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*For any queries and advertisement contact:*
**Chief Editor** *CAU Farm Magazine*
Email: dee_cau@yahoo.co.in



**Layout & Design**

**Y. Premchand Singh**
Computer Operator, DEE, CAU, Imphal

**Technical Assistant**

G. Amritkumar Sharma, Kh. Saratkumar Singh, Y. Sanjoy Meitei, W. Khagemba Singh, Mrs. Narita L., O. James Singh, Th. Ningthou Singh & R.K. Sandeep

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# From the Editor's Desk

**Prof. Ph. Ranjit Sharma**
Director (Extension Education)

*In the ever-evolving world of agriculture, it is crucial that we adapt and innovate to meet the demands of a changing environment. As the Director of the Directorate of Extension Education at Central Agricultural University (CAU), Imphal, I take immense pride in witnessing the university's journey under the visionary leadership of our esteemed Vice Chancellor, Dr. Anupam Mishra. His exceptional leadership has been a catalyst in elevating CAU Imphal to the forefront of agricultural education, research and extension, making it one of the top institutions in the country today.*

*At the Directorate of Extension Education, we understand that the heart of agriculture lies in connecting knowledge with practice. Our goal has always been to bridge the gap between research and real-world application, ensuring that the latest technologies and best practices reach the farmers, enabling them to make informed decisions that improve their productivity and income. Under our Vice Chancellor's leadership, we have expanded our outreach efforts by publishing various materials aimed at disseminating knowledge and fostering a culture of learning.*

*Our publications have played a pivotal role in strengthening the connection between scholars, researchers and faculty from different campuses of CAU Imphal, as well as in facilitating knowledge sharing with farmers across Northeast India. We have been committed to providing farmers with the latest advancements in agricultural practices, encouraging the adoption of innovative techniques that lead to sustainable and profitable farming. We are continuously working to ensure that our publications address both the scientific community and farmers, helping them overcome challenges and create better agricultural practices.*

*Our ongoing initiatives have covered several critical topics that aim to address the challenges faced by farmers today. These include Natural Farming: A Way to Sustainable Crop Production; Role of Botanicals in Pest Management; Composting: A Component of Natural Farming; Climate Smart Agriculture: Adapting to Climate Change; Indigenous Knowledge: The Key to Save for a Sustainable Future; African Swine Fever: A Major Challenge to Farmers' Socio-Economic Stability; Popularization of Vanaraja in South Garo Hills and others.*

*These topics are just a glimpse into the comprehensive and relevant information that we continue to share through our publications. Our efforts to empower farmers with practical knowledge and scientific insights have made significant strides in improving agricultural practices, enhancing productivity and ensuring food security in Northeast India.*

*As we continue this journey, I would like to express my heartfelt gratitude to all our readers, farmers, scholars, and stakeholders for their continued support and engagement. Your valuable feedback and suggestions help us improve and tailor our efforts to better serve the farming community.*

*Thank you for your time and dedication to making agriculture a sustainable and prosperous sector.*

(Prof. Ph. Ranjit Sharma)
Chief Editor





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# *HAMEI*: THE MIRACLE AGENT REVOLUTIONIZING LOCAL ALCOHOLIC BEVERAGE PRODUCTION

**Ng. Taibangnganbi Chanu and Ng. Iboyaima Singh**[1]
*College of Food Technology, Lamphelpat, Imphal, Manipur*
*Central Agricultural University, Imphal - 795004*

## 1. Introduction

In the realm of alcoholic beverage production, tradition and innovation often find themselves in a delicate balance. Enter *Hamei*, a remarkable agent that is reshaping the way local alcoholic beverages are crafted, especially in regions where indigenous methods and flavors dominate. Derived from natural sources and rooted in cnturies-old practices, *Hamei* is gaining recognition for its unique role in enhancing both the efficiency and quality of brewing processes. This paper will explore its benefits, applications, and the impact it has on the industry and its potential to revolutionize beverage crafting.

## 2. What is *Hamei*?

*Hamei* is a natural and traditional starter culture used in the fermentation of various indigenous alcoholic beverages in various parts of Asia, particularly the Himalayan region. This mixed dough inoculum is typically prepared from rice (grains) combined with wild herbs, flowers, roots, and spices, depending on local customs. It acts as a catalyst to enhance the fermentation process, facilitating the transformation of sugars into alcohol through yeast and bacteria. It enhances the flavor, aroma, and overall quality of alcoholic beverages. Found prominently in the Himalayas and other parts of South and Southeast Asia, *Hamei* has been a cornerstone of traditional brewing methods for beverages like *Atingba or Yu* in Manipur and various types of local wines. *Atingba and Yu* are popular fermented rice wines of India, especially in the Manipur state. *Hamei*, a natural starter culture with a flat rice-cake form, is used, as in the fermentation of *Atingba and Yu* (Jeyaram, 2008). By utilizing local ingredients, *Hamei* promotes sustainability and supports local economies while delivering exceptional taste. In the modern context, Hamei is celebrated as an eco-friendly, sustainable alternative to synthetic fermentation agents. It aligns seamlessly with the growing global demand for artisanal and natural products, making it a key player in both small-scale local production and the emerging craft beverage industry.

The *Hamei* acts as a catalyst or starter. This *Hamei* plays an indispensable and inseparable role in the production of alcohol in Manipur. *Albizia myriophylla* is the most important species widely used in the preparation of yeast culture.

## 3. Preparation of *Hamei*:

*Hamei*, the fermented food ingredient, is prepared by mixing powdered rice and sun-dried bark of *Albizia myriophylla* (a wild creeper), locally known as *Yangli*. The preparation of *Hamei* is an art passed down through oral tradition, usually taught by elders to younger generations. This ensures that traditional recipes and methods remain alive despite modern influences. A typical traditional method for preparation of Hamei in Manipur is explained here.

Traditionally, *Hamei* is prepared from crushed raw rice mixed with powdered bark of *'Yangli'* and a pinch of previously prepared powdered *Hamei*. The dough is pressed into flat cakes and is kept over rice husk in a bamboo basket for 2–3 days at room temperature (20–30° C) and then sun-dried for 2–3 days. *Hamei* is used to prepare a rice-based beverage locally called *Atingba* and a distilled clear liquor called *Yu* in Manipur. (Jeyaram *et al.*, 2009; Tamang, 2010; Tamang *et al.*, 2010; Bhanishana *et al.*, 2012; Bhanisana, 1993).


Fig. *Hamei*, ready to use for alcohol fermentation


Fig. Different Hameis collected from different places of Manipur

Fig. Hamei Market (Mode of selling)

Moreover, the preparation of *Hamei* is a popular domestic business for the people of the schedule caste and tribes, as it is also used as an ingredient of cattle feeds. The traditional practitioners believe that the quality of *Hamei* fermentation will be responsible for the quality and quantity of ethyl alcohol.

## 4. Cultural Significance

The cultural significance of *Hamei* lies in its ability to connect past and present, tradition and innovation, and individuals and communities. *Hamei* is not just a practical fermentation agent but a cultural artifact, reflecting the deep relationship between communities and their environment. Derived from locally available resources like rice, roots, or flowers, it embodies centuries of brewing tradition, passed down through generations, symbolizing heritage, community, celebration, identity, and connection to nature. Beverages made with *Hamei* are often consumed during festivals, marriages, and religious ceremonies, symbolizing unity and prosperity.

## 5. How Does *Hamei* Work?

The Science Behind *Hamei*'s Magic

At its core, *Hamei* is a natural fermentation starter made from grains, roots, or flowers. Its unique composition includes:

- Yeast and Lactic Acid Bacteria: These microorganisms are essential for breaking down sugars into alcohol, producing beverages with rich, complex flavors.
- Natural Enzymes: These enhance the fermentation process, improving efficiency and alcohol yield.

This combination ensures that *Hamei* not only initiates fermentation but also enhances the taste, aroma, and quality of the final product. The use of Hamei brings numerous advantages, including improved fermentation rates and enhanced flavor profiles.

The primary role of *Hamei* is to introduce a rich microbiome of yeast and beneficial microorganisms, particularly lactic acid bacteria (LAB), into the brewing mixture, which are essential for fermenting starches into alcohol. Studies have identified LAB strains such as *Pediococcus pentosaceus*, *Lactobacillus plantarum*, and *Lactobacillus brevis* in *Hamei,* contributing to its effectiveness as a starter culture. *Albizia myriophylla* is the most important species widely used in the preparation of yeast culture. This microbiome:

1. ***Kickstarts Fermentation***: Initiates and accelerates the alcohol production process.
2. ***Enhances Flavor***: Adds unique, complex notes to the final beverage, often tailored to regional tastes.
3. ***Preserves the Product:*** The lactic acid bacteria inhibit harmful microorganisms, extending the shelf life of the beverage.
4. ***Health benefits***

### 5.1. Kickstarts Fermentation

The fermentation process using *Hamei* is complex and fascinating. It involves the conversion of sugars into alcohol and carbon dioxide, facilitated by yeast.

*Hamei* ensures a robust and efficient fermentation process:

- *Quick Start:* Activates fermentation quickly, reducing production time.
- *High Alcohol Yield:* Promotes effective sugar-to-alcohol conversion.
- *Consistency:* Provides a stable and reliable fermentation process when properly managed.

*Hamei* enhances this process, resulting in a distinctive flavor profile that is cherished in local brews. Incorporating *Hamei* into the fermentation process has been shown to increase alcohol yields. For instance, when Hamei is added to rice-based fermentations, alcohol production can reach up to 81 ml, compared to 48 ml without it. This enhancement is attributed to the synergistic action of the microorganisms present in Hamei, which optimize the fermentation environment.

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### 5.2. Flavor Enhancement

One of the remarkable benefits of *Hamei* is its ability to enhance flavors. The natural compounds in *Hamei* contribute to a rich, complex taste that elevates the drinking experience, making local alcoholic beverages more appealing to consumers. Beyond its role in alcohol production, *Hamei* contributes to the development of unique flavors and textures in traditional beverages, reflecting the rich cultural heritage of the regions where it is used. Its application exemplifies the innovative use of indigenous knowledge in modern fermentation practices. It allows producers to create unique beverages that reflect local terroir, fostering a deeper connection between consumers and the products they enjoy. It can be concluded that LAB present in *Hamei* play a role in imparting flavor, antagonism, and acidification of the substrates (Tamang *et al.*, 2007).

### 5.3. Health Benefits

*Hamei* is not only a flavor enhancer but also offers several health benefits. It contains essential nutrients and antioxidants that can promote overall well-being. Understanding these benefits can encourage more people to appreciate local alcoholic drinks made with *Hamei*. The lactic acid bacteria in *Hamei* contribute to (a) product preservation: inhibiting harmful microorganisms, extending shelf life naturally, and (b) probiotic potential: introducing beneficial microbes, adding potential health benefits to beverages. As global consumers become more health-conscious, *Hamei's* potential probiotic properties are being explored:

- Gut Health: Products fermented with *Hamei* may offer benefits similar to other probiotic-rich foods.
- Functional Beverages: Its use in creating low-alcohol or non-alcoholic drinks with health benefits is being studied.
- Researchers are isolating and studying microbes from *Hamei*, leading to innovations in probiotics, functional foods, and alcoholic beverages.

## 6. The Revolution in Local Brewing

While traditional methods have their charm, *Hamei* integrates modern science to optimize production. The incorporation of *Hamei* into modern brewing practices is revolutionary for several reasons:

1. Boosts Accessibility: For small-scale producers, *Hamei* offers an affordable and readily available alternative to commercial fermentation agents.
2. Sustains Tradition: By leveraging a time-honoured ingredient, communities preserve their cultural heritage while modernizing production techniques.
3. Improves Sustainability: *Hamei* production is often eco-friendly, relying on natural fermentation and local resources.
4. Expands Market Potential: Beverages made with *Hamei* have distinct, authentic flavors that appeal to niche markets seeking craft and artisanal products.
5. Filling the gaps: It bridges the gap between age-old traditions (heritage) and innovative brewing techniques, ensuring that local producers can compete in a global market while maintaining authenticity.

The integration of modern techniques with traditional methods is reshaping the production of alcoholic drinks. Innovations in fermentation and flavoring using *Hamei* can lead to new products that appeal to a broader audience while maintaining cultural authenticity.

## 7. *Hamei* in Local Communities and Economic impact

*Hamei* plays a pivotal role in the social, economic, and cultural fabric of the communities that use it. Rooted in tradition and closely tied to daily life, its significance extends beyond brewing, influencing community dynamics, livelihoods, and heritage preservation. *Hamei* fosters community engagement by supporting local farmers and suppliers. This creates a network of collaboration that strengthens local economies and encourages sustainable practices in the production of alcoholic beverages.

Numerous local breweries have successfully integrated *Hamei* into their production processes, resulting in award-winning beverages. These case studies showcase the versatility and potential of *Hamei* to elevate local brands on a national and international stage. The process of making *Hamei* and the beverages it produces often brings communities together.

The production and use of *Hamei* contribute to the economic resilience of small-scale brewers:

- *Income Generation:* Local families sell *Hamei* and beverages made with it, supporting livelihoods.
- *Tourism Opportunities:* Regions known for their traditional brewing practices attract visitors, boosting local economies. Villages showcasing





their traditional brewing techniques attract culinary and cultural tourists, boosting income.

- *Women's Role:* Women, as the primary keepers of this knowledge, gain autonomy and respect within their communities.

### 7.1. Economic Impact to the villagers who are in the *Hamei* based beverage industries (A case study):

In fact, along with agriculture, it is the main source of income for the people of the village *(Awang Sekmai, Imphal East, Manipur)*. Almost every household of *Sekmai* produces it or is engaged in the alcoholic rice beverage business in one way or the other. In short, the economy of the village largely centers around the production of it. For the individual family, it is not only a major source of family income but also an enterprise that helps them to take up other important and related income-generating enterprises. For instance, most of the households in *Sekmai* are also engaged in piggery, and it is very successful there. The leftovers found in the alcohol making are very good for feeding the pigs. As the people engage themselves in alcoholic rice beverage preparation throughout the year, there is no dearth of food for the pigs. As a result, piggery is also an ever-flourishing economic enterprise in the village. And the income so generated supplements the family income very well. This further brings another benefit to the people. The manure of the pigs is properly collected and used for producing biogas, which is a great money saver. Many families in the village successfully use the biogas generated from pig manure for cooking and other purposes. Thus, the alcoholic rice beverage distillation is not only a major source of income for the people of *Sekmai*, but it also supports other economic enterprises.

## 8. Challenges and Future Potential

While *Hamei* offers many advantages, its use is not without challenges. The adoption of *Hamei* faces challenges such as education, resource availability, and market acceptance. Addressing these obstacles is crucial for maximizing its impact on local beverage production and ensuring widespread use. Despite its benefits, *Hamei* faces challenges in the modern era:

- *Standardization vs. Tradition:* Industrialization pressures communities to standardize production, risking the loss of traditional methods. Standardizing fermentation processes and maintaining consistent quality can be tricky due to variability in microbial content. However, research into microbial composition and controlled cultivation of *Hamei* is paving the way for its broader adoption in the beverage industry.
- *Access to Markets:* Small-scale producers struggle to compete with industrially produced beverages.
- *Knowledge Erosion:* Younger generations may show declining interest in traditional practices, risking the loss of ancestral knowledge. They may opt for modern fermentation agents, leading to a decline in traditional *Hamei.*

To address these challenges, initiatives promoting cultural preservation, education, and sustainable practices are crucial. Efforts to document and share the art of *Hamei* preparation can help ensure its survival for future generations.

The future of *Hamei* looks promising as more producers recognize its potential. Ongoing research and development will further enhance its applications, paving the way for innovative beverages that cater to evolving consumer tastes and preferences. As consumers become more conscious of their choices, the demand for local and sustainable products rises. *Hamei* aligns perfectly with these trends, offering a unique selling point for local breweries aiming to attract eco-conscious customers. As interest in craft and local brews continues to grow, *Hamei* stands as a shining example of how traditional practices can lead to innovative solutions. This miracle agent is not just enhancing the production of alcoholic beverages; it's reviving and celebrating the cultural identities tied to them.

Research institutions and beverage companies are exploring *Hamei* to blend tradition with cutting-edge science: Microbial Studies: Analysing *Hamei*'s microbial composition to optimize its use in controlled brewing environments. Standardization: Developing standardized processes to adapt *Hamei* for industrial-scale brewing without losing its traditional essence.

## 9. Sustainability Practices

Emphasizing sustainability in *Hamei* production is crucial for the future. Sustainable practices not only preserve the environment but also ensure the longevity of traditional brewing methods, allowing future generations to enjoy these unique beverages. With the push toward environmentally friendly production, *Hamei* offers a sustainable alternative to synthetic fermentation starters:

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- Eco-Friendly Brewing: It supports the use of natural, local resources, reducing dependency on industrial additives.
- Biodegradable and Renewable: Its production and usage leave minimal environmental impact, aligning with global sustainability goals.

### 10. Global Impact

The global impact of *Hamei* demonstrates how an age-old tradition can inspire innovative and sustainable solutions in modern industries. Its journey from local villages to global markets underscores the value of preserving and sharing traditional knowledge. While *Hamei* has traditionally been rooted in local and indigenous brewing practices, its unique properties are gaining recognition worldwide. As industries and enthusiasts explore natural and sustainable fermentation methods, *Hamei* is making a global impact, bridging the gap between traditional knowledge and modern innovation. The influence of *Hamei* extends beyond local borders. As interest in craft beverages grows worldwide, *Hamei's* unique characteristics can attract global markets, promoting cultural exchange and appreciation for traditional brewing methods.

### 11. Conclusion: The *Hamei* Revolution

In conclusion, *Hamei* serves as a miracle agent in local alcoholic drink production, enriching flavors and enhancing cultural significance. It is not just a fermentation agent; it is a revolutionary force in the local alcoholic beverage industry. By embracing *Hamei*, producers can enhance their offerings, support local economies, and contribute to a more sustainable future by unlocking new opportunities for innovation while honouring tradition, ultimately benefiting both producers and consumers.

