ICAR Research Complex for NEH Region including those of the Nagaland Centre, have played a pivotal role in strengthening livelihoods and nutritional security for farmers by providing advanced technologies and essential input support systems.

Looking ahead, I am confident that the Institute will continue to lead efforts in improving agricultural productivity, enhancing self-reliance in hill farming, and transforming it into a vibrant, technology-driven sector capable of meeting future challenges. I look forward to seeing the Institute's continued progress and innovations in the years to come.

I wish the Golden Jubilee celebrations every success and hope this occasion will inspire new milestones in agricultural research and development of the Northeast Region.

(MHATHUNG YANTHAN)

PREFACE

The journey of agricultural development in hilly regions, particularly in the Northeastern Hill (NEH) region of India, offers a compelling narrative of challenges and opportunities. This bulletin titled "Agricultural technologies to transform rural livelihoods in Nagaland" encapsulates this narrative through 39 technologies that delve into various aspects of smart agriculture and entrepreneurial ventures in these terrains. Insights and innovative solutions presented are pertinent not only to Nagaland and the NEH region but also to other similar hilly regions.

Over the past five decades, ICAR-Nagaland Centre has developed and promoted a range of technologies aimed at enhancing the productivity and resilience of farming systems in Nagaland. Integrated farming system models suitable for small and marginal farmers have been promoted, incorporating crop diversification and livestock farming to improve income and resource use efficiency. Technologies like rainwater harvesting, soil health management, low-cost water storage solutions have been implemented to ensure sustainable farming practices amidst climate variability. Crop production technologies have focused on the development and promotion of high-yielding and climate-resilient varieties of staple crops *viz.* rice, maize, sesame, linseed. In horticulture, high-density planting of crops like G-9 banana and the promotion of Naga Mircha in *jhum*-based agro-ecosystems have led to increased productivity and diversification of income sources additionally, innovative products like Naga Mircha pickle have been introduced to enhance marketability. The Centre's effort in livestock farming have been equally transformative with artificial insemination in pigs, promotion of improved poultry breeds *viz.* Vanaraja and Srinidhi for backyard farming, low-cost boar training and dietary improvement to enhance fertility, these interventions have led to improved livestock health, higher productivity and better income for farmers. In the field of fishery, the Centre has introduced innovative practices such as short-duration carp farming in polythene-lined rainwater harvesting ponds under mid-hill and foothill conditions, incorporation of species like *Labeo calbasu* in rice-fish farming diversified aquaculture practices and high stocking density short term carp farming in cemented tank enhances fish production and contributes to the overall food security of the region. Additionally, soil health sustainable technologies like vermicomposting, agroforestry systems and composting enhances soil

fertility and crop productivity, and these technologies, combined with promotion of organic disease management have contributed to more resilient farming systems.

This comprehensive technical bulletin aims to be a valuable resource for researchers, practitioners, policymakers and students interested in sustainable agriculture in hilly regions. The knowledge shared within these pages aspires to contribute to a resilient, productive and sustainable agricultural landscape, fostering economic growth and improving livelihoods.

The editors are highly thankful to the Director, ICAR Research Complex for NEH Region, Umiam, Meghalaya (Headquarter) for his continuous support for development of the technologies at the Centre. Also, appreciate the efforts of previous Joint Directors, Scientists, Technicals and other staff who have contributed for development of these technologies.

Editors

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Introduction

Nagaland, one of the eight states in the North Eastern Hill Region of India, spans an area of 16,579 sq. km. The state is bordered by Manipur to the south, Assam to the north and west, Arunachal Pradesh to the northeast, and shares an international boundary with Myanmar to the east. The state has predominantly mountainous terrain, ranging in altitude from 194 meters to 3,840 meters above sea level. With an average annual rainfall of 1,800 mm and temperatures ranging between 4°C and 35°C, Nagaland enjoys significant agro-climatic diversity. The soils, though acidic due to high rainfall-induced leaching, are rich in organic matter, making them well-suited for agriculture.

The state is home to approximately 19.78 lakh people (Census 2011), comprising 17 major tribes and numerous sub-tribes, each with distinct languages and cultural practices deeply intertwined with an agrarian lifestyle. The literacy rate of Nagaland is around 80%. Agriculture plays a major role in the state's economy, with most farmers depending on rainfed systems. Forests cover 73.9% of Nagaland's geographical area, with 11% classified as very dense, 36% as moderately dense, and 53% as open forest. Jhum cultivation, or shifting cultivation, is the most widespread traditional practice in the state, involving the clearing and burning of vegetation, followed by the cultivation of crops such as rice, maize, pulses, oilseeds, and vegetables for a limited period before leaving the land fallow for natural regeneration. Despite its cultural significance, this method contributes to soil degradation, biodiversity loss, and diminished agricultural productivity over time.



Of Nagaland's total geographical area of 16.57 lakh hectares, 23% (3, 84, 802 hectares) is dedicated to agriculture. The area sown more than once covers 1,45,300 hectares, bringing the total cropped area to 5,30,102 hectares. Rice is the principal crop, followed by maize, soybean, and rapeseed mustard. Rice cultivation spans both upland (jhum) and lowland ecosystems, covering 2,12,000 hectares with a production of 5 lakh tonnes. Jhum paddy accounts for 43% of the total rice area (91,250 hectares), producing 1,82,690 tonnes (36% of the state's rice production). Lowland paddy, meanwhile, constitutes 57% of the rice area (1,20,750 hectares) and contributes 3,22,370 tonnes (64% of the rice output). However, productivity differs significantly: upland rice yields only 1.9 tonnes per hectare, while lowland rice achieves 2.7 tonnes per hectare, comparable to the national average.

The state's rich biodiversity, diverse agroclimatic zones, strong workforce, and family-managed smallholder farms present immense potential for sustainable agricultural practices. Despite its agricultural prominence, Nagaland faces numerous challenges. Only 24% of the state's agricultural land is irrigated, and the cropping intensity stands at 131%. The state also suffers from deficits in critical food items such as pulses, meat, fish, and milk. Fragmented landholdings, limited mechanization, and difficulties in accessing markets and technical resources hinder progress. The rugged terrain of the hill regions exacerbates issues like soil erosion, post-harvest losses, and seasonal constraints. Despite being rich in natural resources such as land, water, and biodiversity, the region faces challenges in ensuring their sustainable use. Over-exploitation, combined with inadequate replenishment threatens soil health and biodiversity. In addition to natural hazards, traditional system of shifting cultivation and increased population pressure has enhanced the process of degradation and desertification. Addressing these issues is critical to safeguarding the region's ecological and agricultural sustainability. Emerging opportunities lie in bridging yield gaps, leveraging export potential, promoting organic farming, and developing agro-based industries. However, threats such as bio-piracy, transboundary diseases, climate extremes, and declining youth involvement in farming necessitate urgent attention.

In response to the challenges and opportunities faced by the agricultural sector, the ICAR Research Complex for NEH Region, Umiam established its Centre at Medziphema, Nagaland, in 1975 with a vision to address the unique agricultural and ecological needs of the region. The Centre's objectives have focused on developing sustainable integrated farming systems to replace traditional jhum cultivation, restoring degraded jhum fallows through tree-based farming, enhancing crop productivity, and advancing livestock and fisheries management.

Over the past five decades, the Centre has developed and promoted a range of technologies aimed at enhancing the productivity and resilience of farming systems in Nagaland. Integrated farming system models suitable for small and marginal farmers have been promoted, incorporating crop diversification and livestock farming to improve income and resource use efficiency. Technologies like rainwater harvesting, soil health management, and low-cost water storage solutions have been implemented to ensure sustainable farming practices amidst climate variability. Crop production technologies have focused on the development and promotion of high-yielding and climate-resilient varieties of staple crops like rice, maize, sesame, and linseed. In horticulture, high-density planting of crops like G-9 banana and the promotion of Naga Mircha in jhum-based agro-ecosystems have led to increased productivity and diversification of income sources. Additionally, innovative products like Naga Mircha pickle have been introduced to enhance marketability. The Centre's efforts in livestock farming have been equally transformative, introducing technologies such as artificial insemination in pigs, the promotion of improved poultry breeds like Vanaraja and Srinidhi for backyard farming, and other advancements like low-cost boar training and dietary improvements to enhance fertility. These interventions have led to improved livestock health, higher productivity, and better income for farmers. In the field of fishery, the Centre has introduced innovative practices such as short-duration carp farming in polythene-lined rainwater harvesting ponds, which have proven to be successful under the region's mid-hill and foothill conditions. The incorporation of species like *Labeo calbasu* in rice-fish farming has further diversified aquaculture practices, enhancing fish production and contributing to the overall food security of the region. Additionally, soil health technologies, including sustainable practices like vermicomposting, agroforestry systems, and composting have been developed to enhance soil fertility and crop productivity. These technologies, combined with the promotion of organic disease management methods, have contributed to more resilient farming systems.

Through these efforts, ICAR Nagaland Centre has made significant strides in transforming the region's farming systems, addressing ecological challenges, and improving the socio-economic well-being of the farming communities. This book, a 50-year compilation of technologies developed at the Centre, highlights the progress made and the continuing journey toward sustainable agricultural development in Nagaland.

I. AGRONOMY

Title of the technology:

Integrated farming system models suitable for small and marginal farmers of Nagaland.

Nagaland's rich natural resources and biodiversity, coupled with favourable soil and climate, offer great agricultural potential. However, varied terrain, poor infrastructure, and limited access hinder crop and livestock productivity. Over 75% of annual rainfall (2000 mm) occurs between June and September, restricting crop intensification and diversification. Small landholdings, low investment capacity, and limited knowledge of modern practices further challenge productivity and profitability. In order to attract rural youth in agriculture, ensuring better productivity and income from agriculture production system are of immense importance. Therefore, a systematic and holistic approach for appropriate blending of technology demonstration, capacity building and linkage establishment will go a large way in transforming rural economy to a profitable enterprise. Keeping in view of the cognizance of the above present proposal was conceived.

Application procedure of the technology or SOP for using the technology

A total of 04 no. of IFS models were established involving the crops (fig 1 & 2) *viz.* Model 1: Horticulture + Agriculture + Fishery + Piggery + Vermicompost, Model 2: Agriculture + Horticulture + Fishery + Goatery + Vermicompost, Model 3: Agriculture + Horticulture + Fishery + Duckery+ Vermicompost and Model 4: Agriculture + Horticulture + Fishery + Poultry + Vermicompost + Mushroom.

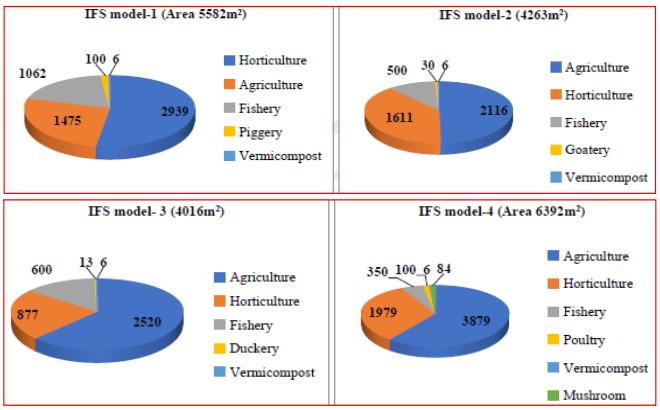


Fig1: Different components under various IFS models in square metre area.



Fig: 2. Glimpses of different IFS models.

These models are designed to optimize resource utilization and increase productivity through a systematic combination of agriculture, horticulture, livestock, fishery, and vermicomposting. In addition to the primary components, intercropping of pumpkin, beans, and bottle gourd above ponds utilizes vertical space and provides additional income. Residual biomass from crops and livestock is repurposed for vermicompost production, enhancing soil fertility sustainably. Regular demonstrations and training sessions are conducted for farmers on adopting and managing these IFS models effectively.

Benefits of the technology

- Increased farm productivity and profitability by utilizing small landholdings more effectively.
- Employment opportunities for rural youth, with low-cost, sustainable livelihood options that combine multiple revenue streams.
- Enhanced soil health and fertility through organic practices and resource recycling.
- Improved income security for small and marginal farmers by diversifying income sources and reducing reliance on single-crop systems.

Impact of the technology

Table 1. Economics of different IFS models (compilation of data from 2020-24).

Model	Gross return (Rs.)	Cost of cultivation (Rs.)	Net return/ unit (Rs.)	B:C Ratio	Employment generation (man days/year)	Sustainable Value Index (SVI)
Model 1	171544	86083	85460	1.98	319/unit or 571/ha	0.42
Model 2	177443	95619	81825	1.85	284/unit or 666/ha	0.38
Model 3	161120	95863	65257	1.70	210/unit or 523/ha	0.32
Model 4	211268	113536	98482	1.84	320/unit or 501/ha	0.40

The results on the basis of four years evaluation reveals that the highest farm profitability (B:C Ratio) was found in Model 1 (1.98) followed by Model 2 (1.85), Model 4 (1.84) and Model 3 (1.70). Highest sustainable value index (SVI) was found in Model 1 (0.39) followed by Model 4 (0.37). Soil health status also recorded to be improved after 4 years by increase in organic carbon, available nitrogen, phosphorus and potassium. The cultivation of pumpkin, beans and bottle gourd above the pond using majang should be promoted to utilize the space and to get additional yield and income.

