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## 1. MAJOR RESEARCH HIGHLIGHTS

### Banana Germplasm Exploration in North Eastern India

A germplasm exploration was undertaken during October–November 2025 across the North Eastern states of Assam, Arunachal Pradesh, Meghalaya, and Nagaland to collect valuable wild and cultivated banana genetic resources. Collections were made in the form of seeds and suckers of wild and cultivated banana accessions.

Significant accessions collected included Chinichampa (Mysore type) and Bhimkol from Assam; *Musa cheesmanii*, *M. velutina* (variant), *M. itinerans*, *M. sikkimensis*, *M. aurantiaca*, and hill banana types from Arunachal Pradesh; Liyo, Yukhim, Echum Yothi (Malbhog), Eran Yothi (Monthan type), and Poni banana from Nagaland; and 18 accessions from West and South Garo Hills of Meghalaya.

Leaf samples from all collections were preserved for DNA isolation and characterization. Fruits were ripened and seeds extracted for both *in vitro* and *in vivo* germination studies. Among the collections, *Musa nagensium* was germinated under *in vivo* conditions and established in the field gene bank.

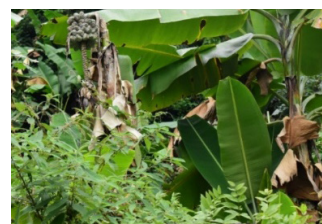
**M. S. Saraswathi, P. Durai, R. Sudha & R. Selvarajan**



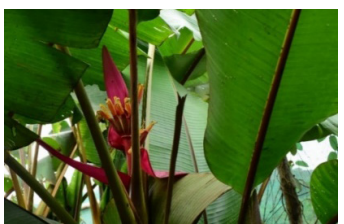
*Musa aurantiaca*



*Musa cheesmanii*



*Musa saddlensis/Musa puspanjalae*



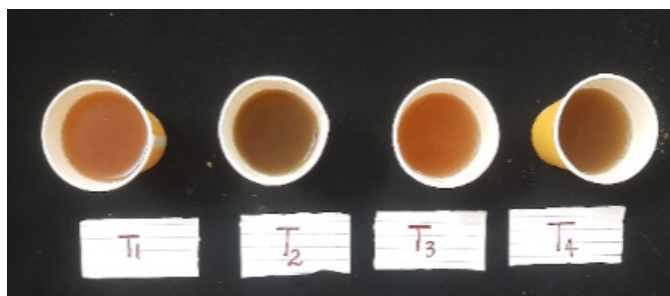
*Musa marukkuana*

**Fig. 2. Banana Germplasm Exploration in North Eastern India**

## Development of Value-added products in banana

### Synergistic use of spices blend and banana flour decoction for diabetic management

Pisang Lilin banana demonstrated notable functional and nutritional advantages, particularly at Stage 6 maturity. The variety recorded a low glycemic index (42.08–42.37%), which can be attributed to its higher resistant starch and dietary fiber content, making it suitable for diabetes-friendly dietary applications. Among the value-added products, the PL-S6-T4 decoction prepared with lemon and stevia achieved the highest sensory score (6.67), reflecting superior palatability and consumer acceptance. With advancing maturity, raw banana varieties such as Nendran, Ney Poovan, and Pisang Lilin exhibited increased size parameters. Additionally, Pisang Lilin Stage 6 flour showed the highest TSS (37.77 °Brix) and sugar content (53.4 g), highlighting its potential for nutraceutical and metabolic health formulations.



T1 -2% Decoction powder (85% Banana flour and 15% Spice blends)