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# NATURAL FARMING: A WAY TO SUSTAINABLE CROP PRODUCTION

**Sanjarambam Nirupama Chanu[1*], Kalpana Gairola[2], Angam Raleng[3] and Hijam Jiten Singh[4]**

*[1]CAU-KVK, East Garo Hills, Megagre, Meghalaya*
*[2]School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun, India*
*[3]College of Agricultural Engineering and PHT, Ranipool, Gangtok, East Sikkim*
*[4]Agricultural Engineering Section, ICAR-Research Complex for NEH Region, Umiam-793103, Meghalaya*

Conventional agriculture system in present days has become a highly energy/resource consuming system in order to meet the demand of ever increasing population causing threat to our environment within creased greenhouse gas emissions, soil erosion, water pollution and also to our human health. Moreover, mono culture of crops such as rice, maize, wheat, cotton, etc. repeated on the same land reduced the soil viability, decreased soil microbial diversity, ground out water purity and depletion of topsoil and crop plants amenable to pest and pathogens attack. Conventional farming practices not only reduce production but farmers also undergo debt and several other food security and environmental concerns. The only way to reduce the issues arising from conventional farming practices is to adopt Natural Farming (NF) in the agricultural system to make the farmers economically viable. Natural farming refers to using indigenous farming practices such as crop rotation, inter-cropping, mixed cropping and low-cost naturally available input resources such as cow urine, cow dung and plant-based products. This farming practice excludes the use of externally purchased inputs such as synthetic fertilizers, chemicals, pesticides, or organic fertilizers. In recent years, NF has been adopted by farmers of various states such as Andhra Pradesh, Himachal Pradesh, Chhattisgarh, Kerala, Odisha, Tamil Nadu and Madhya Pradesh. Natural farming (NF) aims to reduce the use of chemicals in farming, protect the soil and environment and improve the economic benefits of farming.

### Natural farming vs. Organic farming vs. conventional farming

The primary difference between natural, organic and conventional farming is based on the input used. Natural farming uses indigenous chemical-free natural inputs such as cow urine, cow dung, jeevamrit, beejaamrit, ghanjeevaamrit, etc. Organic farming uses chemical-free FYM, vermicompost, and panchgavya while conventional farming uses chemical-based

fertilizers and FYM. Organic farming makes use of off-farm resources, organic inputs such as vermicompost, compost and bio formulation as well as plant-based products while natural farming makes use of on-farm nutrient-based resources inputs and traditional seeds. On the other hand, conventional farming makes use of chemical fertilizers, pesticides, herbicides, hybrid and improved cultivars.

## Models of NF

There are many working models of natural farming all over the world, the Zero Budget Natural Farming (ZBNF) is the most popular model in India. This comprehensive, natural and spiritual farming system was developed by Padma Shri Subhash Palekar.

The four main components of NF are beejamrit, mulching, whapasa, and jeevamrit.


Figure1: Component of NF(Source: NITI Aayog)

## Beejamrit

It is a treatment used in seeds, seedlings, and any other planting materials. Seed treatment with indigenous cow urine and dung is effective in protecting the seed and seedlings from fungus, soil and seed-borne diseases as well as promoting healthy seed germination and plant growth.

## Preparation of Beejamrit

Mix cow dung, cow urine, lime and soil. Cow dung is tied in a cloth and kept in urine for 12 hours. The cow dung is removed and squeezed 2 to 3 times and added urine with 50 grams of lime.

## Application of Beejamrit

Beejamrit is added to the seed of any crop, coated, mixed by hand and dried. For leguminous crops dip quickly and let them dry.

## Mulching

Mulching is the process of covering the topsoil with organic materials. Three types of mulching have been reported in NF.

## Soil mulch

Soil mulch protects topsoil during cultivation and tilling operations over the soil. Soil mulch promotes aeration and water retention in the soil. It reduces soil evaporation loss, enriches soil nutrient status, and controls weed growth.

## Straw mulch

Dry organic material decomposes and forms humus through the activity of soil bio-ta and microbial culture.

## Live mulch

Multiple cropping patterns of monocotyledons and dicotyledons in the same field supply nutrients to the soil and crops. Dicots such as pulses are nitrogen-fixing plants and monocots such as wheat and rice supply potash, phosphate, and sulphur.

## Whapasa

It is a conditionwhere both air and water molecules are present in the soil. This reduces the irrigation requirement of plants. Irrigating crops at once, in alternate furrows is sufficient to fulfill the water requirement of the crop.

## Jeevamrit

Jeevamrit is a mixture of fermented microbial cultures. It provides nutrients to the plants as well as acts as a catalyst to promote the activity of microorganisms in the soil and improves the number of native earthworms. It also increases the soil carbon content and improves the physical properties of the soil and the ability of the plants to resist the attack of soil-borne pathogens.

## Preparation of jeevamrit

Put 200 litres of water in a barrel and add 10 kg of cow dung, add 5 to 10 kg of aged urine, 2 kg of jaggery, 2 kg of pulses flour, and a handful of soil from the bund of soil farm (Kumaret. al, 2020). Stir the solution and let it ferment for 48 hours in the shade. The solid form of the jeevamrit is known as ghanjeevamrit and it is prepared in the same way with a low quantity of water and stored for about 8 months.

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### Application of jeevamrit

200 litres of jeevamrit is sufficient for 1 acre of land. Jeevamrit should be applied on the crop twice a month in the irrigation water or 10 % foliar spray (Kumaret. al, 2020). Preparation can be stored up to a maximum of 15 days in the field. Jeevamrit is applied on individual plants for horticultural crops.

### Soil and water conservation method in natural farming

Vegetative measures of soil and water conservationmeasures are very useful methods to conserve soil as well as water and applicable in the areas where land slope is ≤2 %. These measures help

Contour farming

in reducing the impact of raindrops through the soil coversthereby increasing the soil infiltration rate and water absorption capacity with less runoff and soil erosion. Some of soil and water conservation method under natural farming are mentioned as follows.

### Contour farming

Contour farming is the practice of tillage, planting and other farming operations performed on or near the contour of the field slope performed mostly in sloppy hilly areas. It is mostly effective for reducing soil erosion on uniform slopes that range between 2% and 8%. The ridges and furrows formed across the slope build a continual series of small barriers to the flowing water which reduces the velocity of runoff and thus reduces soil erosion and nutrient loss. It conserves soil moisture in low rainfall areas due to increased time of concentration formore infiltration, whereas in high rainfall areas, it reduces the soil loss.

### Mulching

It is the practice of covering the top soil to create more favorable soil and water environment for better plant

Mulching

growth and efficient crop production with the used of plant material such as straw,leaves, bark, grass, twigs, wood chips, crop residues, saw dust etc. In case of natural farming, mulching is preferably practice with the use of organic and biodegradable plant materials. It give multiple benefits such as mulch act as insulating layer to the top soil making a cooler environment, reduce weed growth, decomposition of mulch material improves the nutrient in soil and also increase the water holding capacity of soil, reduce the rainfall impact on soil and prevents soil erosion.

### Strip cropping

It is the farming method that involves growing alternate strips of erosion permitting and erosion resistant crops with a deep root system and high canopy density within a same field. This practice reduces the runoff velocity and checks erosion processes and nutrient loss from the field there by maintaining soil fertility.

Strip cropping

### Minimum tillage

It is a conservation tillage practice that involves reduced or shallow ploughing of the top layer of soil by mixing with crop residues. Minimal tillage has many benefits in natural farming suchas improving soil health, reduce erosion, and increase soil organic matter content, increase soil water storage and promote crop root

Minimum tillage

development, maintain soil structure and reduce runoff, weed control, the use of previous crop residue as living compost crop, reduces work time and mechanization costs, preserves the nitrogen in the soil. Minimum tillage is well suited to compacted soil like heavy clay soils, and can also be beneficial for light sandy soils to reduce water runoff.

## Adoption of Drip irrigation system

Adoption of advance irrigation system like drip system in natural farming can be beneficial in many ways. This system precisely deliver water to the crop's root zone drop by drop instead of flooding the whole area as in case of surface irrigation system thereby saving significant amount of water which is crucial in regions with limited water resources, reducesevaporation, runoff, soil erosion, higher yield, can save farmers time and energy.

Drip irrigation system

## Intercropping and Crop rotation

Inter-cropping is the cultivation of different crops on the same land to better utilize resources such as land, solar light, water, nutrients, etc. Inter-cropping helps in reduction of soil erosion, checking of evaporation rate, and enrichment of soil physical properties


Intercropping and Crop rotation

and nutrient level, water holding capacity, porosity, etc. Diversification of cropping patterns is another important practice followed by NF to break its habitat and result in better growth of the plants and reduction in pests and diseases. Moreover, intercropping increases the farmer's income and provides subsistence in the case of failure of the main crop. Planting of different crop species in a specific order, instead of planting the same crop repeatedly on the same plot offarmlandis called crop rotation and it helps in improving the soil structure, less soil erosion and combat pest and weed infestation, increases soil microbial activity and thus increase soil fertility. The inclusion of legume crops in crop rotation isimportant for conserving soil and water and also helps in supplementing atmospheric nitrogen to the soil.

## Pest management in NF

Use of biopesticides such as neemastra, agniastra, bramhastra, etc. made from organic or bio or natural products are permitted in ZBNF to effectively control soil-borne, seed and air-borne diseases as well as the insect pests such as aphid, thrips, jassids, whiteflies etc.

## Neemastra

Neemastra is prepared by adding 5 l of cow urine, 5 kg of cow dung, 5 kg of neem leaves, and 5 kg of neem pulps and keeping it airtight for 24 hours for fermentation.

## Agniastra



Agniastra is prepared by mixing 10 l of cow urine, 1 kg of tobacco leaves, 500 g of green chili, 500 gm of local garlic, and neem leaves pulps crushed in 5 l cow urine and stored in a cool place.

### Brahmstra

Bramhastra is prepared by collecting leaves of different plants such as neem, custard apple, guava, pomegranate, papaya, white datura, and lantern camelia crushed and boiled in urine and filtered.

### Bunds and contour

Bunds and contours are formed in ZBNF to reduce soil erosion, and land erosion and to conserve the soil for crop production.

### Earthworm species

According to Palekar, soil has its own earthworm species in the deeper zones which is sufficient to enhance the fertility level of the soil. The exotic earthworm species Eisenia foitidais dangerous as it absorbs toxic metals and contaminants in the groundwater (Mishra, 2018).

### Cow dung

Faeces of Indian cows are sufficient for crop cultivation in ZBNF as Indian species contain more beneficial microorganisms (3 to 5 cores) than the foreign breed. Hence, ZBNF suggests not mixing foreign breeds and asks farmers to use urine and dung of locally available cows.

### Benefits of NF

1. Improve yield of the farm similar to conventional farming.
2. Offers the food of highest nutrient quality hence ensuring better health benefits.
3. Ensures better soil biology, agro ecology, and judicious use of natural resources.
4. Increases farmers'income by cost reduction, inter-cropping and reduces risks.
5. Generate employment on account of input enterprises, marketing to local areas, value addition, etc.
6. Minimizes cost of production by using on-farm resources, biological inputs and local resources.
7. Reduce water consumption by adopting diverse crops to help each other and protect the soil from unnecessary water evaporation.
8. Rejuvenate soil health using soil microflora and fauna.
9. Livestock sustainability by integrating livestock in farming and restoring the ecosystem.
10. Reduces dependency of many farmers on credit and from exploitative input credit and linked credit markets.
11. Flexible than any other farming practices.
12. Reduces India's fertilizers subsidy bill.
13. Offers the sage at an affordable price.
14. Help in combating climate change by higher carbon fixation in the soil.
15. Reduces ocean acidification and marine to river pollution.

### NF in India

In India, many states have adopted natural farming as a way of crop production such as Andhra Pradesh, Karnataka, Tamil Nadu, Odisha, Himachal Pradesh, Chattisgarh, etc. In Karnataka, NF has been adopted through a grassroots social movement, spearheaded in 2002 by the Karnataka Rajya Raitha Sangha (Khadse et al.,2017). Khadse et al. (2017) reported that around 1 lakh farmers have already shifted from conventional farming to NF and also observed NF met all the purposes of farmers of Karnataka regarding health improvement (100 %), income improvement (85.7%), household and quality of products (91.1%), selling price (57.9%), pest and mitigation (84.1%) and debt issue (92.5%). On the other hand, in Andhra Pradesh NF started in 2015 and made NF a central pillar for state agricultural and rural development policy. In 2018 Govt. of Andhra Pradesh announced the shift state's agriculture system to zero-budget natural farming (ZBNF) by 2022 (Saldanha,2018). Govt. of Andhra Pradesh installed a non-profit organization Rythu to spread ZBNF in Andhra Pradesh and collaborated with national and international organizations to make ZBNF a successful model. By the end of 2017-18, 16300 farmers from 972 villages had adopted NF and the action plan was to cover 5,00,00 farmers in 2018-19 and 6 million farmers in 2024 and cultivate an area of 8 million hectares by the end of 2026 (Saldanha,2018). Consequently, the farmers in Andhra Pradesh had observed a declining rate in the cost of cultivation, increment in yield, improved food and nutritional





securities, reduction in inequality in economic positions of small farmers, single women farmers, tribal farmers, and landless farmers, etc. increased in net income of farmers adopting ZBNF in rice, rain-fed groundnut, and cotton. Increased in rice and groundnut yields by 9 % and 36 %, respectively in ZBNF fields of Anantapur, Andhra Pradesh (Tripathi et al.,2108). Exudation of chemicals in farming can improve the health condition of the farmer community. In Andhra Pradesh NF was also successful in achieving the gender equality goal by providing direct participation of women and their self-help groups in training, camps, agriculture workers, direction, monitoring of farming, and even entrepreneurship(Tripathi et al.,2108). Several initiatives have been taken by govt. such as group-based rent for machinery, non-pesticide shops for selling biopesticides, cow dung formulation, seed banks at villages, etc. to run ZBNF at an accelerated rate (Saldanha,2018).In Maharashtra, ZBNF training encouraged the transition of 10,000 farmers from conventional farming to a natural way of farming. In Maharashtra, farmers cut down 45 to 50 % cost of cultivation, improved soil health, increased productivity, and got high profits by selling their produce without and interference of middle men.

## Conclusion

NF is the best alternative to reduce the dependency of Indian farmers on chemicals for crop cultivation. Moreover, pesticides cause serious damage to the environment, soil, and human health.NF not only increases crop production but is also a sustainable way of farming worldwide. NF is the way of farming to protect the soil biodiversity, soil health, and environment, yet to increase crop production and the overall economics based on law cost inputs, and cost of cultivation.

## Future prospects

Natural farming is the only way to reduce the harmful effects of chemicals and pesticides used in conventional farming.NF improves the soil health and microbial consortium in the soil in order to benefit crop growth and food production. Nowadays, many states viz., Andhra Pradesh, Kerala, Tamil Nadu, Himachal Pradesh, and Odisha are in support of the NF concept.ICAR is also in support of research ongoing in NF to evaluate the practices' impact on soil health, productivity, and economics. NITI ayog is also supporting the NF concept nationwide. Thus, NF is the best way of farming and prominent strategy to make the country self-sufficient in food production and a way forward to regenerative agricultureto save the planet Earth for future generations.

# EIGHT ROW DRUM SEEDER IN PADDY CULTIVATION- A SIGNIFICANT ERA FOR PADDY GROWERS

**Gunajit Oinam, Nandini chongtham, Hemam Ramananda Singh, M.A. Salam and Jotish Nongthombam***
*Krishi Vigyan Kendra, Central Agricultural University, Imphal*
**KVK Aizawl, Central Agricultural University, Imphal*

Imphal East District is one of the 16 districts of Manipur state in North-Eastern India. The total area of the Imphal East district is 709 Sq Km where rice is the main crop. Annual rainfall average of Manipur is 1474.3 mm, 90% of which fall during the period of June to October. Erratic monsoon behaviour also affects the grain production, especially in rainfed area and the rainfall over last five years was highly fluctuating (Table no.1)

The district has a cultivable area of 42.37('000ha), out of which 33.4('000ha) area is under paddy under which around 70% of the total area is sown by broadcasting method and the rest by transplanting and to some extent by SRI method. Transplanting and SRI methods are labour intensive and the availability of labour during the peak season is limited and very costly.

To overcome this problem Krishi Vigyan Kendra,Imphal East introduced the "Eight row drum seeder" for direct sowing of paddy in line. The farmers show great interest in adopting direct paddy seeding technology due to shortage of labour during peak season. Initially the Eight row drum seeder was demonstrated at Andro and Uchol after that extended to Lamlai, Pukhao, Khongman, Nungbrang and Nongpok Keithelmanbi of Imphal East District. The direct sown paddy drum seeder has attracted a lot of farmers in nearby villages as the equipment is lighter in weight,

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portable ,easy to transport and easy to handle/operation. Moreover, it maintains proper spacing between row to row in line, reducing the seed rate and thinning cost. Apart from saving in transplanting cost, the line sowing of paddy allow the farmers to utilise cono weeder for weeding and ease movement of manual weeding also. Line sowing also increase efficiency of other operations such as fertilizer application, spraying of insecticides/ pesticides etc. Based upon the success, farmers from nearby villages purchase their own Eight row drum seeder for their use with the help of KVK,Imphal East as it is also cheap, affordableand economically viable.