The weeds/grasses, crop residues and trace materials from vegetable and animal components are used for vermicompost preparation. Demonstration and trainings for these models have been given to the small and marginal farmers in the state.

Name of the inventors

L. K. Baishya, J. Barman, D. J. Rajkhowa, Azeze Seyie, Aabon W. Yanthan, Christy B. K. Sangma, Mahak Singh, Harendra Verma, Pempa L. Bhutia, H. Kalita.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

This technology is recommended for small and marginal farmers in the upland/ lowland regions of Nagaland and similar ecosystems in the North East India where diverse, integrated farming systems can be implemented effectively.

Title of the technology

Enhancing production and productivity of maize and groundnut for livelihood improvement and promotion of livestock farmers.

Maize is an important cereal crop next to rice in Nagaland. Of late, increasing emphasis needs to be put for cultivation of this crop not only for securing food and nutritional security but also for promoting livestock farming. As the state is deficient in meat production to the tune of 80 %, large scale farming of pigs and poultry are inevitable. Continuous efforts have been put for introduction of improved breeds of pigs and poultry in the state both by ICAR-Nagaland centre as well as state department of veterinary and animal husbandry to reduce the demand supply gap. One of the major limitations for scientific livestock farming, more particularly pigs and poultry is the lack of availability of quality feeds. The increase in area, production and productivity of maize is therefore, of utmost importance not only to promote livestock farming but also development of entrepreneurship among the educated youths of the state. Introduction of improved varieties including quality planting material (QPM) and appropriate production technology are keys for enhancing the productivity and profitability of maize cultivation. As such, in the present proposal, effort has been put to demonstrate the improved technology of maize cultivation in a participatory mode. The tremendous scope for enhancing the productivity of maize is yet to be realized which warrants large scale popularization of this crop through extensive demonstration on scientific cultivation. Similarly, there is tremendous scope for introduction of groundnut crop either as sole or as intercrop which will not only help in increasing resource use efficiency but also help in improving soil health and reduce soil erosion.

Application procedure of the technology or SOP for using the technology

This project targeted sustainable agricultural development for tribal farmers by increasing the productivity of maize and groundnut, which in turn supported livestock farming, particularly for pigs and poultry. Covering approximately 50 hectares across three hill districts in Nagaland—Longleng (10 ha), Wokha (10 ha), Peren (30 ha), the project involved:

Capacity building and training: Conducted for rural youth and women on scientific cultivation practices in locations including Wokha, Jalukie, Peren and Longleng.

Input support: Farmers were provided with seeds for improved maize varieties (HQPM-1, All Rounder, RCM-75, RCM-76) and groundnut (ICGS-76), along with lime, organic manure, bio-fertilizers and other essential inputs.

Field demonstrations: Techniques such as optimum crop spacing, weed management, pest control, and post-harvest processing (including the preparation of animal feed) were demonstrated with the assistance of local KVKs. Maize grinders were also used to process feed thereby cutting costs for pig and poultry farmers.

Benefits of the technology

- Increased Crop Productivity and Livelihood Security: Improved yield potential and profitability for smallholders by enhancing agronomic practices.
- Enhanced Livestock Feed Supply: High-quality maize and groundnut by-products serve as cost-effective feed, reducing expenses in pig and poultry farming.

Impact of the technology

Farmers in Longleng, Wokha and Peren adopted the maize-groundnut intercropping system, achieving notable improvements. Maize productivity increased to 2.9 t/ha, compared to 1.6 t/ha under traditional practices. Net returns from groundnut cultivation reached ₹58,500/ha, underscoring the project's potential to improve farmer incomes and promote sustainable practices in upland and jhum regions.

Technology dissemination: A team of scientists from ICAR- Nagaland centre and Subject matter specialist from KVKs of Peren, Wokha and Longleng visited the farmers' field and organized training and demonstrations and field day at different crop growth stages in the respective districts covering 200 nos. of farmers in each districts.





Name of the inventors

L. K. Baishya, D. J. Rajkhowa

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

This technology is suitable for small and marginal farmers in upland and jhum regions of Nagaland and similar North Eastern ecosystems, where diverse, integrated crop-livestock systems can enhance food security and resilience.

Title of the technology

Technology for rain water harvesting and its efficient utilization for higher water productivity.

Nagaland is known for its rich natural resources and biodiversity. The state is bestowed with favourable soil and climatic condition. However, due to varied physiographic, inaccessibility and poor infrastructure, the potentialities of crop and livestock productivity is yet to be realised. More than 75% of the rainfall (2000mm) is concentrated during the period of June to September which constraints crop intensification and diversification. Small and fragmented land holding, poor investment capacity and lack of adequate knowledge about improved agricultural practices further concentrate the problems of poor productivity and profitability of agriculture sector. Farm mechanisation is also yet to start for reducing dragger to the farmers and timely ensuring agriculture practices. Therefore, a systematic and holistic approach for appropriate blending of technology demonstration, capacity building and linkage establishment will go a large way in transforming rural economy to a profitable enterprise. ICAR- Nagaland Centre conceived the training and demonstration programme under National Innovations on Climate Resilient Agriculture (NICRA) and Tribal Sub Plan (TSP) on promotion of water harvesting structures in Dimapur, Peren, Wokha, Longleng, Kiphire and Tuensang districts of Nagaland for increasing the cropping intensity, crop diversification and farm profitability. The centre also popularized the scientific cultivation of Maize and Groundnut for feed production to promote livestock farming in the state as almost all the people of Nagaland are meat eater. The Centre and its KVKs have also taken part for development of hill agriculture in the state through agro advisory services, farmers participatory seed production for catering the need of quality seed to the farming communities and other stake holders, mechanization of hill farming on custom hiring basis, promotion of vermicomposting, mushroom production and scientific poultry and pig farming in the state.

Application procedure of the technology or SOP for using the technology

The technology involved the construction of rainwater harvesting structures tailored to local conditions, with capacities categorized as follows: 15 large structures (8.75 lakh litres), 3 medium structures (2.0 lakh litres), 52 small structures (63,000 litres), and 110 micro structures (30,000 liters). These were developed for demonstration on farmers' fields in the Dimapur, Peren, Wokha, Longleng, Kiphire and Tuensang districts of Nagaland. Training programs were implemented to guide farmers in the effective utilization of these structures for efficient water management. These programs included instruction on techniques for sprinkler and drip irrigation, as well as best practices

for crop cultivation and livestock management during lean periods. Regular training sessions and demonstrations were conducted to ensure proper implementation and maximize the benefits.

Benefits of the technology

- Increases water availability during dry seasons enhances the viability of winter vegetables, fishery, piggery, and poultry.
- Improved farm productivity and profitability are achieved through efficient water utilization and crop diversification.
- Farmers are empowered through training and capacity building, fostering sustainable agricultural practices.

Impact of the technology

This initiative successfully trained approximately 3,500 farmers across six districts in Nagaland, leading to the harvesting of 20.3 million litres of water for productive use. As a result, farm incomes increased by 200%, demonstrating significant improvements in agricultural sustainability and profitability.

Technology dissemination

ICAR - Nagaland Centre in collaboration with its KVKs, is actively disseminating rainwater harvesting technology tailored to farmers' and crops' needs. Through awareness programs, training, and demonstrations with a participatory approach, the initiative aims to enhance cropping intensity and double farmers' incomes across the state.





Name of the inventors

L. K. Baishya, D. J. Rajkhowa, Jyotish Barman.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Suitable for upland and lowland ecosystems.

Title of the technology

Crop diversification and intensification with pre-kharif green gram.

Application procedure of the technology or SOP for using the technology

The project was implemented covering an area of 30 acre (approx.) in Dimapur district of Nagaland, where the majority of the farmers relied on agricultural and livestock farming and they have not yet been exposed to improved agricultural technologies like, crop intensification and diversification, natural resource management and other secondary agriculture. The technology involved the cultivation of green gram as a pre-kharif crop in the foothills of Dimapur district, utilizing local farming practices. ICAR - Nagaland Centre organized a "field day cum farmer-scientist interaction programme on pulse cultivation and promotion" on 8th June, 2017 in order to popularise the scientific pulse cultivation in Nagaland. More than 253 farmers from different region of the state attended the programme and various critical farm inputs, green gram seed, bio-fertilizers and organic manures etc., were also distributed to the farmers. Regular training sessions and counselling were held to ensure effective implementation and to maximize the benefits of the program.

Benefits of the technology

- Crop diversification and intensification with pulses, green gram resulted in net return (Rs. 48500/- per ha) and Improved crop profitability of Rs. 692/- per hectare per day.
- Enhanced soil fertility was noted through the incorporation of green gram residues.
- Additional crop yield from the same piece of land resulted in increased farmers' income.
- Sustainable agricultural practices and crop diversification were promoted.





Impact of the technology

The introduction of pre-kharif green gram cultivation significantly improved productivity and profitability for farmers in Setheikima and Singrijan villages. Farmers reported high satisfaction with the crop, leading to better resource management and increased income from their lands.

Name of the inventors

L. K. Baishya, D. J. Rajkhowa.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended:

Suitable for rainfed farming systems in both upland and lowland ecosystems.

II. HORTICULTURE

Title of the technology

Enhancement of banana production through high density planting.

Banana is a common fruit crop in Nagaland covering an area of 6,874 ha with a production of 87,082 MT. Most often, the traditional way of cultivation with local cultivars encounters several problems like lack of disease-free suckers, high mortality in the field during establishment, long gestation period and low yield.

Application procedure of the technology or SOP for using the technology

In 2019, ICAR - Nagaland Centre took initiatives to promote the scientific cultivation of tissue cultured Grand Naine (G-9) banana varieties across the state. Demonstrations on scientific cultivation of G-9 banana were conducted at farmers' fields in Chumoukedima and Dimapur districts with technological inputs such as drip irrigation, high-density planting system (paired row), INM, IPM, IDM and other GAP in banana. The recommended package of practice is mentioned as follows.

Planting method

Pit planting is followed in garden land system of cultivation. Pits of 60 cm x 60 cm x 60 cm size are dug, filled with a mixture of soil, sand and FYM (Farm Yard Manure) in a 1:1:1 ratio. Suckers are planted in the centre of the pit and soil around is compacted.

- Planting is done during July-August.
- Paired row planting system with a spacing of 1.5m x 1.5m x 2m.
- Plant population of 3800 plants per hectare.

Manuring and fertilizer application: 8-10 kg/ plant FYM; 180:100:250 g NPK/plant.

Intercultural operations:

- Desuckering
- Propping
- Mulching
- Removal of withered styles and perianth
- Pruning of leaves
- Mattacking
- Earthing up
- Bunch covering
- Denavelling

- Bunch thinning
- Peduncle wrapping
- Tagging
- Wind break

Plant protection measures:

- Use of banana pseudostem traps (swabbing the cut surface of the traps with *Beauveria bassiana indica* @ 20g/ trap) @100/ha effectively to control banana weevils.
- Use of neem oil @ 5-8ml/ litre of water against sap sucking insects.



Harvesting

The maturity of banana is indicated by drying of top leaves, change in colour of fruits from dark to light green. The mature fruit becomes plumpy and all the angles are filled in completely. When tapped the fruit gives metallic sound.

Benefits of the technology

Disease free saplings with uniform maturity, land and water use efficiency and increased income.

Impact of the technology

Increased productivity by 30-79% compared to conventional methods. Improved water and fertilizer use efficiency by 25-30% and resist winds better. Increased farmers' income with 30-40% increase in profit per unit area and additional income through vermicomposting of the biomass after harvest.



Name of the inventors

D. J. Rajkhowa, Azeze Seyie, Jyotish Barman, Aabon W. Yanthan.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Lowlying conditions with assured drainage and irrigation.

Title of the technology

Plastic film mulching in pineapple for undulating hilly topography.

Pineapple (*Ananus comosus*) is one of the important fruit crops of Nagaland. The state produces one of the finest qualities of pineapple in the world. It occupies a total area of 7,060 ha and production of 94,690 MT with the average productivity of 14.86 t/ha. The recommended slope of the terrain for pineapple cultivation in the region should not exceed 5%, but pineapples are grown in selected hillocks up to the slope of 30-40% or beyond in Nagaland and that too along the slope. At this slope, soil erosion is very high during monsoon and the field face severe water scarcity during winter. Soil and nutrient loss and moisture stress adversely affect the yield and quality of pineapple. In addition to that, the farmers practices traditional planting system (50-100 x 50-100 cm – 15000 plants/ha) which leads to low productivity in Nagaland (14.86 t/ha).