T2 -2% Decoction powder + pinch of Stevia

T3 -2% Decoction powder + 4 drops of lemon

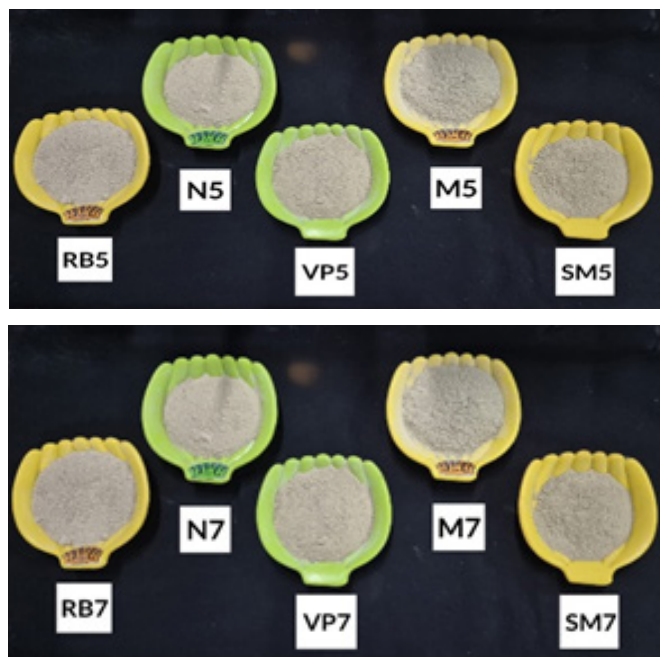
T4 -2% Decoction powder + pinch of Stevia + 4 drops of lemon

#### Banana flour decoction

### Development of iron enriched banana-based millet malt

The study focused on the development of an iron-enriched banana-based millet malt with enhanced nutritional and functional properties. Banana flour and malt exhibited significantly higher iron and nutrient content compared to raw banana, along with desirable functional attributes such as improved water absorption capacity and swelling index, supporting ease of processing. Among the formulated products containing 5% and 7% malt from five banana varieties, Red Banana malt recorded the highest sensory scores for taste (7.85),

appearance (7.55), and overall acceptability (7.55), followed by Nendran, while Virupakshi was least preferred. The developed banana-based millet malt demonstrated strong potential as a nutrient-dense dietary intervention to address iron deficiency anaemic, particularly among nutritionally vulnerable populations.



Malt developed from different combination of banana flour, millets, moringa leaves and curry leaves

### Extrusion Process-Dependent Starch Structure-Function Relationships in Instant Banana Powders Across Ripening Stages

This study evaluated the influence of banana ripening stage and extrusion processing on the functional and nutritional quality of banana powders. Extruded banana powders (BEP15 and BEP20; 15–20 °Brix) exhibited optimal performance due to partial starch pre-gelatinization, improving water absorption, solubility, and rapid reconstitution. These samples maintained structural integrity and thermal stability, unlike highly ripe samples (BEP25), which showed excessive degradation. Particle size reduction enhanced flowability and hydration. Importantly, BEP15 and BEP20 demonstrated balanced digestibility with moderate glycaemic index values, making them suitable for instant food applications.

### Enhanced Techno-Functional and Bioactive Characteristics of Dietary Fibre from Banana Pseudostem Scutcher through Greener Technologies

Dietary fibre was extracted using eco-friendly methods including UAE, MAE, and combined UAE+MAE. The dual treatment yielded high

extraction efficiency (~95%) and significantly enhanced total and soluble dietary fibre content. Functional properties such as water- and oil-holding capacity, swelling power, and adsorption capacities (glucose, cholesterol, nitrite) improved markedly. Structural analysis confirmed increased porosity and reduced crystallinity, explaining improved functionality.

### **Nutritional Composition and Biofunctional Properties of Seed from diploid banana**

Banana seed powders from seven varieties were analyzed. Significant variation was observed in nutritional composition and bioactive compounds. Bhimkol exhibited the highest antioxidant activity (72.13%) and strong antimicrobial and anticancer potential (IC<sub>50</sub>: 44.11 µg/mL), highlighting its value as a nutraceutical ingredient.

### **Impact of Ultrasound on Banana Starch Modification**

Ultrasound treatment (100% power, 30 min) induced structural changes such as pore formation and reduced crystallinity, enhancing functionality. Resistant starch increased significantly (31.35% to 50.22%), while glycaemic index decreased, indicating improved nutritional quality and suitability for low-GI foods.

### **Optimisation of Banana Rhizome Fortification in Rusk**

Banana rhizome flour (BRF) was incorporated into rusk up to 16%. BRF improved nutritional content, shelf stability, and functional properties. Sensory analysis confirmed acceptability at 8–16% substitution, supporting its use in value-added bakery products.