Table 1. Distribution of rainfall in comparison with normal in last 5years (2019-23)

| Rainfall summary for month | Actual rainfall (mm) for last 5years | | | | | Normal (mm) Based on last 65 years | Deviation (%) (Actual - Normal) x 100 Normal | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2021 | 2022 | 2023 | | 2019 | 2020 | 2021 | 2022 | 2023 |
| Jan | 3.4 | 65.8 | 6.6 | 30.4 | 0.0 | 12.8 | -73.44 | 414.0 | -48.44 | 137.5 | -100 |
| Feb | 20.3 | 13.3 | 7.5 | 47.9 | 0.0 | 39.3 | -48.35 | -66.1 | -80.92 | 21.88 | -100 |
| Mar | 36.0 | 12.1 | 55.6 | 57 | 36.6 | 76.1 | -52.69 | -84.0 | -26.94 | -25.0 | -51.9 |
| Apr | 77.6 | 102.8 | 54.8 | 141 | 67.8 | 123.3 | -37.06 | -16.6 | -55.56 | 14.36 | -45.0 |
| May | 87.1 | 148.6 | 118.7 | 382.9 | 77.5 | 173 | -49.65 | -14.1 | -31 | 121.3 | -5.52 |
| June | 181.4 | 307.4 | 228.5 | 286.2 | 173.2 | 261 | -30.49 | 17.78 | -12.45 | 9.66 | -33.6 |
| July | 202.6 | 270.8 | 220.1 | 148.4 | 256.2 | 240.7 | -15.83 | 12.51 | -8.56 | -38.3 | 6.44 |
| Aug | 62.9 | 205.7 | 248 | 94.8 | 166.0 | 197.6 | -68.19 | 4.09 | 25.51 | -52.2 | -15.9 |
| Sep | 253.7 | 229.9 | 208.9 | 98.6 | 150.3 | 152 | 66.91 | 51.25 | 37.43 | 35.13 | -1.12 |
| Oct | 159.8 | 165.8 | 77.7 | 146.3 | 41.7 | 125 | 27.84 | 32.64 | -37.84 | 17.04 | -66.6 |
| Nov | 38.7 | 104.9 | 2.0 | 5.4 | 63.9 | 35.6 | 8.71 | 194.6 | -94.38 | -84.8 | 79.49 |
| Dec | 13.6 | 0.0 | 70.9 | 18.8 | 47.3 | 14.8 | -8.11 | -100 | 379.05 | 27.02 | 219.5 |

**Source:** *ICAR, Imphal, Manipur Centre*

## TECHNOLOGY

Eight row drum seeder technology was introduced since 2017 which is a new intervention to Imphal East, District for direct sowing of pre-germinated paddy seed in wet land field.It involves direct seeding of pre-germinated paddy seeds using drums made up of fibre materials to dispense seeds evenly in lines space at 20cm apart in puddle and levelled fields. About 40kg paddy seed/ha is soaked overnight in water and allowed to sprout. Care should be taken not to delay sowing as seeds with long shoot growth are not suitable for drum seeding. The sprouted seed is air-dried in shade for 30min prior to sowing for easy dispensing through the holes in the drum seeder. Excess water in puddle field is drained out ensuring the soil surface is moist. Drum are filled with sprouted seed (3/4th full) and pulled across the field maintaining a steady speed for evenly sowing. There are 4 numbers of drum with 8 numbers of lines in one pass. Irrigation water should not be applied for 2-3 days after sowing to allow rooting and anchoring to soil. However, heavy rainfall immediately after sowing is likely to wash away the newly sown seeds. As the seedlings grow, water level in the field can rise for better weed control. Intermittent irrigation is given till the panicle initiation stage. Where weed problem is severe, herbicide is applied within 1-2 days after seeding. Line sowing permits operation of modified cono weeder between the rows in the same direction adopted for drum seeding. Drum seeding in one hectare area can be completed within 5 to 6 hours by three persons compared to transplanting operation which requires about 30 to 40 mandays. This technique can help in saving seeds,water,labour requirement apart from improving productivity because of line sowing(Spacing of 20cm between rows) and early maturity of crop (by 7-10 days).

Drum seeding reduce the cost of cultivation as it doesnot require raising paddy nursery and transplanting thereafter.Initially Eight row drum

seeder was demonstrated with short duration varieties (CAU-R3) at 0.25ha during the year 2018-19 at Andro and Uchol. Cost of cultivation was reduced by Rs10,235/- per ha compared to the sowing method. More Farmers in the village came forward to take up Eight row drum seederand extended to other village in Top Chingtha, Lamlai, Pukhao, Khongman and Nongpok Keithelmanbi of Imphal East District and covered upto 110 ha till now.

## SOURCE OF TECHNOLOGY AND SPECIFICATION OF THE MACHINE

This type of Eight row drum seeder was developed by TNAU, Coimbatore, Tamil Nadu. It is Hyperboloid shaped seed drum with 200mm diameter, 8 numbers of seed metering holes of 9mm hole diameter.Baffles are provided inside the seed drum between seed holes resulting in uniformity of seed rate throughout the operation.These baffles also ensure hill dropping of seeds.Each seed drum has two rows of planting.Four such drum can be assembled to form 8rows of seed drum as shown in the picture.Wheels are provided at both ends. These wheels are made up of plastic material to provide floating characteristics. Wheel diameter is 2feet. These square shaft to be joined to make a single axle and the four seed drums are assembled together with the square shaft. The lower, middle and upper handle are joined together using the handle joiner which is meant to pull along.

| Power Source | Hand operated |
|---|---|
| Shape of the seed drum | Hyperboloid |
| Row to row spacing | 200mm |
| Number of rows | 8 rows |
| Diameter of the drum | 200mm |
| Diameter of the seed metering hole | 9mm |
| Number of seed metering hole | 8 Nos |
| Weight of the unit | 10kg |
| Type of ground wheel | Lugged wheel |
| Diameter of the ground wheel | 600mm |
| Operating speed | 1km per hr (walking speed) |
| Level of filling the seed drum | Half |
| Volume Weight of seed drum | 600grams |
| Material used | PP CP |
| Seed consumption | 25kg per hectare |
| Field Coverage | 1 hectare per day |
| Seed preparation | 24hrs soaking in water and 12hrs incubation |

## FIELD PREPARATION

- Field must be well puddle and levelled.
- Water must be drained out atleast 24hrs before sowing to form hard slurry pan of puddle soil.
- At the time of sowing, only paper thin of water should be maintained in the puddle field.
- Water should be flooded to the puddle field once in three days after sowing and drained out immediately.
- This practice must be continued for 12 days. Thereafter, depending upon the height of the seedling, water should be allowed to stand in the field.

## OPERATION PROCEDURE

- After assembling, fill the drum with pre-germinated seeds. Only two-third of the drums are to be filled at a time.
- Close the mouth with the knob provided.
- Pull the seeder manually at a normal walking

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speed (1km/h) in the backward position as in the picture.

- The wheel impression in the first pass will serve as a marker.
- In the second pass the wheel should pass on the same wheel impression of the previous pass to maintain the row-to-row spacing of 20cm.
- Occasionally watch the dropping of the seeds through the holes of the seeder.
- Refill the drums when it reaches one fourth capacity.
- Continue the seeding operation

## WEEDING

- Weeding can be done by cono weeder
- First weeding must be done after 10 days of sowing
- Second weeding must be done after 20 days of sowing
- And third weeding must be done after 30 days of sowing

## SALIENT FEATURES

- Labour cost is reduced drastically.
- Uniformity in seed sowing and plant population.
- Continuous drilling of seeds is eliminated.
- Reduction in seed rate and thinning cost.
- Weeding can be done by cono weeder.
- Crop matures 7-10 days earlier than transplanted paddy.
- Light in weight and easy to handle.
- An area of 1hectare can be sown in a day.
- Increasing Benefit cost ratio.

Crop Condition at Nungbrang, Imphal East

Crop Condition at Top Chingtha, Imphal East

Crop Condition at Uchol,
Imphal East





## ECONOMIC ANALYSIS

### 1.Cost of cultivation (Rs/ha)

| Sl. No. | Particulars | Transplanting Method | Direct Sowing | Paddy Drum Seeder |
|---|---|---|---|---|
| **Nursery** | | | | |
| 1. | Land Preparation | 1200 | - | - |
| 2. | Seed Cost | 2100 | 2800 | 980 |
| 3. | Fertilizer | 330 | - | - |
| 4. | Sowing | 500 | - | - |
| 5. | Plant protection | 570 | - | 285 |
| **Main field** | | | | |
| 1. | Land Preparation | 15200 | 15200 | 15200 |
| 2. | Fertilizer | 6330 | 6330 | 6330 |
| 3. | Uprooting of seedlings | 8000 | - | - |
| 4. | Transplanting/Seeding | 16000 | 2000 | 4800 |
| 5. | Weeding | 16000 | 18000 | 8000 |
| 6. | Plant protection measures | 2800 | 3000 | 1500 |
| 7. | Reaping/harvesting | 8000 | 8000 | 8000 |
| 8. | Threshing and winnowing | 14000 | 14000 | 14000 |
| **TOTAL** | **91030** | **69330** | **59095** | |

### 2) Yield and B:C ratio

| Sl. No. | Particulars | Direct sowing | Paddy drum seeder |
|---|---|---|---|
| 1. | No. of effectivetillers per plant | 7 | 12 |
| 2. | Grain yield/ ha | 4.1 ton /ha | 4.6 ton/ha |
| 3. | Benefit Cost Ratio | 1.3 | 1.8 |

## CONCLUSION

Increasing production and productivity from the limited land area with reduced cost of cultivation is a dream of every farmer which can be achieved through farm mechanization only. Eight row paddy drum seeder is a quick and easy method of direct and timely sowing of paddy by maintaining appropriate row to row spacing which facilitates the use of intercultural operation implements (Cono weeder, Japanese paddy weeder etc.). Such technology that reduce time and labour consumption should be popularised in other district also.

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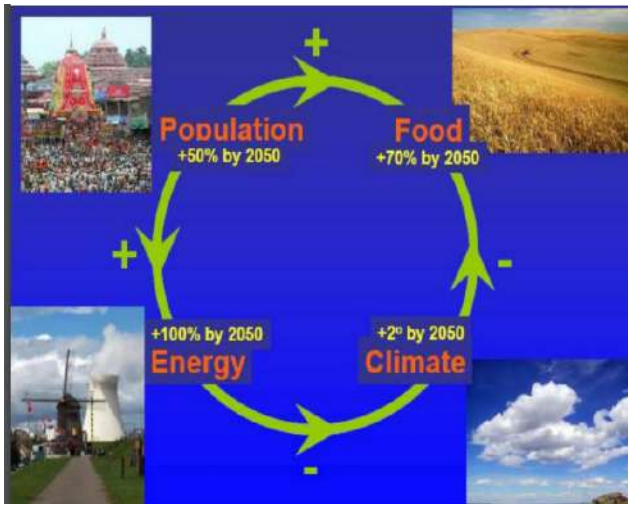
# IMPORTANCE, POTENTIAL AND CHALLENGES OF NEGLECTED AND UNDERUTILIZED CROP

**Punabati Heisnam, Tanu Oinam, BidyapatiNgangom, Sourabh Sharma, Y. Linthoingambi Devi, Keisham Donyand Joseph Koireng**

*College of Agriculture, Central Agricultural University, Imphal*

Growing world population will cause a "Serious Storm" of food, energy and water shortages by 2050. Demand for food and energy will jump 70 % and 100 % and fresh water by 30% as the population tops 9 billion. In the past, only 12 crops received the major attention of scientific interventions. Three crops: maize, wheat, and rice, account for approximately 50% of the world's consumption of calories and protein, and about 95% of the world's food needs are provided by just 30 species of plants. Despite this, the list of crop species compiled as edible extends to around 12,650. Among these are plants that have been used for food and other uses on a larger scale historically, but whose usage has dropped in modern times. Reduction in use is due to supply or consumption constraints, poor shelf life, unrecognized nutritional value, poor consumer awareness, and perception as famine food («poor people›s food»), partially due to the modernization of agricultural practices. Some crops experienced genetic erosion of their gene pool due to this neglect, which resulted in them becoming regarded as lost crops. As the demand for plant and crop attributes changes (reappraisal or discovery of nutritional traits, culinary value, adaptation




to climate change, etc.), some previously neglected crops, such as oil palm, soybean, and kiwifruit, have overcome such constraints via more large-scale production and use, becoming regarded as globally significant crops. Alongside their commercial potential, many underused crops such as sorghum provide essential environmental services as they have adapted to marginal soil and climate conditions. Recently, more than 1000 neglected and underutilized crop species (NUFCs)across the world have been recognized as forthcoming survival crops (Mayes *et al.* 2012).


**Neglected and Underutilized Crop Species (NUSs)** refer to a group of crops that are notwidely cultivated or promoted despite their potential to contribute to food security, nutrition and biodiversity. These crops often have local or regional importance but have been over shadowed by more commonly grown staple crops like rice,wheat, and maize. Underutilized crops "were once grown more widely or intensively but are falling into disuse for a variety of agronomic, genetic, economic and cultural reasons. Farmers and consumers are using these crops less because they are in some way not competitive with other species in the same agricultural environment. The decline of these crops may erode the genetic base and prevent distinctive and valuable traits being used in crop adaptation and improvement".Regarding the socio-economic implication of the term, many species represent an important component of the daily diet of millions of peoples in different parts of the world but their poor marketing conditions make them largely underutilized in economic terms.

## Importance Characteristics of NUS

- NUS are Smart foods which are highly nutritious and environmentally friendly





- They are climate smart with resilient under extreme weather conditions
- Good opportunities to diversify both diets and on-farm
- Represented by wild species, ecotypes and landraces
- Highly adapted to agro-ecological niches and marginal areas
- Cultivated and utilized based on indigenous knowledge
- Important in local consumption and production systems
- Under-represented in ex-situ gene banks
- Characterized by fragile or non-existent seed supply systems
- Overlooked by policy-makers and research and developmentagendas, and scientific information and knowledge about

## NUS Crops

1. **Cereals**- Pearlmillet (*Pennisetumglaucum*), Fingermillet (*Eleusinecoracana*), Foxtailmillet (*Setariaitalica*), Prosomillet (*Panicummiliaceum*), and Barnyardmillet (*Echinochloa spp.*), Teff (*Eragrostis tef*), Sorghum (*Sorghum bicolor*), Fonio (*Digitariaexilis*), Job'sTears(*Coixlacryma-jobi*)
2. **Pseudocereals**- Amaranth, Quinoa (*Chenopodium quinoa*), Buckwheat (*Fagopyrumesculentum*), Chia (*Salviahispanica*), Kañiwa (*Chenopodiumpallidicaule*)
3. **Fruitspecies**-Baobab(*Adansoniaspp.*), Jujube (*Ziziphusjujuba*), Longan (*Dimocarpus longan*), Sacha Inchi (*Plukenetiavolubilis*), Marula (*Sclerocaryabirrea*), CamuCamu (*Myrciariadubia*), Salak (SnakeFruit) (*Salaccazalacca*), Chayote (*Sechium edule*), Cempedak (*Artocarpus integer*), Feijoa (*Acca sellowiana*), MangoSteen (*Garciniamangostana*), Indian Fig Fruit (*Opuntiaficus-indica*), Starfruit (*Averrhoacarambola*), Nance (*Byrsonimacrassifolia*), Lucuma (*Pouterialucuma*)
4. **Nutspecies**-TigerNut (*Cyperusesculentus*), BunyaNut (*Araucariabidwillii*), Candlenut (*Aleurites molucanna*), Mongongo Nut (*Schinziophytonrautanenii*), Pili Nut (*Canarium ovatum*), Marula Nut (*Sclerocaryabirrea*), Kola Nut (*Cola acuminata*), Water Caltrop (*Trapa bicornis*), Butternut (*Juglans cinerea*), Sapucaia Nut (*Lecythispisonis*)
5. **Vegetables**- Moringa (*Moringa oleifera*), Taro (*Colocasia esculenta*), Oca (*Oxalistuberosa*), Yam Bean (*Pachyrhizuserosus*), Chayote (*Sechium edule*), Kale (Wildvarieties) (*Brassicaoleracea*), Sunchoke (JerusalemArtichoke) (*Helianthustuberosus*), Amaranth Leaves (*Amaranthus spp.*), Luffa (*Luffa aegyptiaca*), Samphire (*Salicorniaeuropaea*), Celtuce (*Lactucasativavar.angustana*), Mache (*Valerianellalocusta*), Tindora (*Coccinia grandis*), Chicory (*Cichorium intybus*), Malabar Spinach (*Basella alba*)
6. **Pulses-** Bambara Groundnut (*Vigna subterranea*), Lima Bean (*Phaseolus lunatus*), Mung Bean (*Vigna radiata*), Pigeon Pea (*Cajanus cajan*), Tepary Bean (*Phaseolusacutifolius*), FabaBean (*Viciafaba*), Cowpea (*Vignaunguiculata*), HorseGram (*Macrotyloma uniflorum*), Chickpea (Desi varieties) (*Cicer arietinum*), Winged Bean (*Psophocarpustetragonolobus*), TaraBean (*Taraspp.*), Adzuki Bean (*Vignaangularis*), BroadBean (*Viciafaba*), Lentil (Indigenousvarieties) (*Lensculinaris*), AzukiBean (*Vigna angularis*)
7. **Root and tuber crops-** Oca (*Oxalis tuberosa*), Yam Bean (*Pachyrhizuserosus*), Sweet Potato (Wild varieties) (*Ipomoea batatas*), Jerusalem Artichoke (Sunchoke) (*Helianthus tuberosus*), Taro (*Colocasia esculenta*), Canna (*Canna edulis*), Dasheen (*Colocasia esculenta*), Arrowroot (*Maranta arundinacea*), Chayote (*Sechium edule*), Tacca (*Tacca palmata*), Japanese Kabu (Turnip) (*Brassica rapa var. nipposinica*), Jicama (*Pachyrhizustuberosus*), Chinese Potato (*Stachys affinis*), Suran (Elephant FootYam) (*Amorphophallus paeoniifolius*), Yacon (*Smallanthussonchifolius*)
8. **Oilseed crops-** Moringa (*Moringa oleifera*), Sacha Inchi (*Plukenetiavolubilis*), Nigella (*Nigella sativa*), Pili Nut (*Canarium ovatum*), Mongongo (*Schinziophytonrautanenii*), Balanites (*Balanites aegyptiaca*), Tung Oil Tree (*Vernicia fordii*), Karanja (*Pongamiapinnata*),Hemp(*Cannabissativa*), Flaxseed(*Linumusitatissimum*), Chia (*Salviahispanica*), Jojoba (*Simmondsia chinensis*), Camelina (*Camelina sativa*), Crambe (*Crambeabyssinica*), Ginkgo (*Ginkgo biloba*)
9. **Starch and sugar crops-** Taro (*Colocasia esculenta*), Oca (*Oxalis tuberosa*), YamBean (*Pachyrhizuserosus*), Arrowroot (*Maranta arundinacea*), Canna (*Canna edulis*),Suran (Elephant Foot Yam) (*Amorphophallus paeoniifolius*), Tacca (*Tacca palmata*), Sweet Potato (Wild varieties) (*Ipomoea batatas*), Chinese Potato (*Stachys affinis*), Yacon (*Smallanthussonchifolius*), Sweet Sorghum (*Sorghum bicolor*), Stevia (*Steviarebaudiana*), Palmyra Palm (*Borassus flabellifer*), Jaggery Palm (*Phoenix sylvestris*),Coconut(*Cocosnucifera*), Sugar Date Palm (*Phoenixdactylifera*), Tamarind (*Tamarindus indica*), Maple (*Acer spp.*), Sweet Potato (for sugar extraction) (*Ipomoeabatatas*), Monk Fruit (*Siraitiagrosvenorii*)