Application procedure of the technology or SOP for using the technology

The plastic mulch (black polythene with 70-micron thickness) is laid in the slope with 50-60% or higher slope than that and the pineapple var. Kew has to be planted with double hedgerow (90 x 60 x 30 cm) system of planting across the slope. Plastic mulching and high density double hedgerow planting system is one of the best option to reduce the soil loss, control the weeds, conserve the soil moisture and increase the yield and quality. The plastic mulch (black polythene with 70-micron thickness) was laid in the slope and the pineapple var. Kew has been planted with double hedgerow (90cm x 60cm x 30 cm – 45500 plants/ha) system and this method has been experimented in the slope of >100%. The yield of 45-50 t/ha was achieved along with TSS of 20.5 ^{0}Brix, fruit weight 3.2 kg and 75% uniform flowering . The soil moisture was found to maintain at the uniform level from May to September during monsoon (i.e. 16 to 24% moisture), even after the monsoons the moisture content was maintained at the level of 8-9%. The soil loss was reduced up to 25-30% from the normal soil loss in the sloppy area i.e., 25 t/ha/yr and the weed growth suppression was found to be 50-60%.

Benefits of the technology

Plastic mulching and high density double hedgerow planting system is one of the best options to reduce the soil loss, control the weeds, conserve the soil moisture and increase the yield and quality.The technology is gaining popularity and wide number of farmers has adopted the method. The method of mulching in pineapple in hilly areas give better yield and better moisture conservation is observed following this method.

Impact of the technology

Gives better yield (40-50 tonnes/ha as against 14.86 t/ha in conventional system) and better size of pineapple (3.2 kg/fruit as against 1.8 kg/fruit in conventional system). Conserves moisture, saves labour and time and energy in weeding as the weed growth is suppressed (50-60%). The soil moisture was found to maintain at the uniform level from May to September during monsoon (i.e. 16 to 24% moisture), even after the monsoons the moisture content was maintained at the level of 8-9%. The soil loss was reduced upto 25-30% from the normal soil loss in the sloppy area i.e. 25 t/ha/yr.





Name of the inventors

A. Thirugnanavel, B. C. Deka, Christy B. K. Sangma, Tasvina R. Borah, Azeze Seyie, G. Rajesha.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Hill eco-system.

Title of the technology

Naga mircha as an understory crop in *Jhum*-based agro-ecosystem.

Naga King chilli (*Capsicum chinense*) is native to the north-eastern part of India and Nagaland got the geographical indication tag as 'Naga mircha' in the year 2008. It is grown in almost all the districts of Nagaland and commercially cultivated well in Peren, Dimapur, Mon and Kohima districts. It is an important spice crop preferred by most of the *Jhum* farmers which has very high market. Naga farmers traditionally grow this chilli in the *jhum* (shifting cultivation) fields sporadically intercropped with paddy and also in small homestead gardens. Most of the farmers practice direct seeding during February-march, preferably in a place where bamboo culms have been slashed and burned. However, the yield and productivity is comparatively very low due to existing crop geometry and other biotic and abiotic factors.

Application procedure of the technology or SOP for using the technology

Partial modifications have been made to the traditional practice of Naga mircha in *Jhum* fields for higher productivity. Naga mircha thrives well in warm climate and grows in all types of soil, preferably in well drained and soil with high organic matter content. This crop also thrives very well under partial shade (provided through the rice crop in existing traditional practice) and was grown as an understory crop under tree species *Melia azedarach,* which was grown a year ahead in fallow *Jhum* (at a distance of 3-4 m).

Spacing: 80-90 cm

Nutrient source: Available forest soil and leaf compost

Plant protection measures: Neem oil @ 5-8 ml/litre, yellow and blue sticky traps, Bordeaux mixture (1%), Streptocycline @ 1 g/ 10 litres





Benefits of the technology

Higher yield and productivity, additional income through tree species.

Impact of the technology

The yield was increased from 3.5 t/ha (traditional practice) to 6-7 t/ha. Additional income was also obtained from the harvest of the tree species (5-7 years).

Name of the inventors:

Azeze Seyie and Aabon W. Yanthan.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Jhum land or sloppy land.

Title of the technology

Naga mircha pickle production technology.

Naga King Chilli (*Capsicum chinense* Jacq.) has received massive attention among the scientific community throughout the world due to its unique aroma and has been acknowledged as the hottest chilli in the world, measuring 1,001304 Scoville Heat Units (SHU) in the Guinness Book of world records, 2007 and Nagaland Government has obtained the ***GI*** (geographical indication) rights for this crop in 2008. Though it has high potential, the market demands are barely met for various reasons amongst which, the postharvest loss is one of the pre-dominant factors. In order to combat the postharvest losses, postharvest management, processing and value addition is the need of the hour for tapping the potential of this high valued crop. Value added products such as Naga king chilli sauces and pickle is a remunerative option during peak season in order to tackle the postharvest losses and enhance shelf life, which in the foreseeable future would definitely double the farmers' income.

Application procedure of the technology or SOP for using the technology

S. N.	Ingredients	Quantity
1	King Chilli (Sliced)	1 kg
2	Vinegar	10-15 ml
3	Mustard seed	50 gm
4	Paanchpuran	50 gm
5	Mustard oil	750 ml
6	Hing	1 pinch
7	Salt	To taste

Chilli preparation:

- Harvest fully matured and ripened fruits (preferably red ones)
- Wash in clean running water before removing the stalk.
- Remove the excess moisture either by sun-drying or using a clean absorbent cloth
- Slice the chillies in uniform sizes

Spices preparation:

- Wash/peel the spices
- Dry
- Take the dried spices and roast them slightly in a hot pan

- Grind the spices moderately
- Pickle preparation
- Mix the sliced king chilli and the spices together
- Add the Mustard oil & vinegar
- Fill in clean, dry glass bottles
- Sundry for at least a week

Cost benefit analysis:

Cost of 1 kg of Naga King Chilli= Rs. 250

Cost of spices and Ingredients for pickling 1 kg of Naga King Chilli = Rs 120

Processing cost = Rs. 50/ kg

1 kg of fresh Naga King Chilli yields approx 600 grams of pickle

Cost of 100 grams of pickle = Rs. 100

Total expenditure for processing 1 kg of Naga King Chilli = Rs. 420

Net Income = Rs. 600 - 420

Rs. 180/ kg

BCR=**1:1.43**



Benefits of the technology

Value added products such as Naga mircha pickle is a remunerative option during peak season in order to tackle the postharvest losses and enhance shelf life and income of the farmers and entrepreneurs.

Impact of the technology

Reduction of postharvest losses enhanced shelf life and enhanced income.

Name of the inventors

Azeze Seyie and Aabon W. Yanthan.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

In Naga mircha growing pockets of Northeast region of India.



Title of the technology

Shelf- life enhancement of Naga mircha by packaging systems.

Application procedure of the technology or SOP for using the technology

Naga Mircha, with inherent high moisture content (>90%) and soft pericarp, the crop is susceptible to moisture loss leading to rapid disintegration of tissue structural integrity and ultimately under ambient condition, only 3-4 days of shelf life can be achieved. Therefore, different packaging materials were evaluated to develop standard protocol for Naga Mircha. Fresh Naga Mircha was packed in low density polyethylene (LDPE), polyethylene terephthalate (PET) and paper bag respectively, stored under ambient condition (20±5 ^{0}C) and various physiological and biochemical parameters were determined with 2 days interval between analyses. PET material showed significantly lesser changes in physiological loss in weight (11.01±1.34 %) as compared to control (51.93± 2.24 %) and paper bag (36.05±1.82 %) on 8th day of storage. The control recorded increment in PLW of 12.96% while PET recorded only 2.98% on 2nd day which indicated that the control sample had lost its marketable shelf life on 2nd day itself. The increase in TSS was recorded least in LDPE (8.78±0.22 %) as compared to control (12.20±0.32 %), and total acidity exhibited increasing trend. However, it was lesser in LDPE (1.31±0.05 %) than control (1.79±0.06 %) on the 8th day. Texture analyses indicated that PET packaging (0.94±0.23 N) retained significantly better texture compared to control (0.09±0.02 N) during the entire storage period. Thus, PET can be an effective packaging material for storage of fresh Naga mircha under ambient conditions.





Benefits of the technology

Using PET as packaging material can render an effective shelf life of more than 8 days as compared to control (<3 days) in Naga mircha.

Impact of the technology

Reduction of post-harvest losses of Naga mircha, enhance marketability and quality of the produce and the income enhancement of farmers.

Name of the inventors

Aabon W. Yanthan, Azeze Seyie, S. R. Assumi and H. Kalita.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Northeast region of India.

Title of the technology

Technology for Naga mircha puree.

Application procedure of the technology or SOP for using the technology

Processing protocol for value added product of Naga mircha by development of Naga mircha puree was developed. Protocol involved harvesting of fresh, colourful and well ripened Naga mircha followed by sorting and washing. Pulp extraction was done at high temperature (110 ^{0}C for 15 minutes) and low temperature (70 ^{0}C for 15 minutes) to determine the changes in quality as influenced by temperature followed by sieving, concentration of puree to desired thickness and packaging. Organoleptic rating (0-10 score) of the developed puree indicated that processing at low temperature (70 ^{0}C for 15 minutes) resulted in better score in terms of appearance (7.4), flavor (5) and overall acceptability (8.33). Determination of colour using Hunter L*a*b* scale recorded *L** value (black to white) of 33.21, *a** value (red to green) of 21.19 and *b** value (yellow to blue) of 11.97 in low temperature processed puree as compared to high temperature which recorded L*a*b* values of 33.55, 21.97 and 12.22 respectively.

Benefits of the technology



Naga mircha or Bhoot jolokia (*Capsicum chinense* Jacq.) is a high value export oriented crop and popularly cultivated in the northeast region of India. However the crop is susceptible to rapid moisture loss, shrinkage and decay leading to huge post-harvest loss. One of the ways to alleviate the post-harvest losses is through value addition. Establishment of protocol for Naga mircha puree can unlock potential for mass production of puree which will serve as a base material for development of various Naga Mircha based value added products. Moreover due to concentrated size of the product as compared to fresh produce, export promotion will be enhanced.

Impact of the technology

Alleviation of post-harvest losses of Naga mircha in Nagaland Entrepreneurship development through processing of Naga mircha.

Name of the inventors

Aabon W. Yanthan, Azeze Seyie and H. Kalita.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Northeast region of India.

Title of the technology

Instant mushroom soup powder production technology.

Application procedure of the technology or SOP for using the technology

Oyster mushrooms have been extensively utilized for human consumption for generations and valued for their texture, flavor and medicinal values. Technology of healthy mushroom based instant soup powder was developed and standardized by supplementing with locally and readily available ingredients such as tree tomato (*Solanum betaceum*), Burmese coriander (*Eryngium foetidum*), Sichuan pepper (*Zanthoxylum peperitum*), Ginger (*Zingiber officinale*), Garlic (*Allium sativum*) and Tapioca (*Manihot esculenta*). Mushroom and all vegetable ingredients were cut into small pieces and dried in cabinet drier at 50℃ and grinded into powder form. To prepare 1 kg mushroom soup powder, 250 g of dried mushroom, 250 g of tapioca powder, 16.6 g of black pepper, 6.6 g of Sichuan pepper powder, 25 g ginger powder, 25 g of garlic powder, 83.3 g of tree tomato powder, 166.6 g of milk powder, 10 g of Burmese coriander, 100 g of salt, 25 g of sugar were mixed, homogenized, packed and labelled.

Benefits of the technology

Organoleptic evaluation using hedonic scale of 0 to 10 indicated average score of 8 which is considered as highly acceptable in terms of flavor, taste and overall acceptability. This convenient healthy soup mix has great potential as the development of foods from locally and readily available ingredients have been in the limelight lately. The instant soup mix can be a great source of nutrition in fast food and alternative of animal proteins as value added materials. It can also be a good source of value-added food for commercial processed food production.



Impact of the technology

With over 140 wild mushroom including oyster mushroom in Nagaland only fresh and a dehydrated mushroom were available in the market earlier. With product diversification, mushroom products like soup powder using local herbs and ingredients was developed and found good acceptability by consumer and now some entrepreneurs are venturing into making of mushroom soup. In addition, this technology leads to promotion of indigenous underutilized vegetables, spices and herbs.

Name of the inventors

Aabon W. Yanthan and Azeze Seyie.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Northeast region of India.

III. PLANT BREEDING & GENETICS

Title of the technology

Enhancement of lowland rice production through HYVs.

Seven promising rice breeding lines has been identified *viz.* NLCJ-395, NLCJ-308, NLCJ-171, NLCJ-138, NLCJ-189, NLCJ-295 and NLCJ-131 in terms of high yield.

Package of practice:

Seed rate: Transplanted crop without line sowing: 50-60kg/ha.

Line transplanted crop: 40kg/ha.

Sowing time: Nursery sowing: 1st week of June to 20th June.

Transplanting time: 25th of June to 20th July.

Manuring: 5-10 tonnes of FYM/ compost per ha.

Basal application of NPK: 20N: $40P_2O_5$: $40K_2O$.

Top dressing: 40 kg Urea and 33 kg MOP at 30-35 days after transplanting (DAT) and 2nd top dressing of 40 kg urea at 55 days after transplanting (DAT).

Plant protection: Treat the seed with carbendazim @ 2g/kg of seed, Spray Imdidalorprid @ 2ml/liter of water to avoid the damage from gundhi bug when rice crop attains milky stage.

Harvesting: 75-85% of the panicle turn hard and golden yellow colour.