### **Bioconversion of Banana Residues into Xylitol Using *Candida tropicalis***

Banana peel and leaf hydrolysates were used for xylitol production. Optimised conditions yielded 56.6% xylitol from peel hydrolysate. Structural confirmation via HPLC, XRD, and FTIR validated product quality, demonstrating efficient valorisation of agro-residues.

### **Banana Sheath Cellulose-Based Composite Films**

Banana sheath cellulose reinforced PEC/CAR films showed improved tensile strength, thermal stability, and reduced oxygen permeability. Linalool addition imparted antimicrobial properties, making these

films suitable for active packaging applications.

### **Eco-Friendly Degumming of Banana Fibre**

Ultrasonication and enzymatic treatments were evaluated for fibre degumming. Enzymatic treatment (laccase + hemicellulase) proved most effective, improving fibre quality, reducing chemical usage, and enhancing sustainability.

### **Production of Polyhydroxybutyrate (PHB) using banana pseudostem**

Banana pseudostem hydrolysate was used for PHB production using *Enterobacter cloacae*. Optimized conditions yielded up to 56% PHB. The polymer showed rapid biodegradation (~73% in 21 days), confirming its potential as eco-friendly plastic.

### **Nutrient-Enriched Banana Stem Juice**

Banana stem juice fortified with encapsulated iron and folic acid showed high encapsulation efficiency (96%) and improved nutritional content without affecting sensory quality. The product demonstrated potential as a functional beverage.

### **Banana Fibre–Polypropylene Non-Woven Fabric**

Non-woven fabrics developed using banana fibre blends exhibited improved tensile strength, thermal resistance, and sound insulation. The optimized blend (0.5:1.5) showed potential for automotive and industrial applications.

**P. Suresh Kumar**

## **2. TRANSFER OF TECHNOLOGY (TOT)**

During the period, several technologies were successfully transferred to stakeholders, generating revenue and promoting value addition in banana-based enterprises. Variety-specific tissue culture protocols for commercial banana varieties were licensed twice, first during 13–17 October 2025 to Ms. Snehaben Ramanbhai Prajapati, Ahmedabad, and subsequently during 24–29 November 2025 to the High Value Agriculture Development Agency (HVADA), Directorate of Agriculture, Andaman and Nicobar Islands, each contributing ₹0.50 lakh. In addition, the technology on low-fat fortified and flavoured banana chips was transferred during 23–24 October 2025 to M/s. Banaza Enterprises, Kerala, generating ₹0.25 lakh. Similarly, the technology on cost-effective ripe banana powder and its products was licensed during 15–16 December 2025 to M/s. Elowell, Tiruchirappalli, Tamil Nadu, yielding ₹0.25

lakh. Overall, these technology transfers reflect effective commercialization efforts and contributed a total revenue of ₹1.50 lakh.

**K. Nagendran & C. Sivananth**

### 3. OUTREACH AND EXTENSION

#### Capacity Development Programmes

Particulars	No. of Programmes	No. of Beneficiaries
<b>Training</b>		
One day training	5	150
Training under SCSP	2	40
Training under TSP	2	35
Off campus training	1	300
<b>Exposure Visit</b>		
Farmer's exposure visit	89	1151
Student's exposure visit	13	844
Internship for students	5	20
<b>Total</b>	<b>117</b>	<b>2540</b>



Capacity Development Programmes

#### Transfer of Technology through frontline exhibition activities

During the reported period, ICAR–NRCB set up exhibition stalls at different national-level events, through which banana production, protection, and value-addition technologies were disseminated to various stakeholders. An exhibition stall at the First Nagaland State Banana Festival (22–24 October 2025) held at Wokha, Nagaland, jointly organized by ICAR institutes and NABARD, reached around 5,000 beneficiaries. At the 11th Indian Horticulture Congress–2025 with an international meet, held at UAS, Bengaluru (6–9 November 2025), about 1,000 participants were engaged. The South Indian Natural Farming Summit–2025 held at CODISSIA, Coimbatore (19–21 November 2025) witnessed a large outreach of around 40,000 beneficiaries.