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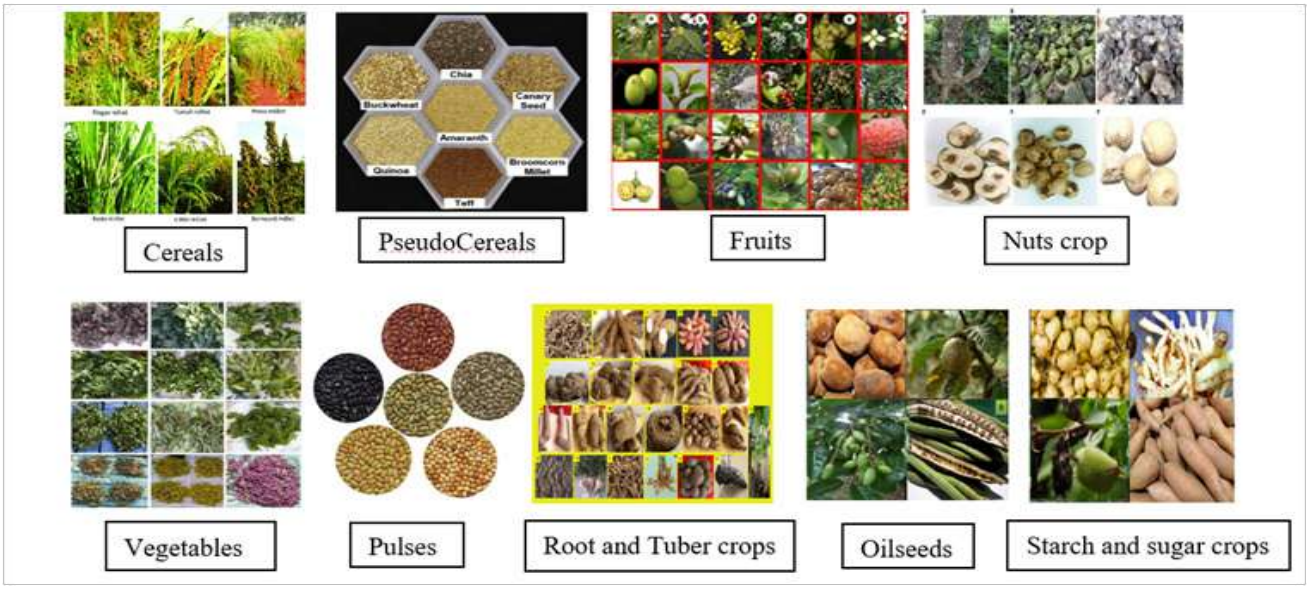



## Challenges to NUS

**Potential**

- Failure of governments to conservation and use
- Lack of funds
- Failure of governments to support research
- Absence of legal frameworks and policies

**Social**

- Replaced with new varieties and Improved crops
- Changing diet
- Loss of indigenous knowledge
- Inadequate awareness of the nutritional value
- Social Stigma
- Migration of farm labor
- Over-exploitation of wild resources

**Agronomic**

- Insufficient seeds
- Lack of seed supply systems
- Insufficiently trained human resources

**Economic**

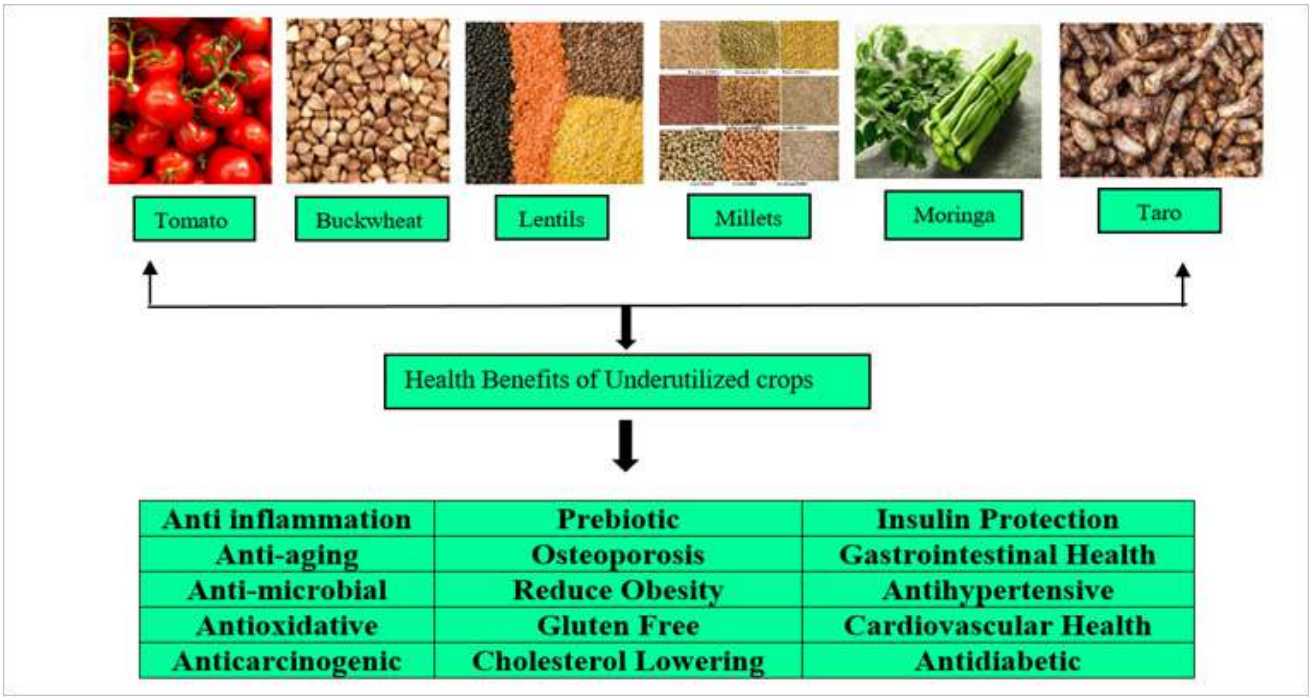
- Changes in land use
- Low commercial value
- Lack of market
- Lack of incentives

**Environmental**

- Genetic erosion
- Climate change
- Environmental pollution
- Ecosystem degradation

## Neglected and under utilized crops (NUS) Health Benefits

Humans have always included wild plant species in their diets. These plants contain a pool of nutritional and medicinal compounds with remarkable pharmacological properties and health-promoting benefits. The nutritional potential of these foods should be kept and promoted and could play a very important role in health promotion and food diversification. Increased awareness of healthy food opens the space for the potential reintroduction of underutilized plants. The cultivation, promotion, and implementation of underutilized crops can help reduce hunger and malnutrition, assist in fighting poverty, and ensure food security for many people worldwide. Many so-called wild underutilized plant species are considered food medicine use to the presence of several active compounds. Underutilized plants contain various nutritional components that, independently or in combination, demonstrate numerous health benefits, such as having anti-cancerous, anti-diabetic and cholesterol-lowering effects.




## Nutritional Value and Energy Content of Some NUS Cereals, Pulses and Oil Seeds in 100 gm (Dry Weight) Quantity

| Crop | Protein (Gram) | Carbs (Gram) | Fat (Gram) | Zn (mg) | Fe (mg) | Ca (mg) | Mg (mg) | K (mg) | P (mg) | Vit B1 (mg) | Vit B2 (mg) | Vit B3 (mg) | Energy (K Cal) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Finger millet | 7.7 | 72.6 | 1.5 | 2.3 | 3.9 | 350 | 137 | 408 | 283 | 0.4 | 0.2 0.2 | 1.1 | 336 |
| Pearl millet | 11.8 | 67.0 | 4.8 | 3.1 | 11.0 | 42 | 137 | 307 | 296 | 0.4 | 0.2 | 2.8 | 363 |
| Sorghum | 10.4 | 70.7 | 3.1 | 1.6 | 4.1 | 25 | 171 | 309 | 222 | 0.4 | 0.2 | 4.3 | 329 |
| Chickpea | 17.1 | 60.9 | 5.3 | 6.1 | 4.0 | 220 | 119 | 875 | 366 | 0.3 | 0.2 | 1.7 | 360 |
| Green gram | 24.0 | 56.7 | 1.3 | 2.7 | 8.5 | 124 | 189 | 1246 | 405 | 0.6 | 0.2 | 2.3 | 348 |
| Pigeon pea | 22.3 | 57.6 | 1.7 | 3.0 | 2.9 | 16 | 79 | 1392 | 367 | 0.6 | 0.2 | 2.9 | 335 |
| Ground nut | 23.7 | 21.5 | 49.6 | 440 | 400 | 1180 | 180 | 470 | 680 | 0.6 | 0.3 | 12.9 | 585 |

**Date source:**


1. *Maize in human nutrition-AO report*
2. *V.S. Settaluri; C.V.K. Kandala; N. Puppala and J. Sundaram. Food and Nutrition Sciences, 2012,3, 1644-1650*
3. *Sorghum and Millets in human nutrition- FAO report*


## Nutrient Profile for NUS:

### Major draw backs affecting the availability of NUS Crops

- Limited awareness and lack of traditional knowledge,
- Limited research and development, inadequate breeding programs,
- Inadequate infrastructure and supplychains,
- Poor market access, lack of processing infrastructure,
- Low production and limited cultivation, small-scale cultivation, competition with staple crops, climate and environmental challenges,

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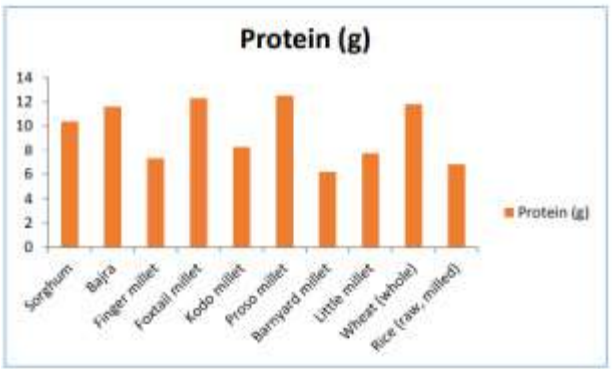


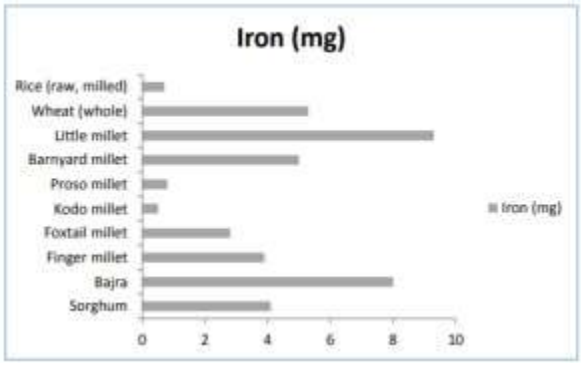


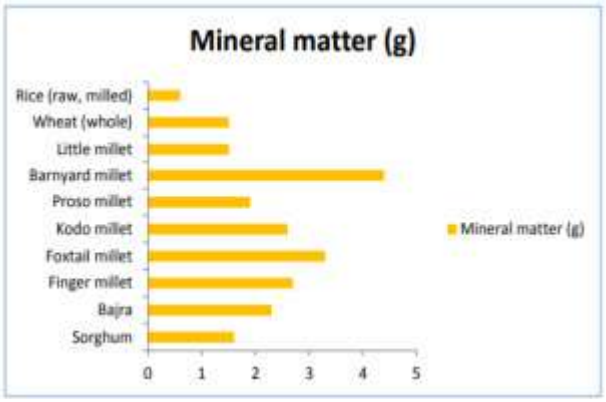


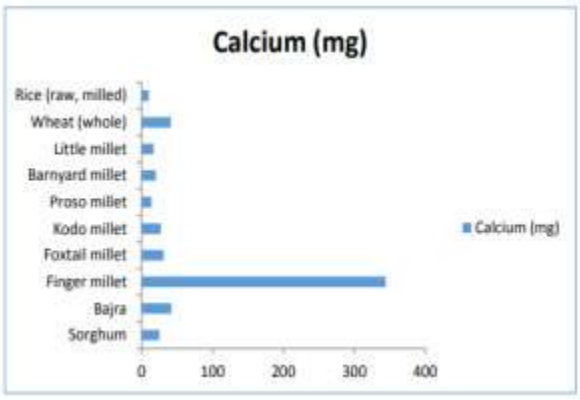


- Vulnerability to climate change, limited adaptation, policy and institutional support,
- Lack of government support, limited policy integration, economic and market viability,
- High production costs, market demand limitations, cultural and dietary preferences, cultural barriers,
- Resistance to change, post-harvest losses, perishability, poor storage techniques, agronomic and agronomic challenges,
- Pest and disease susceptibility, limited agronomic practices.
- Inadequate research and development focus
- Low yields and social stigma
- Potential collaborative and development areas

## Conclusion

Neglected and underutilized crops hold significant potential to address global challenges like food insecurity, malnutrition, and climate change. These crops are often rich inessential nutrients, resilient to environmental stresses, and offer sustainable alternatives to conventional agricultural systems. However, their limited availability, lack of awareness, inadequate research, and poor infrastructure present major barriers to their widespread adoption. By investing in research, improving market access, and promoting awareness,neglected and underutilized crops could play a vital role in diversifying food systems,enhancing nutritional outcomes, and ensuring more sustainable and resilient agricultural practices.





# REVITALIZING MILLET CULTIVATION FOR A RESILIENT FUTURE IN NORTH EASTERN STATES OF INDIA

**Akankhya Gogoi, L. Geetarani Devi, L.D. Hatai, B.R. Phukan, B.N. Hazarika**

*College of Agriculture and College of Horticulture and Forestry, CAU, Pasighat*

Millets, one of the earliest cultivated food crops, are a variety of small-seeded grains belonging to Poaceae family. Millets are gaining significance globally due to their unparalleled benefits. As today's world grapples with climate change, food insecurity, and malnutrition, millets offer a resilient and nutritious solution. Their adaptability to challenging environments makes them an ideal crop for smallholder farmers, enhancing food availability and economic stability. Moreover, millets require minimal external inputs, reducing synthetic fertilizer and pesticide usage, promoting eco-friendly agriculture.

Located to the eastern most part of India, the North Eastern region is home to unparalleled biodiversity, breath taking natural beauty and rich cultural heritage. With primarily agrarian economy,fragile ecology and rain-fed agriculture, the region faces pressing challenges in ensuring food security, environmental sustainability, and economic viability. Amidst these concerns, millet cultivation emerges as a vital strategy for enhancing food security, sustainable agriculture, and rural livelihoods.

## Present scenario of millet production and consumption in North East India

India is the leading producer and consumer of millet crops and their products. The people in arid and semi-arid regions of the country grow and consume millets as staple food. In the rainfed agriculture, grain and fodder yielding 'Dual Purpose' millets are grown basically to ensure food and fodder security.

India's initiative in International Year of Millets, 2023 and G20 presidency highlights the northeastern states of the country to showcase its agriculture policy in terms of farmers' income and livelihood as a global model. Although the northeastern states have a long history of millet cultivation, the importance of millets has been eclipsed by the green revolution's focus on rice and wheat in the recent decades. The lack of access to good quality traditional seeds, fertilisers, and effective farming methods, along with the changing patterns of climate,poor market demand and a lack of policies of the government make millet growing even more difficult. Since very limited efforts have been made to market and link millet-based products to markets, the farming communities have few options for generating revenue. The existing primary processing of millets is labour intensive and there is lack of proper storage facilities which results in poor-quality grains fetching low market prices. Thus, there is a need to develop infrastructure and build the capacity of farmers and other stakeholders along the millet value chain.

## Potential of Millet Cultivation and Varieties Grown across Northeast India

Millets form an integral part of subsistence agriculture in the Northeast region of India. Millets are used for food and beverages and has various traditional and cultural significance. The region grows diverse millet varieties, including finger millet, pearl millet, proso millet, foxtail millet, barnyard millet, little millet, and kodo millet. With over 2.5 million hectares of cultivable land, Northeast India can increase millet production, leveraging its rich biodiversity of indigenous millet varieties. Revitalizing millet cultivation can enhance food and nutritional security, promote sustainable agriculture practices support climate change adaptation and resilience, empower rural communities and preserve traditional knowledge. Effective policy support, research, and market linkages can unlock the full potential of millet cultivation in Northeast India.

Table 1. Different types of millets cultivated across Northeast India

| NORTHEAST-ERN STATES OF INDIA | CULTIVATED MILLETS |
|---|---|
| Arunachal Pradesh | Finger millet, Pearl millet, Foxtail millet and other small millets |
| Assam | Foxtail millet, Barnyard millet and other small millets |
| Manipur | Foxtail millet and other small millets |
| Meghalaya | Finger millet, Pearl millet, Foxtail millet and other small millets |
| Mizoram | Pearl millet, Sorghum and other small millets |



| | |
|---|---|
| Nagaland | Sorghum, Pearl millet, Finger millet and other small millets. |
| Sikkim | Finger millet and other small millets |
| Tripura | Sorghum, Foxtail millet |

***Source**: Soni, Jeetendra, Sailo, Lalbruaitluangi, Lalramhlimi, B.,Singson, Lungmuana, Shakuntala, Ingudam & Doley, Sunil. (2023). Millets cultivation in Mizoram: Status and future prospects. Vol 73 pp 25-27.*

## Cultural Significance of millet in North East India

Millets have been an integral part of North Eastern culture, tradition and identity for centuries. They are deeply embedded in the region's food culture and traditions. Millets are a staple food in many Northeastern communities and used in many dishes. *Zan*,a famous porridge recipe among the Monpa tribes of Arunachal Pradesh made using millet flour. *Madua Apong*is a popular beverage made in Arunachal Pradesh using *Mirung* (millet), through an unrestrained fermentation process.In Assam*pitha* and *jol moolar* (millet-based curry), in Meghalaya millet-based dessert etc are prepared. *Chang/ Kodo ko jaan*is a popular fermented finger millets-based mild alcoholic beverage. The local Lepcha community of Sikkim calls the drink *Chi* and offers it to their deities during most of their religious ceremonies. In festivals such as *Nyokum Yullo* of Arunachal Pradesh, *Bihu* of Assam, *Lai harooba* of Manipur, as well as in various rituals and ceremonies, millets play a significant role as millet-based offerings. As an agrarian society, the *Angami Naga* tribe celebrates *Tsiinyi* or millet festival, in the month of August, to mark the completion of millet harvest. Millet *kichdi* and millet *apang* are common dishes of millet consuming tribes in Nagaland. Millets are often used in traditional medicines of the North Eastern region of India for health issues such as digestive and respiratory problems.