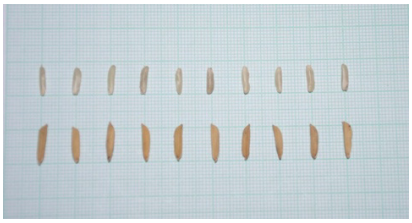
Threshing: Manual threshing by traditional method.

Application procedure of the technology or SOP for using the technology:

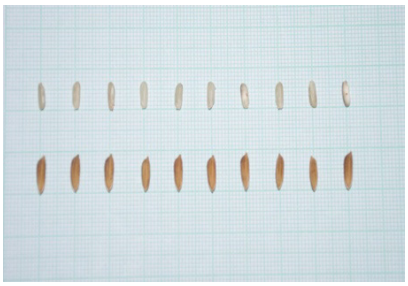
The lines were developed through pedigree method of breeding. It is stable and uniform breeding line of F_{10} generation.

NLCJ-395: It is derived from the cross between Gomati x Tripura Nirog. It is a short duration variety with a maturity of 112-115 days and yield potential of 50 q /ha. It has profuse tillering potential (23 tillers/plant) and suitable for lowland rice cultivation. It has medium plant height of 133 cm.This line is tolerant to blast. It has soft cooking and eating quality. It has long slender grain shape and white kernel colour. Yield is 4.7-5.0 t/ha under normal lowland condition.

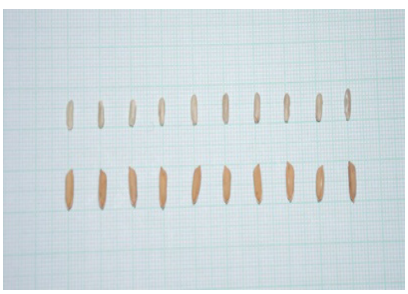




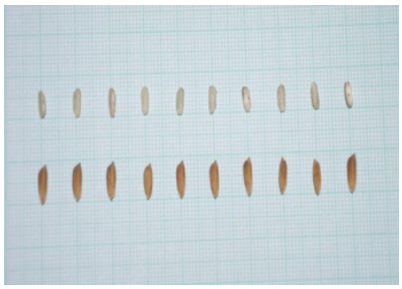
NLCJ-308: It is derived from the cross of Gomati x Tripura Nirog. It is early duration breeding line maturing in 116-118 days and yield potential of 52 q/ha. It has medium plant height of 128 cm. This line is tolerant to brown spot and blast. It has long slender grain shape and white kernel colour. It has preferred cooking and eating quality. Yield is 4.9-5.2 t/ha under normal lowland condition.

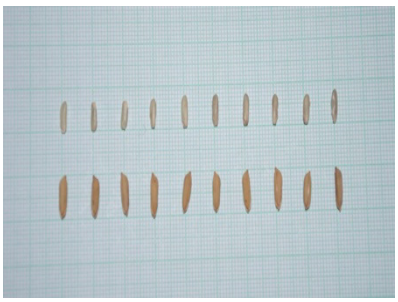
NLCJ-171: It is derived from the cross between Hokuchuk2 x Naveen. It has early duration of maturity (115-117 days) and yield potential of 58 q/ha. It has medium plant height of 134 cm. This line is tolerant to brown spot and blast. It has long slender grain shape and white kernel colour. It has preferred cooking and eating quality. Yield is 5.5-5.8 t/ha under normal lowland condition.

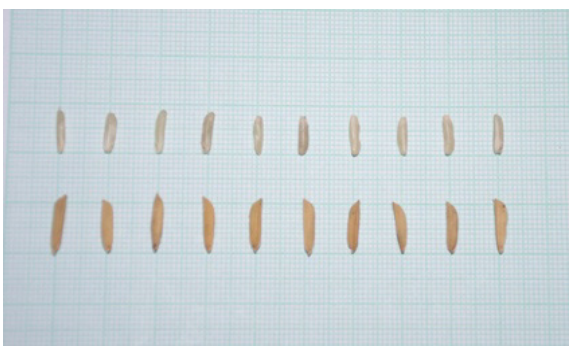
NLCJ-138: It is derived from the cross of Hokuchuk 2 x Tripura Nirog. It is early duration breeding line with a maturity duration of 117-119 days. It has yield potential of 47-50 q/ha. It has medium plant height of 132 cm. It has long slender grain shape and white kernel colour. Yield is 4.7-5 t/ha under normal lowland condition.

NLCJ-189: It is derived from the cross of Hokuchuk 2 x Tripura Nirog parents. It has maturity duration of 117-119 days. It has yield potential of 54-56 q/ha. It has very long panicles and with long slender grains and white kernel colour. This line is tolerant to brown spot and blast. It has low amylose content, that is why preferred by Nagaland farmers. Yield is 5.4-5.6 t/ha under normal lowland condition.

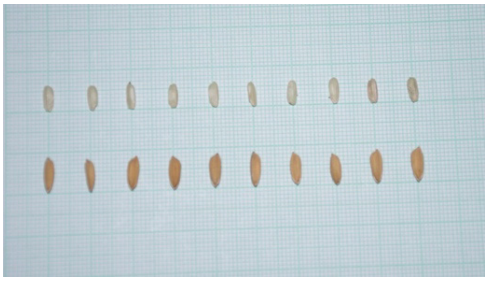



NLCJ-295: It is derived from the cross of Tripura Nirog x Naveen parents. It has early maturity duration of 116-118 days with yield potential of 48-51 q/ha. It has medium plant height of 127 cm. It has long slender grain shape and white kernel colour. This line is tolerant to brown spot and blast. It has low amylose content and soft gel consistency that is why preferred by the Nagaland farmers. Yield is 4.8-5.1 t/ha under normal lowland condition.

NLCJ-131: It is derived from the cross of Tripura Nirog x Naveen parents. It has early maturity duration of 116-118 days with yield of 55-57q/ha. It has medium plant height of 133 cm. It has long slender grain shape and white kernel colour. It is tolerant to blast disease. It has low amylose content and soft gel consistency. Yield is 5.5-5.7 t/ha under normal lowland condition.





Benefits of the technology

It is early duration variety, therefore provides opportunity for timely sowing of *rabi* crops and utilization of residual soil moisture and efficient utilization of resources. It may help in enhancing the cropping intensity of the state. It assists in enhancing overall farm income by providing sufficient window for timely sowing of other crops. This promising breeding line is suitable for foothills, low to mid hills of Nagaland. This promising breeding line is suitable for foothills, low to mid hills of Nagaland.

Impact of the technology

We have evaluated this breeding lines in farmers field across the state during adaptive trails and farmers were happy by observing its early duration, uniformity, plant type and good yield. It has 20-25% higher yield compared to local landraces and check variety RC Maniphou-7.

Name of the inventors

Harendra Verma, S. P. Das, H. Kalita

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

This promising breeding lines are suitable for foothills, low to mid hills of Nagaland.

Title of the technology

SamroYoh and Aongsho – Promising upland rice for Nagaland.

Application procedure of the technology or SOP for using the technology

A total of 250 upland rice landraces were evaluated for drought tolerance and related physiological traits. "SamroYoh" upland rice landrace has been identified promising and out yielded Vandana and Sahbhagi Dhan check varieties. SamroYoh landrace was mix of different 4-5 pure lines having different in stigma colour and height and grain type. Single best plant was selected and multiplied their seeds and evaluated for drought tolerance. This genotype has been developed through pure line selection method. SamroYoh is a medium duration sticky rice variety suitable for upland rice cultivation in jhum areas of the region. This variety matures in 130-135 days in Nagaland conditions. This crop can successfully be followed by main rabi crop. It has yield of 3.5-4.0 t/ha under good management and 3.2-3.5 t/ha under drought stress condition. It has soft cooking quality. Height is 120.1 cm (Medium), numbers of tillers is 9, amylose content is 14.62% (sticky), gel consistency is 45 mm, gelatinization temperature is 1 min (take more time for cooking) and kernel colour is white.

A total of 180 upland rice landraces were evaluated for yield and yield attributes. The "Aongsho" upland rice landrace has been identified promising and out yielded local check Bhalum-3 variety. The Aongsho landrace was mix of pure lines having different height and grain type. Single plant of different types was selected and multiplied their seeds. This variety has been developed through pure line selection method. Aongsho is a short duration sticky rice variety suitable for upland rice cultivation in jhum areas of the region. This variety matures in 110-115 days in Nagaland conditions. This crop can successfully be followed by main *kharif* crop. It has a yield of 3.5-4.0 t/ha under good management. It has soft cooking quality. Height is 140.8 cm (Tall), Numbers of tillers is 7, Amylose content is 11.80% (sticky), Gel consistency is 50 mm (cooked rice tends to be tender), Gelatinization temperature is 1 min (take more time for cooking), Aroma is MS (Mild-Scented) and kernel colour is white.

Benefits of the technology

The variety is identified suitable for upland ecosystem of Nagaland.

Impact of the technology

The seeds of SamroYohto are being produced to popularize in the state and presently it has been used in crossing programme for development of high yielding drought tolerant varieties for Nagaland. Farmers of *jhum* area like Longleng, Mokokchung and

Wokha prefer to cultivate this genotype due to its taste and adaptability in *jhum* fields and presently it is cultivated in approximately 2,000 ha in Longleng district.





Name of the inventors

SamroYoh - Harendra Verma, Gangarani Ayam, H. Kalita.

Aongsho - Harendra Verma, H. Kalita, Amit Kumar, C. Aochen, S. P. Das.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

SamroYoh is suitable for upland hilly region of Nagaland and other neighbour north eastern states for main *kharif* season. Aongsho is suitable for low and medium hills of Nagaland and other neighbouring Northeastern states for main *kharif* season.

Title of the technology

Production enhancement of sesame through improved varieties ~ Amrit and Prachi.

Application procedure of the technology or SOP for using the technology

Amrit variety of sesame has light brown seeds, tolerant to powdery mildew and *Alternaria* leaf spot, with an oil content of about 43-46%. It has crop duration of 115-120 days, an average yield of 8-9.5 q/ha and are highly suited for the agro-climatic condition of the Nagaland.

Prachi variety of sesame has black seeds, tolerant to powdery mildew and *Cercospora* leaf spot, with an oil content of about 42-45%, It has crop duration of 115-120 days, an average yield of 8-9 q/ha and are highly suited for the agro-climatic condition of the Nagaland.

Package of practices:

Seed rate: 5-6 kg/ha in broadcasting, 2.5-3.0 kg/ha in line sowing.

Sowing time: Summer: 1st week of March to 1st week of April.

Manuring: 3-5 t/ha of FYM during ploughing.

Basal application: 40N: 40 P: 30 K kg/ha.

10-15 t of FYM/compost per ha.

Top dressing: 28 kg Urea and 10 kg MOP at 30-35 days after transplanting.

Planting method: Land preparation and sowing.

Plant protection: Treat the seed with carbendazim @ 2g/kg of seed.

Harvesting: Harvest sesame when leaves and capsules turn yellow and defoliation starts. After harvest, bundles are stacked and dried for several days, and there after threshed.

Threshing: Manual threshing by traditional method.

Yield: 8.0-9.5 q/ha.

Benefits of the technology

The variety recommended for low and medium hills of Nagaland and other neighbouring northeastern states.

Impact of the technology

This is medium duration variety with good oil content and yield. Therefore, a good demand is there for this variety and farmers are interested to continue this variety.

Name of the inventors

This variety is evaluated by ICAR Nagaland centre since 2019 and found suitable for Nagaland based on multilocation trails by ICAR Nagaland Centre and KVKs of the Centre. Harendra Verma, L. K. Baishya, Patukhate Zeliang, Bendangla Imsong, Md Aziz Qureshi, H. Kalita and V. K. Mishra.





Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Amrit- Recommended for low and medium hills of Nagaland and other neighbouring north eastern states for main *kharif* season.

Prachi- Recommended for low and medium hills of Nagaland and other neighbouring north eastern states.

Title of the technology

LSL-93 and Priyam linseed varieties for higher production.

Application procedure of the technology or SOP for using the technology

LSL-93 is developed by VNMKV Latur, however ICAR Nagaland centre evaluated 6 different linseed varieties and identified LSL-93 suitable for Nagaland low and mid hill regions. This variety is resistant to rust, moderately resistant to wilt, powdery mildew and bud fly. It has height of 30-32 cm with light brown medium size seeds and 36-37% of oil content. It has duration of 90-95 days with an average yield of 8.77 q/ha.

Priyam is developed by BAU, Kanke, however ICAR Nagaland centre evaluated 6 different linseed varieties and identified Priyam suitable for Nagaland low and mid hill regions. This variety is resistant to rust, powdery mildew and *Alternaria* leaf spot. It has height of 60-65 cm with brown medium size seeds and 36-38% of oil content. It has duration of 105-110 days with an average yield of 8.83 q/ha.

Package of Practices:

Seed rate: 25-30 kg/ha.

Sowing time: October to 1st fortnight of November.

Manuring: 5 t/ha of FYM.

Basal application of 20 kg N + 20kg P_2O_5 and 20 kg/ha K_2O.

Top dressing of 20 kg N (Urea) at 25 days after sowing.

Planting method: Broadcast and line sowing.

Plant protection: Treat the seed with carbendazim @ 2g/kg of seed.

Harvesting: It is to be harvested when the leaves become dry, the capsules turn brown and the seeds become shiny.