Additionally, an entrepreneurship development programme on value-added banana products for tribal farmers, organized by the Adi Dravidar and Tribal Welfare Department, Government of Tamil Nadu, at Namakkal (29 November 2025), benefitted 300 participants. Furthermore, Kisan Diwas–2025 and the Banana Festival organized at ICAR–National Research Centre for Banana, Tiruchirappalli (23



December 2025), reached around 800 beneficiaries.

Overall, these events collectively engaged a large number of stakeholders and strengthened outreach and capacity-building efforts.

**C. Karpagam & P. Ravichamy**



**Frontline exhibition activities**

### Transfer of technologies through print and electronic media

The institute actively disseminated technologies through print and electronic media, ensuring wider outreach and awareness among stakeholders. A total of 44 media outputs were recorded, including 23 news items published in print media, 3 in electronic media such as television and All India Radio, and 2 through social media platforms. In addition, 3 phone-based press releases, including press meets, were conducted, reflecting consistent efforts to communicate research outcomes and promote technology adoption.

**C. Karpagam & P. Ravichamy**

### Significant Event Organised

#### Stakeholder's meeting on Strengthening Banana Value Chain and Export Promotion

A stakeholders' meeting on "Strengthening Banana Value Chain and Export Promotion" was held at the ICAR-NRCB On 29-09-2025. Nearly 150 participants, including farmers, traders, exporters, entrepreneurs, members of various Krishi Vigyan Kendras (KVKs), Farmer Producer Organizations (FPOs), and aspiring banana growers, took part in the event. The Chief Guest, Prof. Pawan Kumar Singh, Director of IIM Tiruchirappalli, appreciated NRCB's global achievements and highlighted the cultural and spiritual significance of banana.



#### Screening of the 21st instalment release of the PM-KISAN programme at the ICAR-NRCB

ICAR-National Research Centre for Banana (ICAR-NRCB), Tiruchirappalli, organized the live telecast of the 21st instalment transfer of the PM-Kisan Samman Nidhi to farmers by the Hon'ble Prime Minister of India, Shri Narendra Modi, along with the inauguration of the South India Natural Farming Summit-2025 on 19th November 2025. The

programme was attended by more than 165 farmers and other stakeholders from nine neighbouring villages.



### Screening of PM Dhan-Dhanya Krishi Yojana programme at ICAR-NRCB

ICAR–NRCB organized the live screening of the launch of the PM Dhan-Dhanya Krishi Yojana and Pulses Self-Reliance Mission, along with the inauguration and foundation stone laying of more than 1,100 projects under the Agriculture Infrastructure Fund, Animal Husbandry, Fisheries, and Food Processing sectors by the Hon'ble Prime Minister of India, Shri Narendra Modi, at 11:00 AM on 11th October 2025. More than 100 farmers from eight nearby villages, representatives from four FPOs/FPCLs, and the scientific and technical staff of the institute attended the event.



### A celebration of Kisan Diwas 2025 by ICAR-NRCB

The ICAR–National Research Centre for Banana (NRCB), Tiruchirappalli, organized Kisan Diwas and the Banana Festival on 23 December 2025 to commemorate the birth anniversary of Chaudhary Charan Singh and to honour farmers' contributions to agriculture. The programme was attended by over 800 participants, including farmers, entrepreneurs, KVK scientists, and stakeholders. The event included panel discussions, an exhibition with more than 15 stalls, SCSP support through the distribution of

inputs and planting material to 200 beneficiaries, and the signing of a MoA with Vivekananda Trust under the Ainthinai Mission Project.



### Publications

Karpagam, C., Sankaranarayanan, K., Venugopalan, M. V., & Chinnathambi, S. 2025. Socio-economic profiling of drip irrigation technology adopters in cotton cultivation: A comparative study in three states of India. *Journal of Krishi Vigyan*, 13(3), 605–610. <https://doi.org/10.5958/2349-4433.2025.00109.2>

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Saikanth, D. R. K., Prashanth, P., Kaviraju, S., Reddy, M. J., Murugan, P. P., Meera, S. N., Uttej, D., Karpagam, C., Mooventhan, P., Kumar, V., Reddy, M. R., & Guhan, V. 2025. Advancing ecosystem recovery: Cutting-edge research in restoration science. In *Ecosystem-based approaches for resilience building in Himalayan landscapes: Insights for climate change and disaster risk reduction* (pp. 395–428). Springer Nature Singapore.