## Millets for nutritional security

Nutritional insecurity is a major threat to the world's population that is highly dependent on micronutrients deficient cereals-based diet. Millets are nutritionally superior as their grains contain higher amount of proteins, essential amino acids, minerals, vitamins and are rich in micronutrients, fibre and antioxidants. The milletsare gluten free,containing 7-12 percent protein, 2-5 percent fat, 65-75 percent carbohydrates and 15-20 percent dietary fibre. They are called Nutri-cereals or Dry-land cereals and also referred as Smart Food with high calcium, zinc, iron, low glycemic index. They address pressing health concerns like diabetes, obesity and heart disease. Being staple foods, millets can beneficially replace at least one to two portions of cereal intake of an average adult providing bulk of the daily recommended dose. Food market especially in urban areas is selling several modern-day foods, ready to cook and ready to eat items, making available an array of options for consumers to embrace millets.

## Environmental benefits of millet cultivation

Millet cultivation in Northeast India offers numerous environmental benefits, enhancing the region's ecological sustainability. Millet is well known for climate resilience and adaptation, such as requirement of minimal water and ability to thrive in temperatures ranging from 15°C to 35°C, which helps farmers cope with changing weather patterns. It also helps in soil and water conservation. Millets' deep roots hold soil in place, preventing erosion and help recharge groundwater. Millets enhance soil organic matter and nutrient content and also promote diverse agro-ecosystems, supporting local flora and fauna. Furthermore, millets absorb carbon dioxide, mitigating climate change, and their diversity reduces pest and disease pressure. Millets also support pollinators, beneficial insects and microorganisms, providing ecosystem services.

Successful case studies demonstrate the environmental benefits of millet cultivation. For instance, Arunachal Pradesh's millet-based agroforestry systems have enhanced soil fertility and biodiversity. Similarly, Assam's millet-based crop rotation has improved soil health and reduced pest incidence. Meghalaya's millet-based organic farming has increased soil organic matter and water retention.

## Economic Viability of Millets

Millet cultivation in North East India presents a lucrative economic opportunity for farmers, enhancing their livelihoods and contributing to the region's economic growth. With growing demand for millets in domestic and international markets, farmers can reap higher returns per hectare compared to traditional crops like rice and wheat. Additionally, millets require minimal external inputs, reducing production costs and increasing profit margins.

Successful initiatives like Arunachal Pradesh's Millet Mission, Assam's Millet Promotion Scheme, and Meghalaya's Millet-Based Livelihood Program have demonstrated significant economic benefits for farmers.





### What should policy makers do?

To promote millet cultivation in North East India, policymakers should adopt a multi-pronged approach. First, empower smallholder farmers by promoting Farmer Producer Organizations (FPOs) to enhance production, aggregation, value additionand marketing. Second, establish a Centre of Excellence to drive research and development on indigenous millet varieties and value chains. Third, incentivize farmers through state-led procurement and distribution schemes to encourage millet production. Fourth, develop farmgate-level infrastructure for primary processing and marketing to establish backward and forward linkages. Finally, through innovative extension mechanisms, foster awareness creation and behavioural change. By implementing these measures, policymakers can create a supportive ecosystem that promotes millet cultivation, benefits smallholder farmers, and contributes to the region's sustainable agriculture and economic growth.

### Conclusion

In conclusion, revitalizing millet cultivation in North East India is crucial for a resilient future. By leveraging its cultural significance, environmental benefits, and economic potential, millets can enhance food security, sustainable agricultureand livelihoods. Effective policy interventions, research, and community engagement can ensure the long-term viability of millet cultivation, preserving North East India's rich cultural heritage and promoting a sustainable tomorrow.

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# *SONCHUS ASPER* (KHOMTHOKPI): A TRADITIONAL REMEDY

**Rajkumari Mandakini Devi, Widawangbo, Ilamzailie Hemang**

*College of Veterinary Sciences & Animal Husbandry, Central Agricultural University (I), Jalukie, Peren, Nagaland*

### Introduction

*Sonchus asper*, commonly known as the prickly sowthistle or in the local Manipuri dialect as "Khomthokpi," is an annual herb belonging to the Asteraceae family (1). It has been widely used in traditional medicine systems across various cultures for its diverse therapeutic properties. *Sonchus asper*is an annual or winter herb that exudes a milky sap when broken. They excrete milky juice when it is broken. Its stems can grow up to 150 cm tall, are hollow, thickand unbranched. The leaves are 4-18 cm long, deeply lobed, and 0.5-5 cm wide (2). It thrives in a variety of soil conditions, including brown clayey loam, sandy loam, and nutrient-rich soils. It can tolerate seasonally wet areas, lakes and soils with slightly acidic to alkaline pH (3).

### Traditional Uses

In many parts of India, including the northeastern states like Manipur, *Sonchus asper* has been traditionally used to improve the health and productivity of livestock. The plant is often fed to animals in the form of fresh leaves or as a part of a herbal concoction. Some common practices include:

1. Sonchus asper (Khomthokpi

2. Drying plant sample in shades

3. Dried powder

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- Feeding fresh leaves: Fresh leaves of *Sonchus asper* are directly fed to animals, especially lactating cows to enhance milk production.
- Topical application: In some cases, the leaves of *Sonchus asper* are crushed and applied topically to wounds and skin infections in animals.

One of the most significant traditional applications of *Sonchus asper* in animal husbandry is its use as a galactagogue substance employed to stimulate milk production in lactating animals. This property is particularly important for livestock farmers, as it can help increase milk yield and overall productivity. The mechanism behind this galactagogue effect is not fully understood, but it is believed to be related to the presence of phytoestrogens and other bioactive compounds in the plant. These compounds may stimulate the release of hormones that regulate milk production, such as prolactin and oxytocin.

In addition to its galactagogue properties, *Sonchus asper* is also recognized for its potential immunomodulatory effects (4). The plant contains various bioactive compounds, including flavonoids, terpenoids, and phenolic acids, which have been shown to possess antioxidant and anti-inflammatory properties (5, 6). These compounds can help boost the immune system of animals, making them more resistant to infections and diseases.

## Scientific Validation

While traditional knowledge has long recognized the benefits of *Sonchus asper* in animal husbandry, scientific research is still in its early stages. However, recent studies have begun to validate some of these traditional claims. For instance, research has shown that extracts of *Sonchus asper* possess antioxidant and anti-inflammatory properties, which could contribute to its immunomodulatory effects.

## Conclusion

*Sonchus asper* (Khomthokpi) holds significant promise as a natural and sustainable solution for enhancing animal health and productivity. In the context of animal husbandry, it has been particularly valued for its galactagogue and immunomodulatory effects. While more scientific research is needed to fully understand the mechanisms underlying these effects, the traditional wisdom and growing body of scientific evidence suggest that *Sonchus asper* could be a valuable natural resource for improving the health and productivity of livestock.

## Acknowledgement:

The authors are thankful to the Department of Biotechnology, GOI and Dean, CoVSc & AH, CAU (I), Jalukie, Nagaland for providing all the facilities to conduct the present work. The authors are grateful to the herbal practitioners and Local elders of Imphal-west, Manipur and Jalukie, Nagaland for sharing valuable information during the field study.

# ROLE OF BOTANICALS IN PEST MANAGEMENT

**Hari Kesh, Tisu Tayeng and Shivani Dobhal**

*College of Horticulture & Forestry, CAU (Imphal) Pasighat-791102, Arunachal Pradesh*

## Introduction

The growth and quality of Agri-Horticultural crops are constantly affected by a number of pests including, insects, fungi, nematodes, bacteria and viruses. To save the crop from the adverse effect of these pests, farmers generally rely on quick fix pest management solutionsi.e. use of synthetic pesticides. However, the continuous and repetitive use of these synthetic chemicals leads to generation of several serious problems like residual toxicity in soil, water, air, food and feed. Polluted air and water have toxic effect on human and wild life, insecticidal resistance in pests, harmful for non-target organisms, genetic variation in plants, and negative impact on biodiversity. These negative consequences of synthetic pesticides have evoked interests in use of botanicals, biopesticides, and biocontrol agents as an alternative source to manage the pests in an eco-friendly way. Botanical pesticides are derivatives of plants or plant parts (leaves, stems, seeds, roots, bulbs and rhizomes) of different plant species extracted in ethanol or other organic solvents that repel, attract, inhibit growth or kill pests. Botanicals are gaining popularity in organic farming because of easily availability due to their natural occurrence, environmentally safe, no or less residual activity, less expensive and more specific to target pests. Hundreds of botanical pesticides are isolated

or discovered from cultivated, wild and medicinal plants of family, Compositae, Meliaceae, Leguminosae, Chenopodiaceae, Zingiberaceae, Labiatae, Umbelliferae, and Euphorbiaceae etc. The important sources of botanical pesticides available commercially (Fig. 1 and Table 1) are neem (*Azadirachta indica*), pyrethrum (*Chrysanthemum cinerariaefolium*), ginger (*Zingiber officinale*), tobacco (*Nicotiana tabacum*), sabadilla (*Schoenocaulon officinale*), and ryania (*Ryania speciosa*).

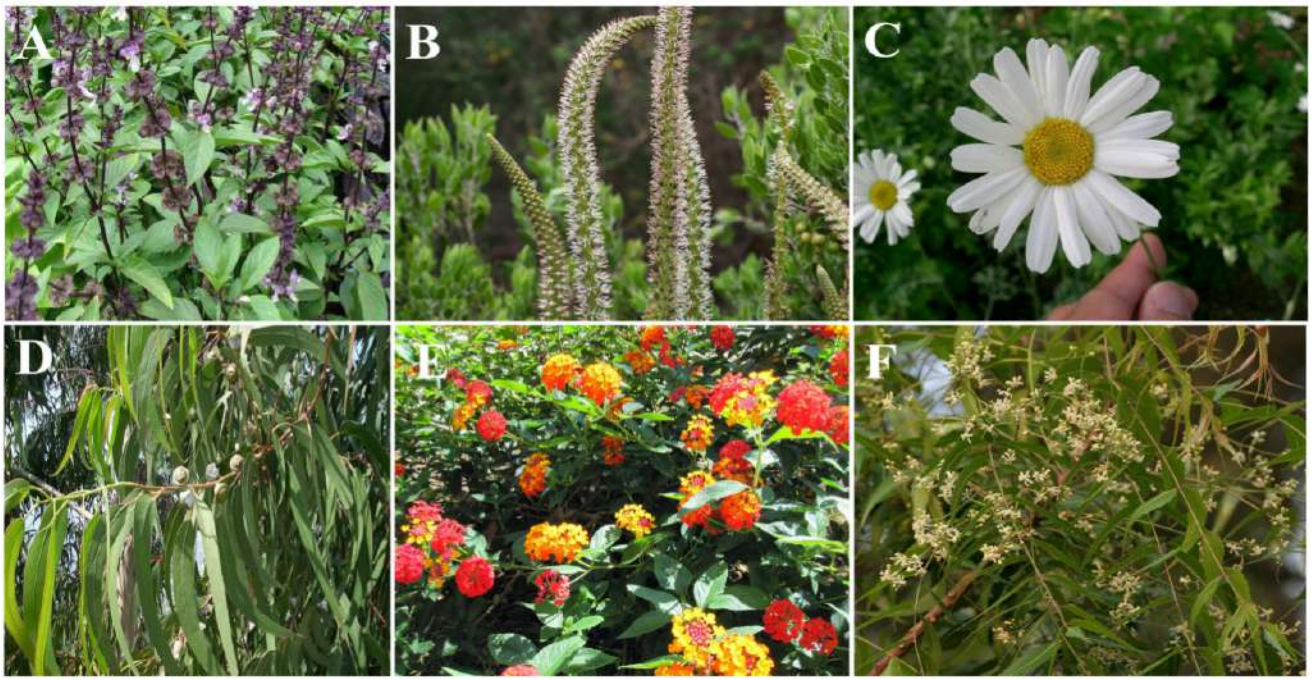


Fig.1. Important source of botanicals effective against targeted pests.A) Ocimum basilicum; B) Schoenocaulon officinale; C)Chrysanthemum cinerariaefolium; D) Eucalyptus globules; E) Lantana camara; F) Azadirachta indica , Source:https://www.wikidata.org/wiki/Q594627


Fig. 2. Commercially available botanical pesticides.
Source : https://www.indiamart.com/MAdhu Feretilizer

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Table 1: Commercially available pesticides along with details of manufacturer

| S. No. | Pesticide | Manufacturer | Type | Target Pests |
|---|---|---|---|---|
| 1 | Roundup | Bayer AG | Herbicide | Weeds |
| 2 | Sevin | Bayer AG | Insecticide | Insects |
| 3 | Actara | Syngenta AG | Insecticide | Insects |
| 4 | Bravo | Syngenta AG | Fungicide | Fungal diseases |
| 5 | Lorsban | Dow AgroSciences | Insecticide | Insects |
| 6 | Dithane | Corteva Agriscience | Fungicide | Fungal diseases |
| 7 | Goal | Corteva Agriscience | Herbicide | Weeds |

**Source :** *http://npic.orst.edu/ and https://www.epa.gov/pesticides*

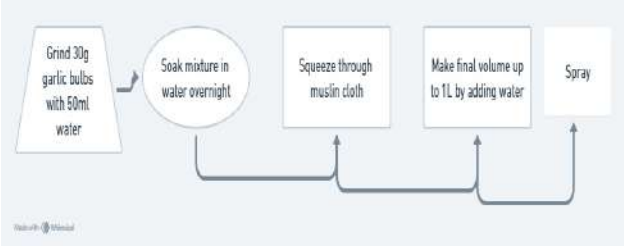
## Preparation of Botanical Pesticides by farmers

### 1. Neem (*Azadirachta indica*) leaf extract

Collect 80 kg of fresh neem leaves (for one hectare) and soakthem in water overnight. Next day, take out the soaked leaves and ground thoroughly in a grinder. Filter the extract through muslin cloth and dilute the extract @ 2.53 L in 50 L water and spray (Table 2).


### 2. Garlic (Allium sativum) extract

Groundthirty gram of garlic bulbs thoroughly in grinder with 50ml water. Soak the grounded mixture in a little quantity of water over night and squeeze



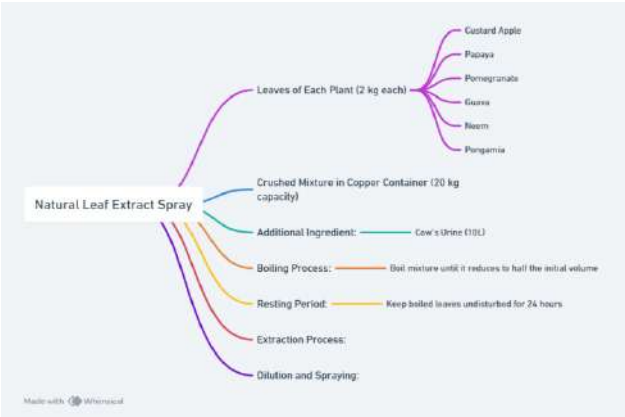

through muslin cloth. Nowmake the final volume up to 1L by adding water and spray.

### 3. Lantana (L. camera) leaf extract

Collect 1 kg of Lantana leaves. Chop and ground the leaves with little water. Filter it and dilute in 30L of water and spray.

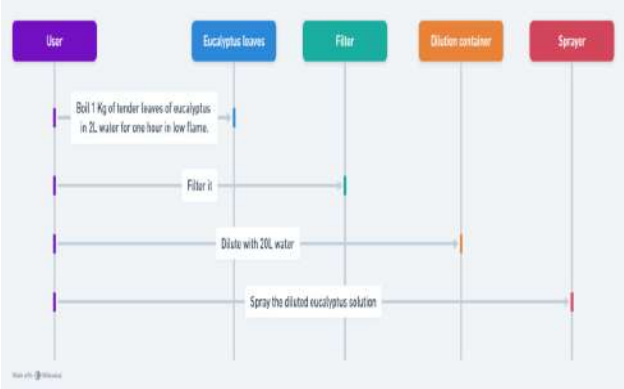

### 4. Mixed Leaves Extract

Take two kg leaves of each plant namely custard apple, papaya, pomegranate, guava, neem and pongamia in a coper container of 20 kg capacity and crush them well. To this, add 10L of cow's urine. Boil the mixture till the mixture became half of the initial. Keep the boiled leaves for 24h without disturbing. After that, squeeze the leaves and collect the filtered extract. Dilute the extract @ 22.5L in 50L water and spray.

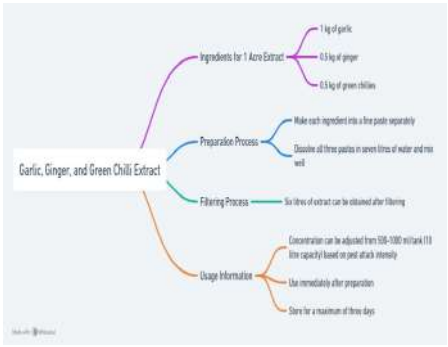



### 5. Eucalyptus globules leaf extract

Boil 1 Kg of tender leaves of eucalyptusin 2L waterfor one hour in low flame. Next day, filter it and dilute with 20L water and spray.



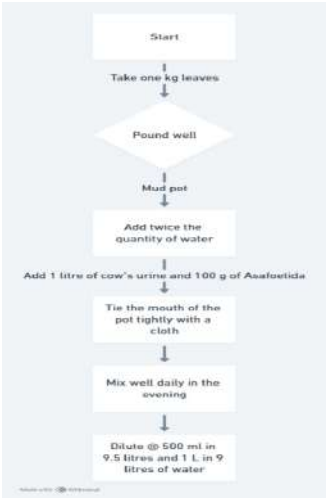

## 6. Ginger, Garlic, Chilli Extract




For preparing the extract for one acre, 1 kg of garlic, 0.5 kg of ginger and 0.5 kg of green chillies are required. Take all the three separately and make them into a fine paste. Dissolve all the three pastes in seven litres of water and mix them well. On filtering six litres of extract can be obtained. The concentration of the extract can be increased or decreased from 500-1000 ml/tank (10 litre capacity) depending on the intensity of the pest attack. This extract should be used immediately after preparation. This extract can be stored for a maximum of 3 days.