Threshing: Manual threshing by the traditional methods.

Yield: 8-10t/ha.

Benefits of the technology

The variety is suitable for low and medium hills of Nagaland.

Impact of the technology

LSL-93 is a short duration variety with duration of 90-95 days with good yield potential of 8.77 q/ha. In Nagaland majority of framers are cultivating long duration rice varieties which offers a short window for rabi crops in this situation in rice fallow land

farmers are interested to grow this variety due to short duration. Presently it is covering an area of 500 ha in the state.

Priyam is a medium duration variety (105-115 days) with a good yield 8-10q/ha. It is dual purpose variety and has good flex length and oil content. Farmers are interested to grow this short duration linseed variety.





Name of the inventors

Harendra Verma, Patukahte Zeliang, Roben Singh, Bendangla Imsong, H. Kalita and V. K. Mishra.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

LSL-93 and Priyam are suitable for low and medium hills of Nagaland.

IV. PLANT PATHOLOGY

Title of the technology

Organic disease management in chilli with bacterial endophytes.

Nagaland being one of the organic hubs in Northeast region of the country makes it easy to achieve the task. In addition, the use of pesticides towards the management of diseases, enhance the pesticide resurgence and biomagnifications of the toxic compounds being pumped in agri-horti ecosystem. King chilli plant is one of the hottest chilli in the world and at the same time it possess a pleasant and palatable aroma. Because of its characteristic features, it gaining prominent status in foreign export. The chilli is widely cultivated in Northeastern states of India such as Assam, Nagaland, Manipur etc. During the crop growth several diseases are seen such as fungal disease and slow wilting leads to the economic yield loss. To maintain the plant health, biological control of diseases is viable method to maintain the export quality of chilli. Use of endophytes is under-exploited towards the biological control of plant diseases. Endophytes are microorganisms (bacteria or fungi or actinomycetes) that dwell within plant tissues by having a symbiotic association. They are ubiquitously associated with almost all parts of the plant. They produce a wide range of compounds within the hosts useful for plants for their growth, protection to environmental conditions, and sustainability. These endophytes act as biocontrol agents by protecting the plant by inducing the large number of bioactive compounds serve as antibiotics and other secondary metabolites which are of economic importance.

Application procedure of the technology or SOP for using the technology

The best isolates of bacterial endophytes were identified by characterizing for its biocontrol efficacy from chilli fruits and screening against the major fungal diseases. The identified best isolates were tested in the field for its bio-efficacy by making consortia of many endophytes, antibiotic production and other secondary metabolites towards the disease control mechanism. The bacterial endophytes which are performing better in managing the chilli diseases were identified.

Benefit of the technology

Promising bacterial endophytes were performed well under field conditions in controlling the fungal disease incidences and severity like damping off (*Pythium* sp.), *Fusarium* wilt and anthracnose (*Colletotrichum* sp.) of Naga king chilli.

Impact of the technology

Bacterial endophytes were effective in controlling the disease incidence and severity of fungal diseases like damping off (*Pythium* sp.), *Fusarium* wilt and anthracnose (*Colletotrichum* sp.) of Naga king chilli. Among the twenty isolates, KEB15, KEB5 and KEB7 were performed well in percent disease reduction of king chilli 66.67, 64.07 and 69.26% respectively over control. The increase production of secondary metabolites *viz*. indole acetic acid, hydrocyanic acid (HCN) production and ammonia production was increased due to presence of bacterial endophytic significantly increased in the yield of king chilli.

Name of the inventors

Rajesha G.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

In hill ecosystems where King chilli is grown.

Title of the technology

Process of oyster mushroom (*Pleurotus pulmonarius*) cultivation for beginners

Mushroom cultivation presents a promising opportunity for income generation, offering a lucrative venture with relatively low investment requirements and high returns. With increasing demand for mushrooms in various culinary and medicinal applications, mushroom cultivation has emerged as a viable option for individuals seeking sustainable income streams. Unlike traditional crops, mushroom cultivation requires minimal space and can be undertaken in controlled environments, making it accessible to a wide range of farmers and entrepreneurs. Moreover, mushrooms are known for their rapid growth and high market value, allowing growers to harvest multiple crops throughout the year. Oyster mushrooms, such as *Pleurotus pulmonarius*, are widely cultivated across the world due to their ease of growth, delectable taste, short life cycle, and strong market demand. We provide the concise technical aspects of oyster mushroom (*Pleurotus pulmonarius*) cultivation for beginners looking to diversify their agricultural activities and generate additional income.

Application procedure of the technology or SOP for using the technology

***Substrate Preparation*:** Paddy straw, locally sourced, served as the substrate for cultivating *Pleurotus pulmonarius*. The straw was cut into small pieces (7 to 10 cm) to promote efficient mycelial colonization, then soaked in water for a duration of 8 to 12 hours. To enhance air exchange, small holes were punctured in the substrate bags at intervals of 10 cm. Moisture was adjusted to around 70%, and the substrate was pasteurized by immersing it in boiling water (100°C) for 60 minutes to reduce potential contaminants. After pasteurization, the substrate was allowed to cool, and any excess water was drained to achieve a moist consistency. Finally, 1% lime (calcium oxide) by weight was added to achieve a pH level of approximately 7.5 to 8.0, which is ideal for oyster mushroom growth.

Spawning and incubation:To prepare the substrate for cultivating *Pleurotus pulmonarius*, mature, fully colonized spawn was introduced at a rate of 10% of the dry substrate weight, which was 1.5 kg of dry paddy straw per bag. The layer method was used for spawning, beginning with an initial layer of sterilized straw, 4 to 6 inches thick, placed at the base of 14 x 23 inch polypropylene plastic bags. Spawn was then evenly distributed over the straw layer by hand, ensuring the spawn reached all edges of the straw. Additional layers of straw, each 4 to 6 inches thick, were alternated with spawn layers until the bag was filled. The final layer consisted solely of straw, with no spawn. Once the bags were filled, they were securely tied, labelled, and placed in a mushroom

cropping room for incubation. Over a period of 15 to 20 days, the mycelium was expected to colonize the entire substrate, visibly turning the straw white. Throughout the cultivation, a moisture content of over 65% was maintained by regularly misting the bags with a hand-sprayer until the final harvest.

Harvesting:

- Harvest at the appropriate stage of maturity to optimize quality and yield.
- Harvest mature mushrooms by twisting or cutting them from the substrate.

Benefits of technology

Oyster mushrooms can be widely cultivated across different regions due to their ease of growth, short life cycle and strong market demand.

Impact of technology

The technology offers a beginner-friendly, step-by-step guide to cultivating *Pleurotus pulmonarius*, covering substrate preparation, spawning, growth management, and harvesting. It empowers small-scale farmers, hobbyists, and entrepreneurs to start mushroom farming, promoting self-sufficiency, sustainable practices, and rural economic growth. Through a five-day training attended by 33 entrepreneurs and enthusiasts, most participants successfully launched their own mushroom cultivation ventures.





Name of the inventors

Mathew S. Baite, Aabon W. Yanthan, Shweta Kamal and H. Kalita.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended:

In hill ecosystems.

V. SOIL SCIENCE & WATER CONSERVATION

Name of the technology

Low cost vermicomposting technology.

Application procedure of the technology or SOP for using the technology:

The process of composting of organic materials by using earthworms is called vermicomposting. Any kind of organic waste *viz.* municipal waste, agricultural waste, decomposable industry waste etc. can be used for the preparation of vermicompost. The most popular earthworm species applied or cultures in vermicomposting are *Eisenia foetida, Eudrilus eugeniae* and *Perionyx excavates*. For preparation of vermicompost concrete pits can be used. But nowadays, ICAR is recommending the low cost readymade LDPE pits. The cost of concrete pits with roofs can cost upto approximately ₹ 12,000 but with LDPE can cost up to approximately ₹ 4000-5000.



Vermicomposting in concrete cement



Low cost vermicomposting

Benefits of the technology

It is beneficial for preparing on farm compost from crop residues.

Impact of the technology

LDPE vermicompost pits were distributed to large number of Nagaland Farmers under TSP programme and the farmers' acceptance and adoption rate is high.

Name of the inventors

D. J. Rajkhowa, L. J. Bordoloi, Christy B. K. Sangma, Dibyendu Chatterjee, James Kikon.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Technology is recommended for backyard kitchen gardens, in crop and horticultural fields and orchards.

Name of the technology

Acid soil management by furrow application of lime.

Application procedure of the technology or SOP for using the technology

Soils of the Northeastern region are acidic (pH below 6.0) in nature, which require amelioration. SMP buffer method is mostly used for determination of lime requirement of an acid soil. Earlier random broadcasting of lime was practiced which requires more lime, and it is not feasible in hilly areas. So, now ICAR is recommending the furrow application of lime @ 200 to 400 kg ha^{-1} at furrows which requires less amount and found to be more effective.

Benefits of the technology

Help in neutralizing the acidic soils and improving the yield of crops.

Impact of the technology

The yields were enhanced in farmers' fields through acid ameliorations by lime.





Name of the inventors

Christy B. K. Sangma James Kikon, Dibyendu Chatterjee and L. J. Bordoloi.

Area /ecosystem like state/Upland/Lowland/ animals etc to which the technology is recommended

Technology is recommended for acid soils in hill region.

Name of the technology

Role of soil health card for production improvement.

Application procedure of the technology or SOP for using the technology

Soil health and quality is the basis for the good production of any crop. Soil health card is a technology through which the farmers can know the major and minor nutrients available in their soils. This will ensure judicious use of fertilizers and reduce cost of inputs and improve soil fertility. For creating this card a soil samples collected from the farmers' field have to be analyzed for number of soil parameters both macro and micro nutrients in the soil chemical laboratory. These parameters are soil pH, electrical conductivity (EC), soil organic carbon (SOC), available nitrogen (N), phosphorus (P), potassium (K), sulphur (S) and micronutrients like zinc (Zn), boron (B), manganese (Mn), iron (Fe), copper (Cu) etc. After analysis of these nutrient contents in the soil samples of farmers' field, each nutrient is rate as low ↔ medium ↔ high based on the critical level of the nutrient content in soil. Based on the level of nutrient content in the soil, after soil test, recommendations are given for addition of lime in case of acid soil, gypsum for alkaline soil and manures and fertilizers to the nutrient deficient soils. This Soil Health Card is distributed free of cost to the farmers, but the analysis of soil samples for others are chargeable (₹ 100/sample).

Benefits of the technology

Any type of soil can be analysed.


General recommendations:

ICAR RESEARCH COMPLEX FOR NEH REGION
(Indian Council of Agricultural Research)
NAGALAND CENTRE, JHARNAPANI, MEDZIPHEMA
NAGALAND-797106

SOIL HEALTH CARD
Swasth Dhara, Khet Hara

Soil Health Card

Signature of Scientist In-charge

Farmer's Name :
Village :


SOIL SAMPLE DETAILS

Date of sample collection:
Farm type and size :
Geo position :
Irrigated/Rainfed :
Main crop :

SOIL TEST RESULTS

Sl. No.	Parameter	Test value	Unit	Fertility class/Rating
1.	Moisture content		%	
2.	pH		-	
3.	EC		dS/m	
4.	Soil organic carbon (SOC)		%	
5.	Available nitrogen (N)		kg ha^{-1}	
6.	Available phosphorus (P)		kg ha^{-1}	
7.	Available potassium (K)		kg ha^{-1}	
8.	Avaialable Sulphur (S)		ppm	
9.	Available Zinc (Zn)		ppm	
10.	Available Boron (B)		ppm	
11.	Available Iron (Fe)		ppm	
12.	Available Manganese (Mn)		ppm	
13.	Available Copper (Cu)		ppm	

Impact of the technology

Farmer's soil samples are analysed for elemental nutrient content. After the result of the analysis, the soil is designated as low, medium and high in nutrients contents and

recommendations are given based on the soil nutrient content for maintaining soil health and increasing the crop yield at the same time.

Name of the inventors

Christy B. K. Sangma, L. J. Bordoloi and James Kikon.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended:

Applicable in any type of ecosystem.

Name of the technology

Large cardamom based agro-forestry system suitable for Longleng district.

Large cardamom (*Amomum subulatum*), known as queen of spices is one of the world's most celebrated spices holding a key economic avenue from which farmers can earn good returns within a very short amount of time. It is an ancient spice cum medicinal herb used by the north eastern people. It contains 2 to 3% essential oils, possesses curative, stomachic, diuretic and cardiac stimulant properties and is also a remedy for throat and respiratory problems. Large cardamom is a widely grown and consumed spice that has good international market demand. After saffron and vanilla, cardamom is the third most expensive spice by weight. It not only contributes to the economy but also play important role in the ecosystem and contribute to the human health. India is having major share in the international large cardamom export market. India is itself by far the most important consuming country for cardamoms in the world. The North Eastern Region (NER) is the major producer of large cardamom in the production pool of the country. Nagaland, a hilly state in NER, has suitable agro-climatic conditions for large cardamom cultivation and occupies 2nd position in area and production after Sikkim among the NE states. The state is emerging as an important competitor in large cardamom export. With its production confined to restricted areas, the state has high capacity to become a major production hub in the country produced (2017-18) 2284 metric tonnes from 4116 hectares (Source: Nagaland Statistical Handbook, 2018). Of which Longleng district produced 112 metric tonnes from an area of 245 hectares. Keeping in mind the profound potential of the crop in the state and to boost and enhance the earning capacity of the farmers in the district, NMSHE (National Mission for Sustaining Himalayan Ecosystem) project adopted two villages *viz*. Mongtikang and Hukphang village.