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Thangavelu, R., Loganathan, M., Saranya, R., Marimuthu, N., & Selvarajan, R. 2025. Potential use of petroleum-based mineral oil and fungicide combinations for the management of leaf spot disease caused by *Pseudocercospora eumusae* in banana. *Plant Science Today*, 12(sp3), 01–09. <https://doi.org/10.14719/pst.10241>

Yashini, M., Singh, A. K., Sheeba, K. N., Paramasivam, S. K., & Haritha, C. I. 2025. Smartphone-assisted colorimetric detection of arsenic using co-functionalized silver nanoparticles in agarose gel matrix. *Journal of the Indian Chemical Society*, Article 102089. <https://doi.org/10.1016/j.jics.2025.102089>

## 4. OTHER INFORMATIONS

### World Soil Day - 2025

ICAR–National Research Centre for Banana (ICAR–NRCB) organized the “World Soil Day 2025” on 5 December 2025 under the theme “Healthy Soil for Healthy Cities.” Approximately 60 farmers participated in the event. On this occasion, *Banana Shakti* (L), a micronutrient mixture formulated for banana cultivation, was distributed free of cost to

all participating farmers. Soil and irrigation water samples collected from the participants were analysed free of cost, and appropriate recommendations were provided based on the analytical results.



### Swachhata Pakhwada-2025

Swachhata Pakhwada 2025 was inaugurated on 16 December, 2025 at ICAR–National Research Centre for Banana (ICAR–NRCB) by the Director. A Mass Administration of the Swachhata Pledge was conducted, in which all staff members actively participated and reaffirmed their commitment towards maintaining cleanliness and hygiene in the institute and its surroundings. The Director, ICAR–NRCB, addressed the staff and delivered a Swachhata awareness message, highlighting the importance of cleanliness as a collective responsibility and its role in ensuring a healthy and sustainable work environment. The staff members were also encouraged to extend the message of Swachhata beyond the workplace by promoting cleanliness practices in their homes and neighbourhoods.



Swachhata pledge taking at ICAR–NRCB

## Vigilance Awareness Week -2025

ICAR-NRCB observed the Vigilance Awareness Week 2025 from October 27 to November 2, 2025, with the theme “Vigilance: Our Shared Responsibility” (“सतर्कता: हमारी साझा जम्मेदारी”). Led by the Central Vigilance Commission (CVC), the week focuses on promoting integrity and transparency in public service, with a three-month preventive vigilance campaign running from August 18 to November 17, 2025. On the occasion, all the staff of the centre took ‘Anti-Corruption pledge’.



## Extension & Farmers Services Corner

**தேசிய வாழை ஆராய்ச்சி மையத்தின்**  
**பனானா சக்தி**  
**ஜந்து நுண்ணூட்ட சத்துக்களின் கலவை**  
Banana Shakti (Solid and Liquid)



இந்த Banana Shakti  
1 கிலோ ரூ. 250 க்கு  
விற்கப்படுகிறது.



இந்த Banana Shakti  
1 லிட்டர் ரூ. 150 க்கு  
விற்கப்படுகிறது.

**தேசிய வாழை ஆராய்ச்சி மையத்தின்**  
**காவேரி நுண்ணாயிர் கலவை**  
Kaveri Microbial Consortium (KMC)



இந்த KMC  
கிலோ ரூ. 150 க்கு  
விற்கப்படுகிறது.

**தேசிய வாழை ஆராய்ச்சி மையத்தின்**  
**வாழை கூன் வண்டு கொல்லி**  
(NRCB-Banana Weevil Killer)  
(பீழுவேவீலா மர்ப்பாணா / *Beauveria bassiana*)









இந்த வாழை கூன் வண்டு கொல்லி  
1 லிட்டர் ரூ. 500 க்கு விற்கப்படுகிறது.



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-  <https://www.youtube.com/@icarnrcb8887>

For Location