## 7. Five Leaf Extract

Take one kg leaves of each plant namely Calotropis, Neem, Adathoda, Vitex and Moringa and pound well. Take them in a mud pot and add twice the quantity of water. To this, add 1 litre of cow's urine and 100 g of Asafoetida. Tie the mouth of the pot tightly with a cloth. This extract should be mixed well daily in the evening. This extract should be used after a period of one week. Dilute the extract @ 500 ml in 9.5 litres and 1 L in 9 litres of water, if it is used for a precautionary measure or severe infestation, respectively. This extract can be stored and used for a period of 25-30 days.




### Table 2. Botanical sprays used by farmers against pests

| Botanicals | Target pests | Mode of Action |
|---|---|---|
| Neem kernel extract | White fly, Fruit borers, Thrips, aphids, whitefly and yellow spider mites | • Antifeedant: Insects avoid feeding on treated plants.<br>• Growth Disruption: Interferes with molting and metamorphosis, preventing insects from developing into adults.<br>• Repellent: Discourages insects from landing and laying eggs.<br>• Sterilant: Reduces the fertility of insects. |
| Garlic extract | Leaf eating caterpillar and fruit borer | • Repellent: Strong odor repels insects.<br>• Insecticidal/Toxic: Sulfur compounds can be toxic to some insects, disrupting their nervous system or other biological processes at high concentrations.<br>• Antifeedant: Discourages feeding. |
| Lantana leaf extract | Beetles, Leaf miners, Defoliators | • Mode of Action:<br>• Repellent: Lantana contains compounds that are known to repel insects.<br>• Insecticidal/Toxic: Some compounds in Lantana have insecticidal properties.<br>• Growth Disruption: Interferes with molting and metamorphosis, preventing insects from developing into adults. |
| Mixed leaves extract | Defoliators like Spodoptera litura, semi loopers | • Repellent: The mixed leaves are likely to have a strong odor that will keep insects away.<br>• Insecticidal/Toxic: Some compounds in the mixed leaves have insecticidal properties.<br>• Growth Disruption: Interferes with molting and metamorphosis, preventing insects from developing into adults. |

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| | | |
|---|---|---|
| Ginger Garlic Chilli extract | Army worm, Shoot, pod and fruit borer | • Repellent: Strong, irritating odors and tastes deter insects.<br>• Insecticidal: Capsaicin can be toxic to some insects.<br>• Nerve Irritant: Affects the insect's nervous system. |
| Eucalyptus leaf extract | Powdery mildew | • Fungicidal: Primarily works against powdery mildew by inhibiting fungal growth.<br>• Repellent: The strong scent can deter some insects. |
| Karanja oil extract | Brown plant hopper, maize borer and citrus butterfly | • Insect Growth Regulator (IGR): Interferes with molting.<br>• Antifeedant: Discourages feeding.<br>• Repellent:<br>• Insecticidal: Toxic to some insects, disrupting their nervous system or other biological processes at high concentrations. |
| Pokasungha extract | Red cotton bug, red flour beetle and Potato tuber moth | • Repellent: Pokasungha contains compounds that are known to repel insects.<br>• Insecticidal/Toxic: Some compounds in Pokasungha have insecticidal properties.<br>• Growth Disruption: Interferes with molting and metamorphosis, preventing insects from developing into adults. |
| Chireita leaf extract | Whorl maggot in rice and rice gundhi bug | • Repellent: Chireita contains compounds that are known to repel insects.<br>• Insecticidal/Toxic: Some compounds in Chireita have insecticidal properties. |
| Kochila seed extract | Cotton leaf roller | • Repellent: Kochila contains compounds that are known to repel insects.<br>• Insecticidal/Toxic: Some compounds in Kochila have insecticidal properties. |

## Mode of Action of botanical pesticides

The mode of action of botanicals depends on the bioactive compounds present in different plant species against different pests. Most common action includes repellence, toxicity, inhibition of growth and denaturation of proteins etc. For example, pyrethrum-based botanicals target the nerve cells of insects leading to paralysis and later death, while neem-based botanicals induce moulting abnormalities, hinder oviposition and disrupt the endocrine system. Garlic and turmeric extracts cause mortality, toxicity and inhibition of progeny emergence on the red flour beetle. Against nematodes these pesticides cause inhibition of egg hatching and suppression of nematode population. The terpenes, phenols and alkaloids, present in botanicals cause toxicity to fungal cell walls, inhibit spore germination, mycelial development and germ tube elongation. Botanical pesticides, derived from plants, offer a diverse range of ways to control pests. This complexity is a key advantage, as it makes it harder for pests to develop resistance compared to synthetic pesticides that often have a single, specific target. Certain plant constituents act on pests like prohibition signs. These compounds can be perceived by the pests' sense of smell (olfactory), taste (gustatory) or even touch. Think of citronella, which keeps mosquitoes away. Repellents don't necessarily kill the pests, but they discourage them from staying in a certain area and thus protect the plants. Some plant substances are directly toxic to pests. They can disrupt essential life processes in various ways: Neem is a prime example here. It contains compounds that mess with insect hormones, particularly those involved in molting (shedding their exoskeleton to grow). This can lead to abnormal molting, preventing the insect from reaching adulthood. Neem can also affect egg-laying (oviposition) and disrupt the endocrine system (hormone system) more broadly. Terpenes, phenols, and alkaloids found in botanicals are particularly effective against fungi. They can damage fungal cell walls, which are crucial for the fungus's survival. Prevent spores from germinating (spores are like the "seeds" of fungi). Stop the growth of mycelium (the main body of a fungus).

## Conclusion

The botanicals play an important role inthe management of different pestsof Agri Horti and forestry crops. However, characterization of bioactive compounds and standardization of concentration in final product is still challenging. Because of their slow active nature, we need to focus on effective approach for their use in Agriculture. As large volume of material is needed to produce botanical pesticides, a large-scale cultivation of source plant ca be done in marginal land to avoid completion with food crops. Moreover, low height plants like rhizomes and herbs can be grown in forest areas without interfering with the forest trees. Processing and extraction of the botanical pesticides using inexpensive solvents should be explored to reduce the cost of production. So, more research is required to improve the exploitation of plants with bioactive compounds of relevance to crop protection.

# DRAGONFRUIT- TRAINING AND PRUNING PRACTICES FOR HIGHER PRODUCTIVITY

**Esther Lalruatsangi, Barun Singh, Lalrinsangpuii and Shri Dhar**

*College of Horticulture, Central Agricultural University (Imphal), Thenzawl, Mizoram*

## INTRODUCTION

Dragon fruit (*Hylocereus spp.*) also known as Kamalam (India) and Pitaya (Thailand) is a unique, colorful, tasty, attractive and nutritious fruit belonging to the Cactaceae family. This plant is originated in Central America and Mexico. The fruit is low in calories; rich in phenolics, flavonoids and antioxidant. It is a hardy fruit crop and prefers a dry tropical climate with an average temperature of 20-29°C. The crop is commercially propagated through stem cutting.

In India, the cultivation of Dragonfruit is fast picking up and farmers of Karnataka, Kerala, Maharashtra, Gujarat, Odisha, Mizoram and Nagaland have taken up its cultivation. The fruit is now gaining popularity in India due to its unique appearance and juicy taste. Dragonfruit being a vine crop, it requires training and pruning for better growth and development.

The College of Horticulture, Thenzawl, Mizoram has conducted a trial at Fruit Research Farm on different training systems of Dragonfruit suitable for the North Eastern Hill Region of India for commercialization to farmers. The training and pruning practices of Dragonfruit for increasing its productivity are as follows:

## TRAINING SYSTEM OF DRAGONFRUIT

Dragonfruit can be trained in two systems *i.e* beam type and pole type.

### 1. BEAM TYPE:

Dragonfruit can be trained by beam system in which a two main trellis (cemented) of 4 inches thickness and 6 feet height (1 foot buried in the ground) are placed at 12 feet apart. A number of 2/3 trellis (cemented or iron pole) of 3 or 4 inches thickness cm are placed at 3 feet apart in between the two main trellis. The 2/3 rooted cuttings of Dragonfruit should be planted around each trellis. The main stem should be trained by cutting off the secondary and tertiary stem as it grows along the trellis and allow them to hang downwards once it reaches the top of the trellis. The beam type training system is more convenient for plain areas and gives higher yield per unit area as compared to pole system.

#### Advantages:

1. Easier to maintain as compared to pole system
2. Higher yield per unit area

#### Disadvantages:

Cost of installation is high

Beam type training system practiced at COH, Thenzawl in 2020

Fruits bearing in 2021

### 2. POLE TYPE:

A cemented pole of 4 inches thickness and 6 feet height are mostly used leaving 1 foot length buried in the ground. A plastic pipe coiled into a circular ring or any used bike tyre can be placed on top of the cemented pole for giving support to the stem which are drooping downwards. A number of 3 to 4 cuttings can be planted per pole. The cuttings must be allowed to grow along the pole until it reaches the top. Once the cutting reaches the top of the pole, it should be allowed to grow towards gravity. Spacing between two poles can be maintained at 3 m apart and between the rows at 4 m apart.

Pole type training system in Dragonfruit

Fruiting of Dragonfruit

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### Advantages:

- Pole system is commonly practiced for commercial cultivation.
- It is more convenient for adoption in hilly regions of NEI.
- Intercropping can be practiced in between the poles.

### PRUNING OF DRAGONFRUIT

Pruning is an essential practices in Dragonfruit crop production for maintaining the shape and size of the plants since they are a vigorously growing vine crop. The pruning operation consists of removal of dry, dead, diseased, criss-crossed and unhealthy branches. They require to be pruned once per growing season in young stage and 2 to 3 times for the matured and productive stage. For pruning practices in Dragonfruit, choose the lighter colored green branches over the darker mature branches. Pruning should be done after harvesting of the fruits and is encouraged especially during February to March to avoid competition for nutrient and water. The pruned healthy stem can be further used for raising of cuttings.

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# BIOLOGICAL CHARACTERISTICS OF *SCHIZOTHORAX RICHARDSONII* (GRAY, 1832), A COMMERCIALLY IMPORTANT HILL STREAM FISH OF NORTH EAST INDIA

**Pampa Bhattacharjee* and Gourank Kumar Verma**

*College of Fisheries, CAU (I), Lembucherra, Tripura – 799210*

### Background

*Schizothorax richardsonii* (Gray, 1832) is one of the dominant species in the Schizothoracinae group, inhabiting streams and rivers of Himalayan and sub-Himalayan regions. In the group Schizothoracid, the species is widely distributed all along the Himalayas in India, besides Pakistan, Tibet, Nepal, Sikkim, Afghanistan etc. *S. richardsonii* inhabits rivers, preferring to live among rocks, near big submerged stones and shows herbivore feeding mainly on algae, aquatic plants and detritus. (Shrestha, 1990). In the central Himalayas *S. richardsonii*, locally known as 'asela' have fishery importance and constitutes as principal subsistence food fishery of the Uttaranchal region. The hill stream modifications noticed in this fish are flattening of the head and thus the eyes are shifted more towards the dorsal side and remain close together. The eyes are small in size due to intensive light in hill streams. Due to its bottom-dwelling nature, thick scales are lacking on the ventral surface of the body. Other structural modifications are adhesive apparatus, small gill openings, reduced air bladder, and short and stumpy barbels (Shrestha, 1994).

The body is spotted, slender, elongated, sub-cylindrical and strong enough to resist the torrential water current of the hill streams. The abdomen is rounded. The head is large and dorsoventrally flattened. Snout is blunt. Mouth is inferior and transverse. It is more or less crescentic or semi-circular in shape with strong jaws. Lips are thick and fleshy. The lower lip is with a free posterior edge forming a papillated sucker. Two pairs of short and stumpy barbels are present, one each rostral and maxillary. The lower jaw has a hard and horny cartilaginous covering inside. (Yadav et al., 2014)

### Materials and Methods

The study was carried out to investigate the food, feeding habits and reproductive biology of *Schizothorax richardsonii*. Fish samples were collected from different water bodies of Teesta River, Sikkim on a seasonal basis from post-monsoon season to pre-monsoon season. Fishing gears like cast net were used for the collection. Fish were largely obtained in the morning hours. Samples were photographed and then preserved in 5% formalin.

**Gut content analysis:** Gut content analysis was carried out as per the procedures of Zacharia and Abdurahiman (2004). The alimentary canals were dissected, and specimens kept in 5% formalin for later investigation.

**Gastro-Somatic Index (GaSI):** The Gastro-Somatic Index sometimes indirectly indicates the spawning season. This index is very low during the peak spawning season because of the greater number of empty stomachs. The rise and fall of Gastro-Somatic Index always show an inverse relationship with the Gonado Somatic Index. The Gastro somatic index (GaSI) was calculated following the formula of Desai (1970) and Al-Hussaini (1949).

GaSI = Total weight of gut (g) x 100 / Total weight of fish (G).

**Relative gut length (RGL):** The relative length of the gut was calculated to understand changes in fish feeding habits across size classes, as a longer relative gut length is thought to reflect a diet of less easily digestible foods (Biswas, 1993).

## Food and feeding habits of *Schizothorax richardsonii*

Food and feeding habits of fish fluctuate with the different seasons of the year. Food consumption of fish is influenced directly or indirectly by changes in climatic conditions such as temperature, pH, and light and dissolved oxygen of water (Keast, 1968). However, analysis of stomach content is a method for determining the food and feeding habits of fish by which we can easily find what the fish take as food.

A total of 192 *S. richardsonii* samples ranging from 7 to 33 cm in length and weighing 4 to 400 g were dissected and analyzed the gut content. Maximum number of the guts were found to be empty or half full. Mouth is inferior, more or less crescentic or semi-circular in shape with strong jaws. Lips are thick and fleshy. The lower lip with a free posterior edge forming a papillated sucker. Two pairs of short and stumpy barbels are present, one each rostral and maxillary. The lower jaw has a hard and horny cartilaginous covering inside (Yadav *et al.*, 2014).

## Food found in the gut content analysis

The gut content was mainly composed of diatoms and green filamentous algae that indicates this species is an herbivore and a bottom feeder. The food items found in the gut content were categorized as diatoms, green filamentous algae, blue-green algae, detritus, and sand (Table 1). Diatoms dominate the gut with 67% of total gut content. Among diatoms, the most dominant was *Navicula* species which implies that it is the most preferred food. After diatoms, the green filamentous algae were dominant (17.5%) followed by blue-green algae (7.5%) and detritus (5.5%). Being bottom dwelling and feeding habit, sand was also found in the gut (2.5%). Diatom were found in the gut of *S. richardsonii* throughout the seasons.

Table 1. Frequency occurrence of different food items found in the *S. richardsonii*

| Seasons | Diatoms | Blue-Green Algae | Green Filamentous Algae | Detritus | Sand |
|---|---|---|---|---|---|
| Post monsoon | 66 | 7 | 18 | 6 | 3 |
| Pre-winter | 68 | 6 | 17 | 6 | 3 |
| Winter | 68 | 8 | 17 | 5 | 2 |
| Pre-monsoon | 66 | 9 | 18 | 5 | 2 |
| **Average** | **67** | **7.5** | **17.5** | **5.5** | **2.5** |

## Study of feeding intensity

Feeding intensity was observed based on the fullness of the gut. It was also found that maximum numbers of the gut were full in the post-spawning season and during the winter season gut was empty and ¼ gut fullness was found during breeding season.

## Study of Gastro-Somatic index (GaSI)

The GaSl values of *S. richardsonii* were elevated during the post- spawning season, particularly in relation to the post-breeding phase when these

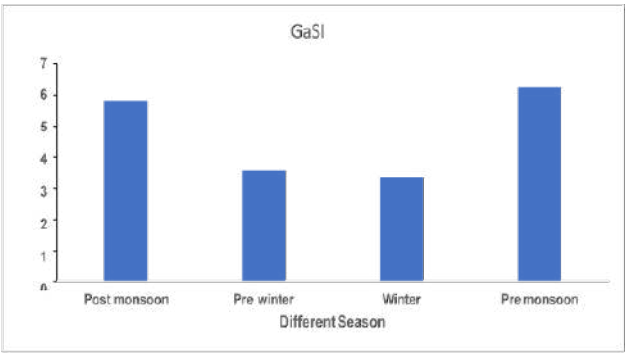


Fig.1. Gastrosomatic Index of *S. richardsonii* in different seasons

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fish exhibit voracious feeding behaviour. However, a gradual decline in GaSl values was observed as the gonads matured, reaching their lowest levels during the winter season. The maximum GaSl values remained high, attributed to the ample availability of food resources. Conversely, as the fish approached maturity, GaSl values decreased due to the increasing occupation of the body cavity by the developing gonads.

## Reproductive biology

### 1. Sex ratio:

The male to female ratio of *S. richardsonii* in Teesta River observed more number of males than females. During the survey in Teesta River, a total of 78 female specimens and 114 male specimens were evaluated. The overall male : female sex ratio observed was 1.46:1, d.f. = 1, $p>0.05$.

### 2. Gonado-somatic index (GSI):

The gonadosomatic index (GSI) was calculated following Hossain and Ohtomi (2008) as

GSI = (gonad weight / body weight) x 100

The GSI determines the maturity of fish. It increases with the gonadal development and ultimately diminishes. In this fish species the highest mean GSI values for males were reported in pre winter season (2.34) while the lowest value (0.96) in pre-monsoon. The highest mean GSI values for females were reported in winter (6.87) while the lowest value (2.74) observed in pre-monsoon. The mean GSI value for males increased from post-monsoon to pre-winter and then gradually decreased significantly. For females the mean GSI value increased from post-monsoon and attained maximum in the winter season as shown in Fig. 2. As a result, the peak spawning season for this species is ascertained as winter. The GSI and GaSl values were found to have an opposite relationship, for both the sexes. Similarly, the GSI and GaSI values for the combined sex were also found to have an inverse relationship, especially in the winter season.

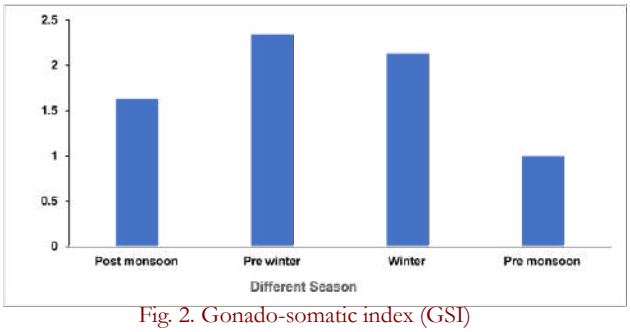


Fig. 2. Gonado-somatic index (GSI)

## Morphological examination of the gonads

### Study of maturity stage of female:

**Stage I (Immature):** The size of the ovaries was very small, thin and slender ribbons occupied 1% of the body cavity, very small size ova were scattered all over the parts of the ovary which were not prominent to the naked eye, the ovaries were pink in color or translucent.