Application procedure of the technology or SOP for using the technology

Prior to intervention, a total of 44 nos. of farmers from these two villages were trained with the proper package of practices. A total area of 9.5 hectares of land was covered for the cultivation of large cardamom. All the necessary inputs and planting materials (Tissue culture planting materials from ICRI, Sikkim) Cv. Ramsay, Sawney and Serenna were provided at free of cost under the project during 2016 to 2018.



Large cardamom plantation, Hukphang village



Large cardamom plantation, Mongtikang village



Large cardamom plantation, Mongtikang village

Benefits of the technology

On an average, the farmers are earning ₹ 20000-30000 per season by selling the capsule @ ₹ 400/kg in the market.

Impact of the technology

A total of 42000 planting suckers were planted in the adopted villages. So far, 18 nos. of farmers from Hukphang and Mongtikang village earned ₹ 40000-50000 per farmer. It is expected that the production of large cardamom capsule will increase in the next season benefitting the growers of these two villages.

Name of the inventors

Rajesha G, Christy B. K. Sangma, Rakesh Kumar, B. C. Deka, L. K. Baishya, Azeze Seyei, KVK Longleng staff, ICAR Nagaland Centre and NMSHE project staffs.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

In hill ecosystem.

Title of the technology

Recycling of pig dung into nutrient enriched compost (PSN compost).

The technology involves a methodology for recycling of pig dung into nutrient enriched compost with minimal use of mineral additives. The protocol used for production of the pig dung recycled enriched compost is furnished below:

Application procedure of the technology or SOP for using the technology

i. Use of pig dung that is 2 weeks or older should be ensured.

ii. Composting can be carried out either in earthen pits or concrete pits or portable compost beds.

iii. Compost recovery percentage ranges from 40 to 46% meaning that 40 to 46 kgs of matured compost can be harvested from an initial substrate quantity of 100kgs.

iv. In a standard pit with dimension of 2m L X 1m B X 0.5m D, approximately 11q of substrates can be accommodated.

v. Optimum application rate of the compost so prepared is 2.5q/ ha, which can be enhanced upto 5q/ ha while working in degraded land.

vi. Application of the compost one (1) week ahead of sowing/ planting gives better results especially in case of short duration crops.

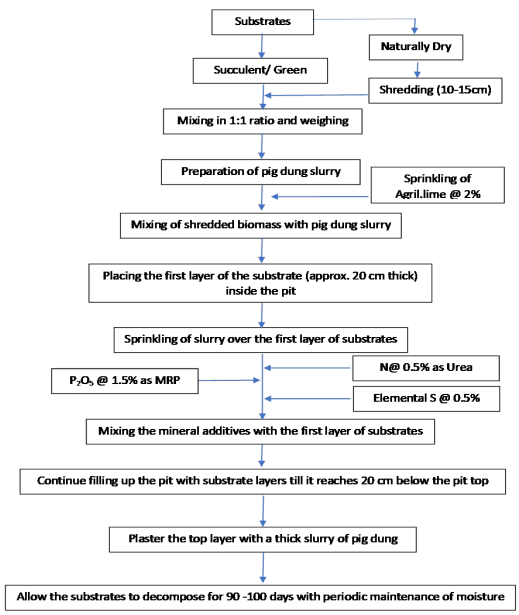


Fig. Flow chart for recycling of pig dung

Benefits of the technology

Provides an avenue for harnessing the benefits of pig dung, the most nutrient rich but underutilized animal dung which is also the most abundantly available source of organic manure in the North Eastern Hills. Can address the menacing problem of disposal of 1550 thousand tonnes of pig dung produced annually in NE India. Enviable nutrient content for any organic manure:

pH	C (%)	N (%)	C: N	P (%)	K (%)	S (%)
7.3	28.9	2.9	9.97:1	4.8	1.8	0.71

i. With an extremely narrow initial immobilization phase of 5 to 8 days immediately after application, pig dung recycled PSN compost guarantees uninterrupted nutrient supply to even the short duration crops with equal effectiveness.

ii. Impressive nutrient use efficiency ranging from 72 to 87%.

iii. Benefit-Cost ratio of 2.14: 1 considering a selling price of Rs. 20/- per kg.

iv. Its application triggers a positive priming effect in the soil system by augmenting the rhizospheremicroflora, especially in the successional dynamics of the K and the R-strategists.

Impact of the technology

After successful preliminary trials in the research farm of ICAR RC for NEH Region, Nagaland centre, Jharnapani (Nagaland), wherein 42 to 56% yield improvement in crops such as maize, sesamum, upland paddy, toria etc. were recorded; pig dung recycled PSN compost is being extensively used in trials and demonstrations in SAS, Nagaland University and CPGS, CAU.

i. In unique agricultural production systems as is represented by the districts such as Kiphire where pig dung is the only tappable source of organic manure and use of agro-chemical is taboo, pig dung recycled PSN compost has proved to be a boon.

ii. At present pig dung recycled enriched compost is the mainstay of 15 numbers of homestead garden based IFS models that have been developed with support from the TSP project in Kiphire covering an area of 42 ha.

iii. Production and application of pig dung recycled enriched compost have registered an adoption level of 72% in the district. At present there are 18 numbers of such production units producing around 5 to 5.2q of compost /batch/ unit. Target is to produce 3 batches/ unit/ year.



Fig. Sesamum & Turmeric flourishing with PSN compost application

Name of the inventors

L. J. Bordoloi, S. Hazarika, H. Kalita, B. C. Verma and B. C. Deka.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Suitable for upland and lowland ecosystem, effective in both short and long duration crops. Particularly suitable for triggering positive priming effect in highly fertile but less productive soils and extremely effective in supporting initial re-vegetation of degraded lands such as short fallow cycled *jhum* lands for their reclamation.

Title of the technology

Jalkund- A viable technology for low cost water storage.

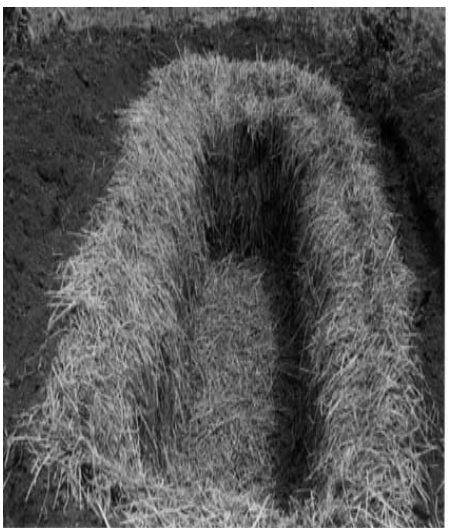
Application procedure of the technology or SOP for using the technology

It is a simple and low-cost rainwater harvesting structure with direct water catch pit for storing rainwater in undulating topography. After excavation of the kund bed, and sides of the kund are levelled properly by removing rocks, stones or other projections and smoothening was done by plastering with a mixture of clay and cow dung in the ratio of 5:1. A 3 to 5 cm thick cushioning was done with locally and easily available dry crop residue or pine leaf @ 2 to 3 kg/sq.m on the walls and bottom. Silpaulin sheet of 250 GSM is used to prevent seepage loss. Construction work has to be completed before monsoon. Total cost of a unit of Jalkund of size 4m×5m×1.5m is Rs. 20,000/- approximately.

S. N.	Dimension (m)	Silpaulin required (m)	Quantity of water stored (litres)
1.	5×3×1	8×6	15,000
2.	5×4×1	8×7	20,000
3.	5×4×1.5	9×8	30,000

Benefits of the technology

It is beneficial for storing water and irrigation to be utilised during off season.



Cushioning the kund



Completed Jalkund

Impact of the technology

Distributed to large number of Nagaland Farmers under TSP programme and the farmers' acceptance and adoption rate is high.

Name of the inventors

Christy B. K. Sangma, Dibyendu Chatterjee, Rakesh Kumar, L. K. Baishya, L. J. Bordoloi, James Kikon.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Recommended for farmers of hill region.

Name of the technology

Use of LDPE lining for conservation of pond water.

Application procedure of the technology or SOP for using the technology

LDPE (250µ) farm ponds are those where agrifilm lining is done for the seepage control. This type of agrifilm lined pond can control seepage loss by 94.7%. It is affordable comparing to the other types of farm ponds *viz.* concrete, bricks, stone slabs etc. After the pond was dug as per the design, pond bed and sides are made weed and stone free. Steps of 50 cm vertical interval were made on sides of the pond to hold agrifilm at its place. After the sides and bed were dressed properly, 10 cm thick layer of sieved sand was spread uniformly on bed and sides to provide cushion to the agrifilm. For joining, bitumen of 85/25 and 80/100 grade in the ratio of 2:1 is used. Over agrifilm soil cover of 30 cm was provided and then stone pitching was done on sides only to safeguard the sides of the pond against erosion and any other external forces. Cost of construction of 17×17 m^2 top dimension and 8×8 m^2 bottom dimension with 3 m depth with side side slope of 1.5:1 is approximately Rs. 75,364.

Benefits of the technology

It is beneficial for storing water and irrigation for off season.

Impact of the technology

Distributed to large number of Nagaland Farmers under TSP programme and the farmers' acceptance and adoption rate is high.





Name of the inventors

Rakesh Kumar, L. K. Baishya, L. J. Bordoloi, Jyotish Barman, Christy B. K. Sangma, Dibyendu Chatterjee, James Kikon.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Technology is recommended for mid and altitude areas hill farmers.

VI. ANIMAL SCIENCE

Title of the technology

Potential backyard poultry farming with Vanaraja and Srinidhi.

Application procedure of the technology or SOP for using the technology

Vanaraja:

- Vanaraja is a coloured bird similar to *desi* chicken.
- High immunity and more than 90% survivability in field condition.
- Adaptable to sub-tropical to temperate climatic condition.
- Performed well at 200 to 3000 meters amsl.
- Lays 120 to 160 numbers of brown eggs in one year. Laying of eggs starts at 140 to 150 days. Egg size and weight is bigger than local chicken eggs, therefore, more nutrition available per egg.
- Male birds attain body weight of 2.5 to 3 kg in three months. However, male birds can grow up to 5 kg in three to four months on commercial balanced feed.
- Female birds attain 2.0 to 2.5 kg body weight in three to four months.
- Meat taste is similar to *desi* chicken.

Srinidhi:

- Srinidhi is an egg type chicken/ layer poultry suitable for backyard rearing.
- Lays 180 to 220 numbers of brown eggs in one year. Laying of eggs starts at 120 to 130 days. Egg size and weight is bigger than local chicken eggs, therefore, more nutrition available per egg.
- Srinidhi is coloured and hardy chicken with survivability of more than 90% in field condition.
- Adaptable to sub-tropical to temperate climatic condition.
- Male birds attain body weight of 2.5 to 3.0 kg in three months. However, male birds can grow up to 5.0 kg in three to four months on balanced feeding.
- Female birds attain 1.5 to 2.0 kg body weight in three to four months.
- Meat taste is similar to *desi* chicken.

Benefits of the technology

Vanaraja gives two to three times' higher productivity as compared to local birds. Srinidhi lays three times' higher egg production compared to local birds.

Impact of the technology

ICAR - Nagaland Centre has supplied around eight lakhs of improved Vanaraja and Srinidhi germplasm to around 10,000 different stakeholders (farmers, self-help groups, KVKs, NGOs, line departments, ICAR institute, CAU Imphal, etc.) in NEH region. The technology was provided to Nagaland, Assam, Manipur, Meghalaya, Arunachal Pradesh and Mizoram. Around 100 numbers of trainings, field visits, exposure visits etc. were conducted (Benefitted more than 5000 persons). Similarly, the technology was demonstrated in the farmer's field under different TSP projects of the institute as well as Poultry Seed Project.





Name of the inventors

Mahak Singh, M. K. Patra, H. Kalita, V. K. Mishra.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Farmers, State Animal Husbandry Department, Self Help Groups, KVKs, etc. of North-Eastern Hill Region of India.

Title of the technology

Poultry hatchery management for quality chicks production.

Application procedure of the technology or SOP for using the technology

- Poultry hatchery consists of Egg Setter and Egg Hatcher. Fertile eggs are put in setter machine for 17 days at 99.5 to 99.9 °F temperature and 86 to 86.8% relative humidity.
- After 17 days, eggs are candled to sort out unfertile eggs or eggs with dead embryo.
- After candling, fertile eggs are put in Hatcher for three days at 98.5 to 98.7 °F temperature and 87 to 92% relative humidity.
- A total of 21 days of incubation is required for fertile poultry eggs to hatch.
- Each batch of eggs is cleaned with mild disinfectant before putting in setter.
- Egg setter and hatcher are to be fumigated after each batch of eggs.
- Fumigation solution: Add 35 mL of formalin (40% formaldehyde) to 17.5 g potassium permanganate "$KMnO_4$" per one cubic metre of space for 20 minutes. When mixing with potassium permanganate for fumigation, always add the formalin to the potassium permanganate, never the reverse.
- Continuous electricity supply is required for setter and hatcher.
- Eggs must be turned on hourly basis in egg setter.
- For small scale hatchery, single egg setter cum hatcher is available in market (1000 to 5000 egg capacity). The cost is approximately Rs.40000 to 60000/- only.
- Fertile eggs can be sourced from commercial supplier or from your own farm. Eggs must be stored below 15°C before setting in egg setter.