**Stage II (Maturing):** The size of the ovaries was bigger and thicker, ova were prominent with light orange, and irregular and smaller sizes of ova were scattered all over the ovary.

**Stage III (mature):** The size of the ovary was much larger and broader and occupied the body cavity with dark orange, ova were regular, large in size, and opaque.

**Stage IV (Ripe):** The size of the ovary was very large, and fully occupied the body cavity with bright yellow to orange, ova were regular and round shaped all over the ovary.

**Stage V (Spent):** The size of the ovaries was found shrunken, and slender only a few large ova were scattered with pale yellow.

### B. Study of maturity stage of male:

**Stage I (Immature):** The size of the testes was very small, thin, threadlike and transparent.

**Stage II (Maturing):** Test sizes were bigger and thicker than stage I, pinkish in colour.

**Stage III (Mature):** Test sizes were larger than stage I and stage II, pinkish or white filled with milt.

**Stage IV (Ripe):** The size of the testes is much larger, creamy, or light yellowish, filled with milt, under little pressure the milt ooze out.

**Stage V (Spent):** The size of the testes was small, reddish and transparent.

### 3. Fecundity:

The relative fecundity indices expressed as the number of ova per unit of body weight was calculated following Bagenal (1978).

Ova-diameter study (Hickling and Rutenberg, 1936) described the monthly progression of ova-diameter.

The spawning season of the species was estimated/ arrived by analysing the seasonal variation in the morphology of gonads, Gonado-Somatic Index (GSI) and ova-diameter.

The fecundity varies according to species, age, body length, weight and environmental factors. In the present study, the fecundity (total number of mature eggs) of *S. richardsonii* varied from 1,074 to 7,202 eggs in individuals of 185 mm to 267 mm with 53 to 182 g. The mean fecundity was 2,098.38±1,691 eggs. The mean relative fecundity (number of ova/g of body weight) was found to be 19.02. Fecundity in *S. richardsonii* increased with the increase in fish length. However, fishes of same length as well as different length evinced variations in fecundity.

## Conclusion

The present work reveals the food and feeding habitats and reproductive biology of snow trout *Schizothorax richardsonii* (Gray, 1832) in Teesta River, Sikkim. The food items found in the gut content are categorized as diatoms, green filamentous algae, blue-green algae, detritus, and sand. After analysis of gut content diatoms were found to dominate the gut with 67% of total gut content. Among these diatoms, the most dominant was *Navicula* species which makes it the most preferred food. Because the RLG values were more than 1 and did not substantially differ between size groups, it was confirmed that the fish is herbivore in feeding habits and the feeding behavior of this fish has not changed during growth. Feeding intensity was measured by how full the gut was and the maximum gut was empty during the winter season. GaSI values were highest in the pre-monsoon season. The sex ratio was displayed by the dominance of males in the Teesta River. Fish were studied at five stages of gonadal development: immature, maturing, mature, ripe, and spent. The highest female mean GSI values were reported highest in the winter season and lowest reported in the pre monsoon season, while male mean GSI values were reported highest in the pre winter season and lowest in pre monsoon season.

The fecundity of *S. richardsonii* ranged from 1,074 to 7,202 eggs. Biology of *S. richardsonii* provided baseline information on the food-feeding and reproductive biology of the fish, which would also be useful in the management and conservation of this species in its natural environment. Besides, all such biological information will be useful for incorporating in the captive breeding and mass propagation experiments of this important commercial and economical species, particularly in North-Eastern hilly states of India.

## Acknowledgement

The authors acknowledge Dean, College of Fisheries and Head, Dept. of Fisheries Resource Management, COF, Lembucherra for the support in conducting the work on the species (*S. richardsonii*) in Sikkim and are also grateful to CAU, Imphal for the funding support through IRP on Habitat ecology, biology and resource assessment of Snow trout (*Schizothorax richardsonii*) in Teesta River, Sikkim.


Fig.1. *Schizothorax richardsonii*

Fig. 2. Mature male of *S. richarsonii*

Fig. 3. Mature female of *S. richardsonii*

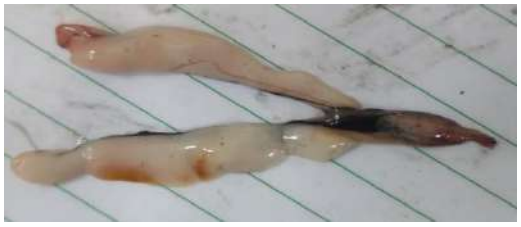

Fig. 4. Testes during spawning season

Fig. 5. Ovary during spawning season

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# ADVANCEMENT IN SOWING DATES OF OKRA IN SOUTH GARO HILLS, MEGHALAYA - A CASE STUDY

**Basu Langpoklakpam, Athokpam Haribhushan, Titus Dalang K. Momin, Tanya R. Marak, Rike Chelchak A. Sangma, Rupam Bhattacharjya, Thongam Monika Devi and Bishorjit Ningthoujam**

*Krishi Vigyan Kendra, South Garo Hills, Meghalaya-794005*
*Central Agricultural University, Imphal*

## Abstract

The present investigation was undertaken at Asugre (NICRA village) in South Garo Hills, Meghalaya during *zaid* season 2023. The results revealed that the growth and yield parameters decreased significantly with delay in sowing time. Sowing of okra on 20th March proved best for plant growth and yield. Days to 50% germination, days to first flower initiation was reduced gradually with delay in sowing from 10th March (S1) to 20th April (S4). Sowing on 20th March recorded significantly taller plants, harvest duration, number of nodes per plant which thereby attributed in production of highest fruits per plant, fruit weight and finally on the yield. The fruit yield was significantly higher under early sown crops over the later sown crops. Hence from the present studies, it is recommended that okra should be sown between 20th March to 30th March in South Garo Hills to harness maximum fruit yield which are free from pest and diseases.

## Introduction

Okra [*Abelmoschus esculentum* (L.) Moench] is an important vegetable crop belonging to Malvaceae family. It is a warm season crop and thrives best under hot and humid condition. Day temperature ranging from 25°C to 40°C and night temperature over 22°C is required for proper growth, flowering and fruit development. But at higher temperature beyond 40 to 42°C, flower may desiccate and drop causing yield losses. It is sensitive to frost and extremely low temperature.

**Before Intervention:** The experimental site lies between the geographical coordinates of 25°35' N latitude, 90°32' S longitude and altitude of 60.0 m above mean sea level. Okra is grown as summer season crop in the river bank during March – April and harvested in June – July which suffers from flash flood and high temperature stress, thereby, affecting the normal growth, flowering, pollination, fruit development and subsequently decreases the yield. Moreover, the harvested produce is exposed to increased population of pests and diseases and suffer from high virus infestation.

**Intervention of KVK:** To intervene the issue of flash flood and high temperature stress experienced by the crop, Krishi Vigyan Kendra, South Garo Hills, CAU(I), conducted a trial on okra by advancing the sowing dates under NICRA project at Asugre village. The good quality seed of okra was provided to the farmers and sown at spacing of 45 cm × 15 cm in a plot size of 3 m × 3 m. The recommended packages of practices were followed for all the treatments under close monitoring by KVK staffs. By adopting optimum sowing dates or advancing the sowing dates such flash flood and high temperature stress on the crop can be escaped.

**Impact of Technology:** Initially, okra growers were getting a net return of Rs. 1,34,001/- only from local varieties but with the intervention of this technology with improved hybrid of Okra (Arka Nikita F1) farmers can obtained an average yield of 185.13 q/ha with a net return of Rs 3,20,395/-. An increase in yield of about 50.51 % was also recorded (Table 1).

Table 1: Performance of Arka Nikita F1 by advancing the sowing dates on yield and economics

| | Average Yield (q/ha) | Net Return (Rs) | B:C | Increase in Yield (%) |
|---|---|---|---|---|
| Demonstration | 185.13 | 3,20,395 | 2.36 | 50.51 |
| Farmers practice | 123.00 | 1,34,001 | 1.57 | |

The data presented in Table 2 showed that minimum days to first flower initiation was observed when okra was sown in 20th April (39.71 days) followed by 10th April (41.94 days) while, maximum days were taken by March sowing dates. Sowing on 20th March recorded significantly taller plants as compared to other sowing dates which may be ascribed to the fact that weather conditions was congenial for plant growth which enhanced plant metabolic activities in the plant. While the plant height in late sown crops was stunted which may be attributed to higher ambient air temperatures encountered by the later sown crop. Harvest duration was maximum in 20th March (52.02 days) followed by 10th March (45.90 days) and 30th March (40.73 days). The least harvest duration was achieved when sown

on 20th April (34.10 days) which was at par with 10th April (35.94 days). This might be due to prevailing low temperature which might have resulted in prolonged harvest duration in earlier sowings. While flowering and fruit setting period in later dates coincided with the high ambient temperature resulting in reduced harvest duration. A declining trend in production of nodes per plant was noticed from March to April. Sowing on 20th March produced maximum nodes (17.79) which was at par with 10th March (17.54), followed by 30th March (16.85), 10th April (16.77) and 20th April (15.85). Fruit weight obtained from 20th March sown crop was significantly superior to 20th April. It might be due to increased length and breadth in March sowings as compared to April sowing dates. The results on fruit yield of okra showed that the fruit yield was significantly higher under early sown crops over the later sown crops. This might be attributed to the favourable climatic conditions that prevailed throughout the crop growth when sown on 20th March. On the other hand, 20th April sowing led to overall reduced growth and vigour of plants due to high temperature (36°C) which are not so conducive for okra and offer short duration for growth coupled with heavy rainfall and flash flood.

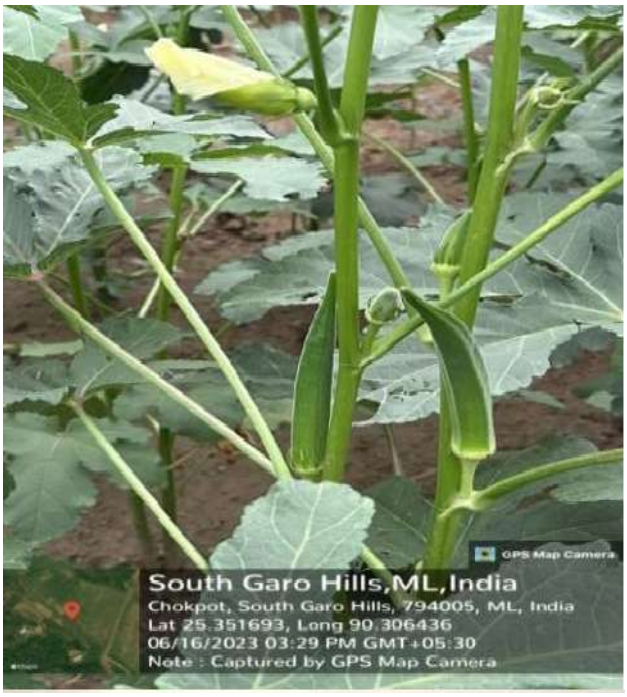
Table 2: Performance of Arka Nikita F1 by advancing the sowing dates

| Sowing dates | Days to flower initiation | Plant height (cm) | Harvest Duration (Days) | Number of nodes per plant | Av. Fruit weight (g) | Yield (q/ha) |
|---|---|---|---|---|---|---|
| 10th March | 45.21 | 112.40 | 46.61 | 18.03 | 8.71 | 113.94 |
| 20th March | 45.51 | 115.40 | 53.49 | 18.13 | 9.25 | 122.14 |
| 30th March | 44.02 | 82.14 | 41.04 | 17.02 | 8.61 | 80.63 |
| 10th April | 41.84 | 70.92 | 36.04 | 16.81 | 8.21 | 70.76 |
| 20th April | 39.54 | 65.87 | 34.46 | 16.71 | 7.56 | 64.47 |

## Conclusion

Sowing of okra from 20th March to 30th March proved to be best for plant height, number of nodes, harvest duration, number of fruits per plant, average fruit weight and fruit yield per hectare. Hence, from the present studies by advancing the sowing dates it is recommended to sow okra from 20th March to 30th March in South Garo Hills which will not only harness maximum fruit yield but also will help to escape flash flood during *kharif* season.


Okra field




Harvesting before occurrence of flash flood

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# A CASE REPORT ON THE DIAGNOSIS AND TREATMENT OF KERATOCONJUNCTIVITIS IN GOAT

**T. Gyaneshori Devi [1], Changamayum Vishwas Singh [2] and K. Merina Devi[3]**

*College of Veterinary Sciences and Animal Husbandry, Central Agricultural University (I), Jalukie - 797110, Nagaland, India*

Infectious keratoconjunctivitis (IKC), often referred to as "pink eye," is a widespread bacterial infection impacting the eyes of domestic goats and sheep, with occasional cases in wild caprine (Abdullah *et al.,* 2013). Characterized by inflammation of the cornea and conjunctiva. IKC in severe cases, lead to blindness (Abdullah *et al*., 2013). The primary causative agent is *Mycoplasma conjunctivae* however, other pathogens including *Chlamydophila spp*., *Staphylococcus aureus*, and *Moraxella ovis*, may also be involved (Pandey, 2018). The condition can be aggravated by environmental irritants such as dust, tall vegetation, and fly infestations, along with stress factors like transport (Fernandez-Aguilar *et al.,* 2017). Highly contagious IKC can spread quickly within a herd, with infection rates reaching as high as 80% over several weeks (Biswas and Saifuddin, 2017).

## Clinical Examination

A 1-year-old Assam Hill goat, weighing approximately 15 kg, the goat exhibited inflammation in left eyes and was being managed under semi-intensive system. Its deworming status was confirmed to be up-to-date. A detailed clinical assessment indicated that the goat was dull and depressed, with a rectal temperature of 102°F and congested mucous membranes. The heart rate was 74 beats per minute, and the respiratory rate was 25 breaths per minute, both within normal limits. Ophthalmic examination of left eyes revealed conjunctivitis, generalized corneal opacity, epiphora, positive menace response, and corneal hyperemia, with early-stage corneal ulceration in the right eye.

## Laboratory Examination

2 ml of whole blood was drawn from the jugular vein into a Lev-Lock K3 EDTA vacutainer for a complete blood count and blood smear examination to check for blood parasites.

## Results

The laboratory results showed positive growth for *Mycoplasma spp*. from the eye swab sample. The parasitological examination of the peripheral blood smear was negative for any haemoprotozoal infections. The complete blood count (CBC) examination of the blood sample collected on day one revealed the following values in **Table. 1**

Table 1: Haematological result on the first day

| Haemogram | Result | Normal range |
|---|---|---|
| Hb (g/dL) | 9.2 | 8-12 |
| PCV (%) | 27.7 | 22-38 |
| RBC ($10^6$/µl) | 14.77 | 8-18 |
| WBC ($10^3$/µl) | 24.74 | 4-13 |
| Platelets ($10^3$/µl) | 367 | 300-600 |
| Neutrophils ($10^3$/µl) | 17.29 | 1.2-6.24 |
| Lymphocyte (%) | 26.5 | 50-70 |

Fig: Showing corneal opacity, corneal

Fig: 1-week post-treatment

## Treatment

Fig: Complete recovery hyperemia, conjunctivitis and epiphora.

The affected goat was isolated from the rest of the flock and placed in a clean, dry, and shaded environment. A widely practiced treatment plan for Infectious Keratoconjunctivitis (IKC) was implemented, which involved the administration of antibiotics. The therapeutic plan included flushing the eyes with 0.9% NaCl solution to remove any dirt particles. Oxytetracycline (20 mg/kg body weight) was administered intramuscularly at a dose of 1.5 ml twice, with a 5-day interval between doses. A single sub-conjunctival injection of 0.3 ml of oxytetracycline (20 mg/kg body weight) was given at the ventral conjunctival fornix to achieve a high localized concentration of antibiotics in the affected area. Neosporin ophthalmic

ointment was applied topically twice a day for 2 weeks. Additionally, a supportive treatment of Vitamin A (1 ml, IM) was administered. The treatment was successful, and within 14 days, the clinical signs returned to normal.

## CONCLUSION

These case highlights the importance of early diagnosis and prompt treatment for managing infectious keratoconjunctivitis in goats. The combination of topical, intramuscular, and sub-conjunctival oxytetracycline, along with Vitamin A injections, effectively managed the disease and led to complete recovery within 14 days. Early intervention during Stage-I prevented progression and complications, contributing to the positive outcome. Proper farm management and herd health practices are critical to reducing the incidence and spread of IKC, emphasizing the importance of early detection and effective treatment strategies in mitigating the impact of this disease. Lastly, we would like to thank the Dean, COVSC & A.H, Jalukie, Nagaland for her support and facilities provided throughout the process of study.

# USES OF *CLITORIA TERNATEA* AS BLUE TEA- A PROMISING HEALTH DRINK

**Y. Ranjana Devi[1], Rocky Thokchom[2], Thongam Chanu Anel[3] and Cassandra H. Ch. Marak[2]**

*[1]Central Agricultural University, Imphal-795004, Manipur*

*[2]College of Community Science, CAU (Imphal), Tura, Meghalaya*

*[3]S. Kula Women's College, Nambol-795134, Manipur*

## Introduction

*Clitoria ternatea* also known as Butterfly pea, blue pea, Asian pigeonwings or Aparajita is a perennial herbaceous plant belonging to the Fabaceae family that grows as a vine or creeper in tropical and subtropical regions of the world and is a highly palatable multi-purpose forage legume. It is used as a ley legume or as green manure and is a valuable cover crop in rubber and coconut plantation. It is also used in fences and in trellises as an ornamental for its showy flowers and is valuable for dyeing and in ethno-medicine. The plant has important traits such as high growth rates, drought tolerance and adaptation to heavy clay soils.

In the world of natural health drinks, few can match the vibrant beauty and impressive health benefits of *Clitoria ternatea*. Its bright blue petals are the main feature, providing the plant with its distinctive, vibrant colour and now gaining popularity worldwide, is making waves in the wellness world as a super drink packed with antioxidants, anti-inflammatory properties, and a host of other health-boosting benefits. Traditionally, it has been used in Southeast Asia for centuries in various culinary and medicinal preparations.