Benefits of the technology

The technology is well proven and can be easily adopted with skill training.

Impact of the technology

Regular capacity building programmes are being conducted for different stakeholders. The technology has been adapted by few progressive farmers in Dimapur district and KVKs.

Name of the inventors

Mahak Singh, H. Kalita, V. K. Mishra.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Farmers, State Animal Husbandry Department, Self Help Groups, KVKs, etc. of North-Eastern Hill Region of India.

Title of the technology

Scientific pig farming with Rani pig breed.

Rani pig is a crossbreed of Hampshire and Gunghroo pigs.

Application procedure of the technology or SOP for using the technology

- The Rani pig is well adapted to different agro-climatic conditions and their production performance is significantly higher than local or *desi* pigs.
- The Rani pig is a 50% cross of Hampshire and Gunghroo breed. Therefore, it has high growth rate of Hampshire and large litter size of Gunghroo.
- The colour of the animal is mostly black which is preferred by people of NEH region.
- The average body weight gain varied from 250 to 320 gram per day in farmer's field.
- The pig attains 90 to 110 kg body weight in 300 days.
- The average litter size varies from eight to 10 piglets. Litter size in first farrowing is less and reaches peak at third to fifth farrowing.
- Under good management condition, the animal farrows two times in a year producing around 20 piglets in one year.
- During her life time (five years), Rani pig produces around 70 to 90 piglets.
- The animal is suitable for rearing at low altitude (200 meters amsl) to high latitude (2500 meters amsl).
- The technology is economical and has BC ratio varied from 1.87 to 2.52 at different places.

Benefits of the technology

The technology is well adapted to agro-climatic condition of NEH region with two to three times' higher productivity as compared to local pigs.

Impact of the technology

ICAR - Nagaland centre has provided 4000 Rani piglets to 1000 beneficiaries in Nagaland, Assam, Manipur and Arunachal Pradesh. Pig entrepreneurs have been established in Nagaland. Around 100 training programmes were imparted to 1000 farmers.





Name of the inventors

Mahak Singh, R. Talimoa Mollier, H. Kalita, V. K. Mishra.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Farmers, State Animal Husbandry Department, Self Help Groups, KVKs, etc. of North-Eastern Hill Region of India.

Title of the technology

Artificial insemination in pig with liquid boar semen.

Application procedure of the technology or SOP for using the technology

- Lack of good breeding boar and high cost (Rs.1500 to 2000/- or one male piglet) of natural mating prohibit the pig farmers to rear pig for breeding purpose.
- Artificial insemination kit is available at ICAR Nagaland Centre throughout the year. The cost of the technology is approximately 1/10th of natural breeding.
- The technology is cheap, easy to do and help in improving the reproductive efficiency of the pig farm.
- It is recommended to do two times AI in pig on second day of heat at 12 hrs interval
- Semen kit can be transported in cooled thermous or cooled hotcase or cooled thermocol box. Do not keep it on ice packs or in refrigerator.
- Timely artificial insemination ensures farrowing rate of 80% with average litter size of 10 to 12 piglets.
- Semen availability is 24 x 7 and therefore the farmers can always inseminate sows without letting a fertile heat pass.
- Litter size from AI is increased by 2 piglets on average as compared to natural breeding.
- Female pigs of any bodyweight can be served.
- AI enables extremely rapid upgradation of field herds.

Benefits of the technology

The technology is easy to do and cheap with farrowing rate of 60 to 80%.





Impact of the technology

ICAR - Nagaland centre has promoted 25 entrepreneurs in pig AI. Till now, around 8000 AI were done in field and produced approximately 50000 piglets in Nagaland. The technology is well documented with research articles, popular articles and success stories.

Name of the inventors

Mahak Singh, R. Talimoa Mollier, H. Kalita, V. K. Mishra.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Farmers, State Animal Husbandry Department, Self Help Groups, KVKs, etc. of North-Eastern Hill Region of India.

Title of the technology

New protocol of estrous synchronization in pig.

Application procedure of the technology or SOP for using the technology

- This is the first report of new protocol of estrous synchronization in pig.
- This is done to induce heat in large numbers of animals at once and therefore doing AI at pre-determined time. It saves time and labour cost.
- Non availability of PG-600 (Universally used drug for estrous synchronization) in India.
- This protocol includes 300 IU pregnant mare serum gonandotrophins and 150 IU human chorionic gonadotrophin.
- The hormone cocktail is given in three mL sterilized water intramuscularly.
- Pigs come into heat after 48 to 96 hours of hormone administration.
- It is recommended to do deworming of the animals at least three days before estrous synchronization.
- Around 80 to 90% animals will come into heat.
- Farrowing rate of 80% with litter size of 10 to 12 piglets are produced.





- The non-pregnant pigs of one village can be served at one time.

Benefits of the technology

The technology is well suited to the remote areas of NEH region.

Impact of the technology

The technology has been successfully demonstrated in the farmer's field in collaboration with KVK Dimapur and KVK Porba.

Name of the inventors

Mahak Singh, R. Talimoa Mollier, Ebibeni Ngullie, H. Kalita, V. K. Mishra.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Farmers, State Animal Husbandry Department, Self Help Groups, KVKs, etc. of North-Eastern Hill Region of India.

Title of the technology

Low cost boar training technology for semen collection for artificial insemination in pig.

Application procedure of the technology or SOP for using the technology

Male piglets of excellent dams are selected from large sized litters (more than 10). The breeding boars are selected at two stages i.e. first at weaning and second times at 6 months of age. The boar training for semen collection starts at 8 to 9 months of age as per the procedure developed by ICAR - Nagaland Centre. With this protocol, boars can be trained in 15 days time. After training, semen quality of boar is assessed in the laboratory and the boars are kept for siring generations of pigs.

- Low cost wooden dummy sows of different sizes are made as per the sizes of the trainee boars.
- Selected male pigs are trained to gradually mount the dummies and ejaculates are collected for inseminating female pigs.
- The locally designed dummy sows are portable, stable, long lasting and eco-friendly.
- Dummies can be easily washed, cleaned and disinfected.

Benefits of the technology

The boars can be easily trained for semen collection.

Impact of the technology

ICAR - Nagaland Centre has established satellite AI Centre in KVK Wokha with trained boar.





Name of the inventors

Mahak Singh, Moa Sangtam, H. Kalita, V. K. Mishra.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Farmers, State Animal Husbandry Department, Self Help Groups, KVKs, etc. of North-Eastern Hill Region of India.

Title of the technology

Method of low cost beltsville thawing solution (BTS) semen extender preparation.

Application procedure of the technology or SOP for using the technology

High cost of imported commercial extender was a big challenge for regular production of AI kit. So ICAR Nagaland Centre has standardized the semen extender with the use of different ingredients.

- The costs of the ingredients are cheaper than commercial extenders.
- Regular supply of semen kit for AI is being maintained.
- Quality of extender is monitored at each stage.
- Extenders are freshly prepared and give good results with prolonged semen viability even beyond expected time limit. Easy and long storage life of ingredients.

Benefits of the technology

The technology is easy and cheap. It decreases the cost of boar semen processing.

Impact of the technology

The cost of production of liquid boar semen has been greatly reduced.Quality semen extender is being produced at low cost and freshly prepared extenders are giving better stored semen viability and farrowing rate.There is no dependence on imported extenders now and imported expensive extenders are now phased out.





Name of the inventors

Mahak Singh, H. Kalita, V. K. Mishra.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

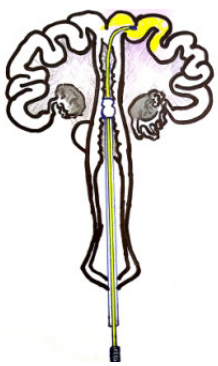
Farmers, State Animal Husbandry Department, Self Help Groups, KVKs, etc. of North-Eastern Hill Region of India.

Title of the technology

Post-cervical or intra-uterine artificial insemination in pig with low sperm dose.

Application procedure of the technology or SOP for using the technology

- Traditional AI in pig involves use of three billion spermatozoa per dose to be deposited in cervix.
- Post-Cervical or Intra-Uterine Artificial Insemination employes 1.5 billion spermatozoa in one dose and deposited in uterine horn with the help of intra-uterine catheter.
- This is 100% more efficient than traditional AI. With single boar ejaculate, minimum 20 AI doses can be prepared.
- Training of one week is required to master this AI procedure.
- Farrowing rate of 83% was obtained with this technology.
- Litter size at birth and litter size at weaning were 13 piglets and 11 piglets, respectively.
- This technology increased the breeding efficiency of genetic superior boar by 100%.



Benefits of the technology

The technology is economical and efficient as compared to traditional AI. With the use of PCAI, the number of boars required for breeding can be reduced to half.



Impact of the technology

Regular capacity building programmes are being conducted for different stakeholders. Approximately 1000 numbers of piglets were produced by use of this technology.

Name of the inventors

Mahak Singh, H. Kalita, V. K. Mishra.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Farmers, State Animal Husbandry Department, Self Help Groups, KVKs, etc. of North-Eastern Hill Region of India.

Title of the technology

Dietary linseed oil to boar for improved fertility.

Application procedure of the technology or SOP for using the technology

Benefits of the technology

The technology is well adapted to agro-climatic condition of NEH region with two to three times' higher productivity as compared to local birds.

Impact of the technology

- High temperature humidity index (THI) during summer and monsoon season causes poor boar semen quality.
- Feeding of 90 ml of linseed oil to boars during high THI months improved the libido, semen volume, total sperm numbers and sperm quality.
- This also improved the antioxidant status of boar and lowered the lipid peroxidation.
- In-vivo fertility of boar was significantly increased after linseed oil supplementation.
- Therefore, reproductive efficiency of boars was improved during high THI months.
- This technology is suitable for tropical and sub-tropical climatic condition.
- Farrowing rate of 90% along with litter size of nine piglets was recorded.

Name of the inventors

Mahak Singh, H. Kalita, V.K. Mishra.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Farmers, State Animal Husbandry Department, Self Help Groups, KVKs, etc. of North-Eastern Hill Region of India.

Title of the technology

Low cost pig feed using distiller's dried grain with soluble (DDGS).

Application procedure of the technology or SOP for using the technology

- High cost of feed is a major deterrent to pig farmers particularly in NEH region.
- ICAR Nagaland centre has developed low cost feed using DDGS and it reduces the feed cost by 50%.
- Composition of low cost feed

S. N.	Ingredients	Composition %
1.	DDGS	64
2.	Crushed maize	29
3.	Groundnut Cake	5
4.	Mineral Mixture	1.5
5.	Salt	0.5
6.	Total	100

Growth rate of pig was higher with this feed as compared to commercial feed. Pig attained body weight of 85 to 90 kg in eight months.

Benefits of the technology

The technology is economical with good growth rate in pig. The DDGS is easily available locally.

Impact of the technology

Feed cost is reduced significantly. The technology is being transferred to farmer's field.

Name of the inventors

Mahak Singh, Ebibeni Ngullie, H. Kalita, V. K. Mishra.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Farmers, State Animal Husbandry Department, Self Help Groups, KVKs, etc. of North-Eastern Hill Region of India.

Title of the technology

Farrowing induction in swine with prostaglandin.

Application procedure of the technology or SOP for using the technology

- In pigs, good management and timely intervention is very important during farrowing stage to reap the full economic benefits.
- In recent years, piglet production per sow per year has gone to 30 to 35 and two farrowing per sow per year is now the standard benchmark mainly because of improvement in genetics, nutrition, reproduction management and health management
- The pregnancy duration of sow vary from 114 to 117 days in different herds mainly because of genetics, however, individual variation of gestation length among sows ranges from 106 to 125 days.
- The piglet's mortality is maximum during farrowing stage (ranges from 20 to 50%) and this leads to discouragement among the pig breeder farmers.
- Therefore, scientific interventions for management during farrowing are critically required particularly in commercial pig farm.
- In this technology, cloprostenol sodium (250 mcg) is injected intramuscularly on 113th day of gestation at 8.00 am in the morning and farrowing takes place on 114th day in day time.

Benefits of the technology

The technology is well suited to the organized pig farms for batch farrowing management. Use of this technology leads to farrowing in day time which is easy to monitor.

Impact of the technology

Batch farrowing leads to batch weaning. This help greatly in farm management.

Name of the inventors

Mahak Singh, H. Kalita, V. K. Mishra.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

Farmers, State Animal Husbandry Department, Self Help Groups, KVKs, etc. of North-Eastern Hill Region of India.

VII. FISHERY

Title of the technology

Short duration carp farming in polythene lined rain water harvesting pond.

Water harvesting structures are either man-made or natural water storage structure. In India, traditionally farm ponds were made either at individual level or on community basis for harvesting rain water or run-off water. Farm pond has been an integral part of farming system which stores water during rains and the same is used for giving lifesaving irrigation. Since ponds are located on a variety of soil type exhibiting wide range of seepage characteristics, it is essential to seal the pond to reduce seepage and percolation losses. Plastics have been found to be very effective in lining the ponds. Rain water is collected by channelling surface runoff water to the pond through an inlet pipe. Alternatively, roof top water can also be channelized into the pond. Water in such ponds can be retained for 6-7 months. Once the structure is made, it can store water which can be used as source of irrigation for standing crops at critical growth stage. Apart from irrigation such ponds can be readily used to culture fish. Depending on the depth of the pond, different composition of fish can be reared for short term to enhance productivity. Following is the technology for short-term carp farming (6 months) in a pond of 2.5 m depth retaining water for 6-7 months (June – December).

Application procedure of the technology or SOP for using the technology



Pond Preparation: While preparing the pond for plastic lining, an inlet is provided to allow rain water/surface run-off to enter the pond. Similarly a suitable outlet is provided to maintain the required depth of water and avoid over flow. After completion of the plastic lining, 10-15 cm of soil layer is provided over the pond bottom. During rainy seasons, when the pond is filled with water, liming is done as per recommended dose after checking the pH of the water. After few days of lime application, the pond is manured with cow dung / poultry droppings / pig dung. Urea and SSP can also be applied after few days of manuring. After application of manures, the water colour slowly turns green. This indicates that there is sufficient growth of fish food organisms and the pond is ready for stocking fish.



Selection of fish species: Depending on the depth of the pond, species selection may vary. For a pond of 2.5 m depth, the six species composition of *Hypopthalmichthys molitrix* (silver carp), *Catla catla* (Catla), *Labeo rohita* (Rohu), *Ctenopharyngodon idella* (Grass carp), *Cirrhinus mrigala* (Mrigal) and *Cyprinus carpio* (Common carp) at 15:25:20:10:15:15 ratio is followed. Fingerlings of 10 cm size are recommended for stocking short duration farming system.

Stocking density: 6000 nos./ha.

Stocking Management: Stocking of fish should be done during cool hours of the day especially in morning time. In polythene lined pond, stocking during noon hours is avoided as the temperature in such pond is high which may lead to high mortality. Fingerlings brought in oxygen packed bag are allowed to float on the water surface for half an hour in order to acclimatise them to pond condition and are then released into the pond.



Feeding Management: After stocking, the fish are fed with supplementary food daily. This is because the production of natural food in plastic lined pond is less and therefore cannot fulfil the total food requirement of the stocked fish. Rice polish, rice bran, wheat bran, mustard oil cake (de-oiled), ground nut oil cake are some of the ingredients used as supplementary feed for fish. The feed is prepared by mixing any one of rice polish/rice bran/wheat bran with soaked mustard or groundnut oil cake in equal proportion and then by adding mineral mixture powder @ 1% of the total feed prepared. The prepared feed can be made into dough and put into the pond. Alternatively, commercial fish feed available in the market can also be fed to the fish. Supplementary feeding is done at 3 % of total body weight daily. For grass carp, banana leaves, leftover leaves of vegetables, grasses like para, napier, etc can cab be fed. In areas where integration with pig/cattle/ poultry is possible, the waste material along with the dung can be flushed into the pond. This shall serve as manure for plankton growth as well as food for fish. In such cases, supplementary feeding on daily basis is not required and can be done 2-3 times in a week.

Post Stocking Management: For ensuring better environment for fish to grow, the water quality and health status of fish is to be monitored on periodic basis. The



physicochemical parameters of water are to be monitored monthly and recommended corrective measures are to be taken accordingly as per standard procedure. Care is taken to keep the physicochemical parameters of water within the acceptable range for fish culture. Sampling of fish is done every month to check the health and growth status. Based on the weight of the fish, the feed requirement is calculated and adjusted accordingly. Liming and manuring is to be done on monthly basis to sustain primary productivity. Liming has to be continued during winter months as it not only helps in checking pH but also act as prophylactic agent. In case where integrated farming is practiced, continuous flushing of animal house waste may lead to excessive growth of plankton leading to bloom like condition. When occurrence of bloom is observed, effort should be taken to remove the bloom. The best way to remove bloom is by dragging fine meshed net. During occurrence of bloom, flushing of waste material and supplementary feeding is suspended till the bloom disappears. In such cases, the animal house waste may be diverted or a separate pit can be made to store the waste. During summer months, in ponds which are directly exposed to sunlight, the pond water temperature increases. This adversely affects the metabolic activity of the fish. Hence, it is necessary to provide shelter for the reared fish. Fish shelter can be provided by providing floating aquatic plants on the pond surface. Care is taken that the plants does not cover more than one-third of the total water surface area. Another problem encountered in plastic lined ponds is the tearing of the lining materials. This usually happens due to frequent human interference or due to rodent activity. Rodents take shelter underneath the lining materials and cut it resulting in loss of water due to seepage. Therefore, one has to keep a strict vigilant and take appropriate measure to control rodents. Moreover, frequent walking over the polythene sheet is to be avoided.

Harvesting: The culture period of fish in rain water harvesting pond depends upon the level of water retained as well as frequency of water usage for irrigation purpose. During lean season, water is needed for irrigating the crops, which reduces the volume of water in the pond. Therefore, fish is usually harvested after six months of culture. On an average from one hectare pond area a production of 2800 kg fish is obtained in 180 days rearing period.

Benefits of the technology

The technology is recommended for mid-hill and foot-hill condition of Nagaland. All polythene lined rainwater harvesting ponds can be effectively utilised for carp farming to enhance productivity.

Impact of the technology

Rain water harvesting ponds are usually built for storing water during monsoon season. Implementation of short duration carp farming in such ponds enables increase in income and enhances productivity. The technology is well adapted in different districts of Nagaland.





Name of the inventors

Jyotish Barman, D. J. Rajkhowa, L. K. Baishya, H. Kalita.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

The technology is recommended for mid-hill and foot-hill conditions of Nagaland.

Title of the technology

Labeo calbasu as a candidate species in rice-fish farming.

Rice fields form the natural habitat for a larger variety of indigenous species of fish which gain entry from the nearby natural water resources. The practice of collecting wild, naturally occurring fish for food from rice field is probably as old as rice cultivation itself. The fishes feed and grow on natural food available and the farmers usually collect the fish during rice growing season and/or when the water level subsides. Fish culture in paddy fields in several rice-growing areas of north eastern states of India is not new. The ecology of rice fields in the region is quite diverse, but can be divided primarily into upland, lowland and deepwater rice ecosystems. The indigenous rice-fish farming practices prevailing among the farmers of north-eastern India are (a) rice field capture fishery systems (b) wild aquatic cropping systems(c) mountain valley rice fish farming system and (f) running water terrace rice-fish systems (Das, 2002). Rice-fish farming practice in Nagaland too holds enough potential. The mountainous valley of the state can be effectively utilised for developing paddy cum fish culture. In fact, farmers of Phek and Kohima district are traditionally practicing fish farming in rice fields. Further, paddy fields in the foot hills region or plain areas that retain sufficient water for few months can easily be developed into paddy cum fish farming plot with slight modification based on its topography. This system not only envisages better growth of paddy but also gives an additional income through sale of fish. Scientific rice-fish systems can ensure higher productivity, farm income and employment in these areas. Common carp has been the principal candidate species for rice-fish farming in these areas. Further, culture of the Indian major carp as well as exotic carp are also being reported from various parts. The present technology involves incorporation of *Labeo calbasu* in place of *Cirrhinus mrigala* in rice-fish farming system. The main objective of the technology is to enhance fish productivity and farmers' income, especially in Rice-fish farming.

Application procedure of the technology or SOP for using the technology

Plot Preparation: Two plot of paddy field was prepared *viz* perimeter trench system model and pond system with lateral trench model.

Model – I: Perimeter Trench System (0.40 ha)

Alow lying rainfed area in Niuland district was selected for perimeter trench system. The total area of the plot is 0.40 ha (plot size: 80 x 50 m = 4000 sq m). The paddy plot is designed with perimeter trench of 260 m length, 0.8 m depth and 1 m width. Once the plot preparation was finished, paddy was transplanted. After 20 days of paddy transplantation, fingerlings of *Labeo calbasu* and *Cirrhinus mrigala* of average size 8

cm in length and 10 g in weight were stocked at a stocking density of 6000 nos./ha. Fingerling of both species was stocked in equal proportion (1:1 ratio). In this system, water was pumped into from a nearby source time to time to maintain the desired level in the trench. After 188 days of rearing, the fish were harvested. A production of 493 kg/ha is obtained from the system with *Labeo calbasu* contributing 320 kg/ha and mrigal contributing 173 kg/ha. Labeo calbasu yielded encouraging result in this system.

Model – II: Central Pond System with lateral canal (0.13 ha)

A low lying rainfed paddy field was selected under foot hill condition in Chumukedima district. The total area of the plot is 0.13 ha (1300 sq m). A pond of dimension 15m x 15 m (225 sq m) and depth of 0.6 m was prepared at one corner of the plot. A lateral trench of 20 m length, 0.6 m depth and 1 m width was also prepared connecting the pond. Fingerlings of *Labeo calbasu* and *Cirrhinus mrigala* were stocked at a stocking density of 6000 nos./ha after 20 days of paddy plantation. The average size of the fingerlings was 8 cm in length and 10 g in weight. The fish were reared for a period of 166 days. A production of 196 kg/ha of *Labeo calbasu* and 126 kg/ha of *Cirrhinus mrigala* is obtained after 166 days of rearing. The total production from the system was 322 kg/ha.

Benefits of the technology

The technology revealed that *Labeo calbasu* showed a better growth performance compared to *C. mrigala* and can be a suitable alternative in rice-fish farming system.





Impact of the technology

Incorporation of *Labeo calbasu* in rice-fish farming system is being continuously adopted in Dimapur and Niuland districts of Nagaland. Under foot hill condition and low lying areas, *L. calbasu* can be a potential candidate species.

Name of the inventors

Jyotish Barman, D. J. Rajkhowa, L. K. Baishya, H. Kalita, Harendra Verma.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

The technology is recommended for low lying area (irrigated/rain fed area).

Title of the technology

High stocking density short term carp farming in cemented tank.

Application procedure of the technology or SOP for using the technology

Polythene lined pond are the most preferred technology for harvesting rain water. Fish culture in such ponds gives an encouraging result. However, due to tearing of polythene sheet by rodents or other factors, the system needs regular maintenance and repairing. Moreover, carp farming has to be done at a lower stocking density, thereby decreasing the possibility to enhance productivity. Cemented tank provides solution to some of the problems as mentioned and does not require regular repairing work. The system also encourages high stocking density as well as increase number of species to enhance productivity. The design and layout is similar to that of polythene lined pond except for lining. Following is the technology for short-term carp farming (6 months) in a cemented pond of 2.5 m depth retaining water for 6-7 months (June – December) following high stocking density.

Package of Practices

Pond preparation: An inlet is provided to allow rain water/surface run-off to enter the pond. Similarly a suitable outlet is provided to maintain the required depth of water and avoid over flow. Soil layer (10-15 cm) is laid over the pond bottom. Once water is filled, liming and manuring is done as per recommended dose. Two ponds of 0.05 ha area each with integration with pig was selected for carp farming. Once water is filled, liming and manuring is done as per recommended dose.

Stocking density: 12000 nos. fingerlings/ha.

Species Composition: Silver carp (20 %), Catla (20 %), Rohu (20 %), Grass carp (10 %), gonius (10 %), calbasu (10 %) and Mrigal (10 %).

Fingerlings of average size 10 cm in length and 12 g in weight were stocked at a density of 12000 nos./ha. The left-over food of pig house (consisting 4 adult pigs) adjacent to the pond was provided in the pond daily. Alternatively, a mixture of rice bran and mustard oil cake (1:1) @ 2 % body weight was provided every three days interval. The physico-chemical parameters were observed every month and were in suitable range for fish culture. Liming was done monthly as per as per recommended dose. month-wise sampling was also done to check growth parameters. In a rearing period of 185 days, the average growth performance in terms of weight observed was highest in silver carp (950 g± 58.90), followed by Catla (708 g ± 40.98), Rohu (325 g± 40.64), calbasu (278 g± 23.88), gonius (255 g± 10.35), Grass carp (251 g± 85.86) and mrigal (158 g± 42.16). Overall, a productivity of 3200 kg/ha was obtained from the cemented tank.

Benefits of the technology

The technology is beneficial for long-term usage and can be adopted in small scale in areas where there is seepage loss.

Impact of the technology

The technology encouraged the inclusion of two new species, *Labeo gonius* and *L. calbasu* along with adopting seven species combination. This technology is adopted in some parts of Dimapur and Chumukedima districts.





Name of the inventors

Jyotish Barman, D. J. Rajkhowa, H. Kalita.

Area/ ecosystem like state/ Upland/ Lowland/ animals etc to which the technology is recommended

The technology is suitable for foot hill areas and areas where seepage loss is prominent.


TIBET AR