Fig. 1. *Clitoria ternatea* flower

Aparajita has long been cherished in traditional medicine, but it's only recently that its benefits have caught the attention of health-conscious individuals and food enthusiasts alike. Whether in the form of herbal tea, an ingredient in smoothies, or a colourful addition to various dishes, butterfly pea flower offers more than just visual appeal—its health-promoting properties make it a drink worth adding to your daily routine.

### 1. Key Chemical Compounds in Blue Tea

#### a. Anthocyanins

Primary pigment: Anthocyanins, particularly ternatins, are responsible for the intense blue colour.

Chemical structure: These are water-soluble



flavonoid compounds with glycosides attached to their structure.

pH-sensitive: Anthocyanins exhibit a color change depending on the acidity or alkalinity of the solution:

Acidic (pH < 7): Colour shifts to purple or pink.

Neutral (pH ~7): Intense blue colour.

Basic (pH > 7): Colour shifts to green or yellowish-green.

### b. Flavonoids

It acts as antioxidants, scavenging free radicals and reducing oxidative stress. Common flavonoids in butterfly pea flower include Kaempferol and Quercetin.

### c. Proanthocyanidins

They are the polyphenolic compounds that contribute to antioxidant and anti-inflammatory properties. It enhances vascular health and improve brain function.

### d. Tannins

Provide astringency and help in detoxification. It also contributes to the bitter taste of the tea.

### e. Saponins

These are the natural surfactants that have foaming properties. It is known for their cholesterol-lowering and immune-boosting benefits.

### 2. pH-Sensitive Chemistry

Anthocyanins are responsible for the colour-changing property of blue tea.

#### Reaction:

In acidic conditions, anthocyanins lose hydroxyl groups, leading to a structural shift that results in a reddish or purple hue, while under alkaline conditions, hydroxyl groups are retained, stabilizing the blue or greenish colour.

**Example:** Adding lemon juice (acidic) to blue tea changes its colour to purple due to the reduced pH.

### 3. Antioxidant Mechanism

Anthocyanins and flavonoids donate hydrogen atoms or electrons to neutralize free radicals, breaking the chain of oxidative damage. These compounds form stable intermediates, reducing cellular damage and inflammation.

### 4. Heat and Light Sensitivity

Anthocyanins are sensitive to temperature and light. Prolonged exposure may degrade anthocyanins, leading to a loss of colour intensity. UV radiation can oxidize anthocyanins, reducing their effectiveness as antioxidants.

### 5. Role of Other Minerals and Nutrients

Iron and calcium ions: May interact with anthocyanins, affecting colour and stability.

Vitamin C (if lemon is added): Enhances the antioxidant capacity by acting synergistically with anthocyanins.

## HEALTH BENEFITS OF *Clitoria Ternatea*

### 1. Rich in Antioxidants

*Clitoria ternatea* is a powerhouse of antioxidants, particularly anthocyanins—the pigments responsible for the flower's striking blue colour. These antioxidants help fight free radicals in the body, reducing oxidative stress and lowering the risk of chronic diseases such as cancer, heart disease, and diabetes. Antioxidants also support the skin by fighting aging signs, making it an excellent addition to beauty regimes.

### 2. Supports Brain Health and Cognitive Function

*Clitoria ternatea* is often referred to as a "brain booster" in traditional medicine. The plant contains compounds that have been shown to enhance memory, focus, and cognitive function. One of its key components, acetylcholine, is a neurotransmitter that plays a crucial role in memory and learning. Regular consumption of butterfly pea flower tea may help improve mental clarity, reduce brain fog, and even lower the risk of neurodegenerative diseases like Alzheimer's and Parkinson's.

### 3. Reduces Stress and Anxiety

In addition to its cognitive benefits, *Clitoria ternatea* is known for its adaptogenic properties, meaning it helps the body adapt to stress. Drinking butterfly pea flower tea has a calming effect on the body and mind. It can help reduce anxiety, promote relaxation, and improve sleep quality, making it an ideal beverage to unwind after a busy day or before bedtime.

### 4. Anti-Inflammatory and Pain-Relieving Properties

*Clitoria ternatea* has powerful anti-inflammatory properties. It contains natural compounds that help reduce inflammation in the body, which can be beneficial for individuals suffering from conditions like arthritis or other inflammatory diseases. Drinking the tea may help alleviate joint pain, swelling, and discomfort associated with chronic inflammation.

### 5. Boosts Immune System

The antioxidants and flavonoids in *Clitoria ternatea* help strengthen the immune system, making it more effective at warding off infections and illnesses. The plant's compounds may also have antibacterial and antiviral properties, further supporting your body's defence mechanisms. Regular consumption can help keep you healthy, especially during cold and flu season.

### 6. Supports Skin Health

The presence of anthocyanins and flavonoids not only benefit your internal health but also contribute to skin health. These compounds have been shown to promote collagen production, which helps maintain skin elasticity and prevent wrinkles. Drinking butterfly pea flower tea regularly may help keep your skin glowing and youthful. It is also often used in beauty treatments and skincare products for its soothing properties.

### 7. Aids Digestion

*Clitoria ternatea* has been traditionally used as a natural remedy for digestive issues. The flowers have mild laxative properties, which can help relieve constipation and improve overall digestive health. Additionally, butterfly pea flower tea can help calm the stomach, reduce bloating, and support the digestive system's normal function.

### 8. Helps with Weight Loss

While more research is needed in this area, some studies suggest that *Clitoria ternatea* may help reduce fat accumulation and improve metabolism, making it potentially beneficial for weight loss. The plant's ability to lower stress and inflammation may also contribute to healthy weight management.

### How to Enjoy *Clitoria Ternatea*

*Clitoria ternatea* is incredibly versatile and can be consumed in several ways:

- **Butterfly Pea Flower Tea**: The most popular form is as a simple herbal tea. Just steep a few dried flowers in hot water, and enjoy the naturally vibrant, blue beverage. You can sweeten it with honey or add a splash of lemon juice for a color-changing effect.
- **Smoothies and Juices**: Add butterfly pea flower extract or a few petals to smoothies or fruit juices for a boost of antioxidants and a stunning blue hue.
- **In Cooking**: The flower can also be used in culinary dishes like rice, curries, and desserts, especially in Southeast Asian cuisine. The flowers can naturally dye food and beverages, giving them a distinctive colour while enhancing their nutritional value.
- **As a Face Mask or Skincare Ingredient**: The tea or powdered petals are sometimes used in beauty treatments to reduce puffiness, soothe skin irritation, and enhance complexion.

SIDE EFFECTS: There are currently no reported side effects from drinking blue tea and is generally considered safe when used in moderation. Although there is no research on its side effects some people have claims that it may lead to digestive discomforts if consumed in large amounts.

### CONCLUSION

*Clitoria ternatea*, or butterfly pea flower, is more than just a pretty drink—it's a nutrient-rich, health-boosting powerhouse. Whether you're looking to improve your cognitive function, reduce stress, support your immune system, or simply enjoy a colourful and flavourful beverage, this magical flower can provide a wide range of health benefits. Its growing popularity is a testament to its effectiveness and versatility as a natural health drink.

Fig. 2. Shade dried Aparajita flowers

Fig. 3. Blue tea


Fig. 4. Packaged blue butterfly pea flower

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# INDIGENOUS KNOWLEDGE: THE KEY TO SAVE FOR A SUSTAINABLE FUTURE

**Chabungbam Victoria Devi & Telem Matouleibi Chanu**

*Central Agricultural University, Imphal, Manipur*

Indigenous knowledge is a highly localized knowledge, is unique to a particular culture or society and based on whole range of human experience. It is also known as local knowledge, folk knowledge, people's knowledge, local knowledge or wisdom or culture, non-formal knowledge, indigenous technical knowledge, traditional ecological knowledge and traditional knowledge.

Since the evolution of mankind it is being used by human beings as per needs, available resources and location in various arenas of livelihood, animal husbandry, ayurvedic medicine, engineering, storage, food preparation, environment conservation and a multitude of other activities. Usually such knowledge is transferred from generation to generation in a verbal manner.

## It is termed as local knowledge

It is considered a part of the local knowledge in the sense that it is rooted in a particular community and situated within cultural traditions. This knowledge is embedded in the experiences of indigenous or local people and involves intangible factors, including their beliefs, perspectives and value systems. It is unique to every culture and society and it is embedded in community practices and rituals. So it is obviously localized and restricted and its generation is normally governed by local environmental factors and cultural conditions. It varies between countries, regions and even between farm to farm.

Indigenous Technical knowledge are also generated out of farmers own knowledge and experience in dealing with day-to-day problems.

## North Eastern States and its Traditional Knowledge

The North Eastern region of India is a gift of nature having rich cultural biodiversity and diversified agro-climatic conditions. For its richness in biodiversity, the region has been identified as one of the 18 biodiversity hot spots of the world. The region is inhabited by many important tribes, which are known for its rich ethnicity and indigenous technical knowledge. The economy of this eastern Himalayan region is mainly based on agriculture, animal husbandry and the allied. The region is a conservatory of indigenous knowledge of cultivating crops, animal husbandry and also the preparation of food and medicines from the highly diversified flora and fauna that are inherent to this region. At every curve of the hills of this unique topography there is music of nature and ripples of culture that characterize the rich biodiversity, praxis and ethnicity. As a matter of fact, the traditional societies in North East India have a rich Traditional Ecological Knowledge (TEK) and Indigenous Technical Knowledge (ITK).

## Urgent needs for the study of this traditional knowledge

In recent years, considerable importance has been ascribed by a growing number of scientists and organizations in indigenous knowledge of the third world countries. In fact, indigenous knowledge used in various part of the world in general and India in particular is still less explored. Unless preserved, indigenous knowledge may pass into oblivion forever and cannot be revived at any cost.

The unique ethnicity, biodiversity and traditional practices of North East have provocated the inquisitive minds to set off an investigation of its rich indigenous traditional knowledge, practices and culture. While there have been changes of biodiversities with the change in topography, there should have been a change of traditional practices. It would critically analyse the unique flow of information, the texture of praxis, the curve of enthnobotanical configuration and the rich traditional knowledge.

Indigenous knowledge is developed and adapted continuously to gradually changing environments and passed down from generation to generation and closely interwoven with people's cultural values. Indigenous knowledge is also the social capital of the poor, their main asset to invest in the struggle for survival, to produce food, to provide for shelter or to achieve control of their own lives. Many traditional agricultural systems need to be redeveloped through incremental, rather than quantum change, based on traditional ecological knowledge; anything drastic may not find acceptance by the local communities.

Today, many indigenous knowledge systems are at risk of becoming extinct because of rapidly changing natural environments and fast pacing economic, political, and cultural changes on a global scale. In





recent years, considerable importance has been ascribed by a growing number of scientists and organizations in indigenous knowledge. But, indigenous knowledge used in various part of North East in general and Manipur in particular is still less explored. Unless preserved, indigenous knowledge may pass into oblivion forever and cannot be revived at any cost.

### Role of indigenous knowledge in the life of the tribals and ethnics people of Manipur

During a research in the hill districts and other plain areas of Manipur, utilization of indigenous technical knowledge in every aspects of livelihood of our people were observed. Mention may be made of some:

Often we find the habit of consuming wild food plants and other minor vegetables found in the region. They are told by our forefathers to have possessed medicinal values.

### Example:

a) *Angom yensil* ( *Polygonum chinense*)-Boiled leaves are used for wrapping on the old wounds for removing pus.

b) *Awa kege* (*Jatropha curcus*)- Leaf extract used in toothache and promoting lactation, latex used in boils, skin sores and rheumatism

c) *Chantrook*(*Capsella bursa pastoris)* - Used as salad, stops bleeding from internal organ.

d) *Leibak Kundo* (*Portulaca oleracea*)- Leaves and stem used in gum and teeth problem, Good for liver disease. Herb used for kidney, bladder disease and used as tasty delicacies.

We usually say some tribal are stronger than the people living in cities. One reason may lie somewhere in the diet which mainly consist of wild food plants. But important aspect of contribution of wild food resources for good health and preventing disease is generally unrecognised. They are regarded as cheap source of energy, vitamins and minerals.

### AGRICULTURE RELATED

a) Wood ash is sprinkled on the leaves of chilly, beans and fruits like orange, banana and papaya for early bearing of fruits since it carries small amount of nutrients like phosphorus, iron, boron, manganese, copper, zinc and potassium.

b) Burning of leftover straws and stubbles to clear left-over in the field destroys insect pests harboring in the field. It also destroys pathogens in the diseased plants and prevents from spreading into the next crop. Also it adds ash to the soil which is beneficial.

c) Paddy seeds are soaked in a cow dung solution for 2 days, sundried and sown to increase resistance of seedling to pest and diseases and also reduce the incidence of leaf spot and rice blast.

### ANIMAL HUSBANDRY RELATED

a) Treating diarrhoea with Bamboo leaves. Bamboo leaves are given abundantly twice a day. Bamboo leaves contains 15.09% crude protein, 23.15% crude fibre, 1.43 ether extract, 18.35% ash, 170mg/100g phosphorus, 1550mg/100g calcium. It is antidyretic. It helps to solidify stool.

b) Feeding of tamarind leaves and mustard seeds to control bleeding dysentery. Animals are to be fed tamarind leaves and mustard seed with some water for consecutively 3 days in the morning in empty stomach. Tamarind contains malic acid,which is a mild laxative. The acid acts as diuretic. Geranial and geraniol in tamarind are inhibitory to several photogenic fungi and bacteria. Tamarind pulp contains metheyel salicylate, which acts like salicylate exerting antipyretic, anti inflammatory and analgesic effects. It is astringent. Again, Ferulic acid and coffee acid present in mustard are anti mutagens. Coumaric acid in mustard is antipyretic. It helps in curing of dysentery.

c) Treating FMD with Neem. Neem leaves boiled in water are used to wash the infected hoves. Neem leaves contain triterpenes and tetranortriter penoids, nimbin, nimbidin, nimbinine, salanin, azadirone, tannins, acids and sulphur. It has antibacterial property. It acts as antiseptic to the wounds.

d) Treating animals with turmeric against bloat. Paste of raw turmeric mixed with molasses and fed twice to the animal. Cineal, linalool present in the crude plant extract of turmeric relief stomach ache and molasses increase the water intake. This process helps in the removal of gas from the stomach. Also,

e) The parts of animal body is rubbed with the decoction of the whole parts of *Mimosa pudica* (Manipuri: *kangphal ikaithabi*) to cure from scabies and other allergic conditions in animals.

f) The leaves of *Syzygium jambos* (hindi: gulab-jamun) mixed with tender shoot of *Arundo donax* (Manipuri; *yenthou*) traditionally used as medicine to increase milk yield in lactating cow.

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### Local knowledge has also been found useful for ecosystem restoration

People also follow ethics that often help them regulate interactions with their natural environment.

In Manipur, various ethnic groups have preserved and protected several forest patches and observed the *"Umang Lai haraoba"* .The forest patches are owned by some deity and conserved by the local people largely on the basis of religious beliefs and cultural practices. They have preserved forest in its pristine**.** Villagers or the people of that locality consider any sort of damage in this sacred forest as a sin.

### Indigenous knowledge for food processing

The ethnic groups of Manipuris consume fermented food and alcoholic beverages, among which *soibum/ soidon* (fermented bambooshoot), *ngari* (fermented fish), *hawaijar* (fermented soyabean seed), *Atingba* (fermented alcoholic beverage). A lot of our ethnics group are economically dependent upon these local products.

a) *Soibum* and *soidon* are the favourite and widely consumed in the state. Micro-organism found are Lactic acid bacteria such as *Pediococcus pentosaceus, Lactobacillus plantarum, Enterococcus faecium* and the Bacillus found *is Bacillus firimus, B. subtilis.*

b) *Ngari* is a compulsory ingredient of everyday consumption in a Manipuri family. Micro-organism found are Lactic acid bacteria such as *Lactobacillus brevis, Leuconostoc mesenteroides*, Bacillus found is *B. cereus, B.firmus* and yeast found is *Debaryonyces hansenii.*

c) *Atingba* (fermented alcoholic beverage) is an integral part of rituals in various ethnic groups in Manipur. Without it no festivals or ceremonies is completed. Microorganism found are Lactic acid bacteria such as *Pediococcus pentosaceus,* Bacillus found as *B licheniformis, B. subtilis* and yeast found is *Saccharomyces cerevisiae.*

Further, minerals present in uncooked rice, raw bamboo shoots and their fermented products were estimated. The results showed higher content of minerals in fermented products than that of the raw substrates.

### Consuming of macro fungi, mushroom, Fungi grown on rotten wood such as

a) *Uchina* (*Auricularia deligata*), It is good for diabetis and constipation.

b) *Kanglayan* (*Schizophyllum commune*). It is prescribed for hoarseness, tonsillitis and diabetis

c) *Chengum* (*Agaricus campestris*). It is given to combat weakness and ricket, diet for T.B patient

d) *Uyen* is similar to Shittake mushroom (*Lentinula edodes*). It has good medicinal properties.

**So many of The ITKs are known by our people since time immemorial** and a lot have been collected during my research and validated scientifically with the help of further research and related scientist. Some are commonly known to us, such as:

a) If there is double rainbow and migration of ants carrying their eggs, uprising of ants with wings, there is possibility of heavy rain.

b) Farmers usually dig well/pond for water. Farmers reveal location of white ants in the field is a clear indication of availability of ground water.

c) Pulling jute ropes drenched with kerosene across nursery bed of rice helps as repellents for stemborer attack.

## CONCLUSION

Indigenous knowledge unless documented is set to be replaced by modern technology. Current forms of development have begun to devalue indigenous knowledge. So, many Indigenous knowledge effectively used in one society can be used to solve the problem in another society in a similar agro-ecosystem, vis-a-vis recommended domain.

Therefore, documentation of indigenous knowledge can help to compare and contrast with international knowledge system. Through science based technology, improvement of the beneficial aspect of the indigenous knowledge system as well as those could be made. So, indigenous and modern approach may be combined as the so called "technology blending" for the evolution of new technology. So it is very important part to do research to gain functional understanding of indigenous knowledge system which includes collection and assessment (validation) of such indigenous knowledge and finally its documentation and validation for saving of our ancient indigenous technical knowledge.

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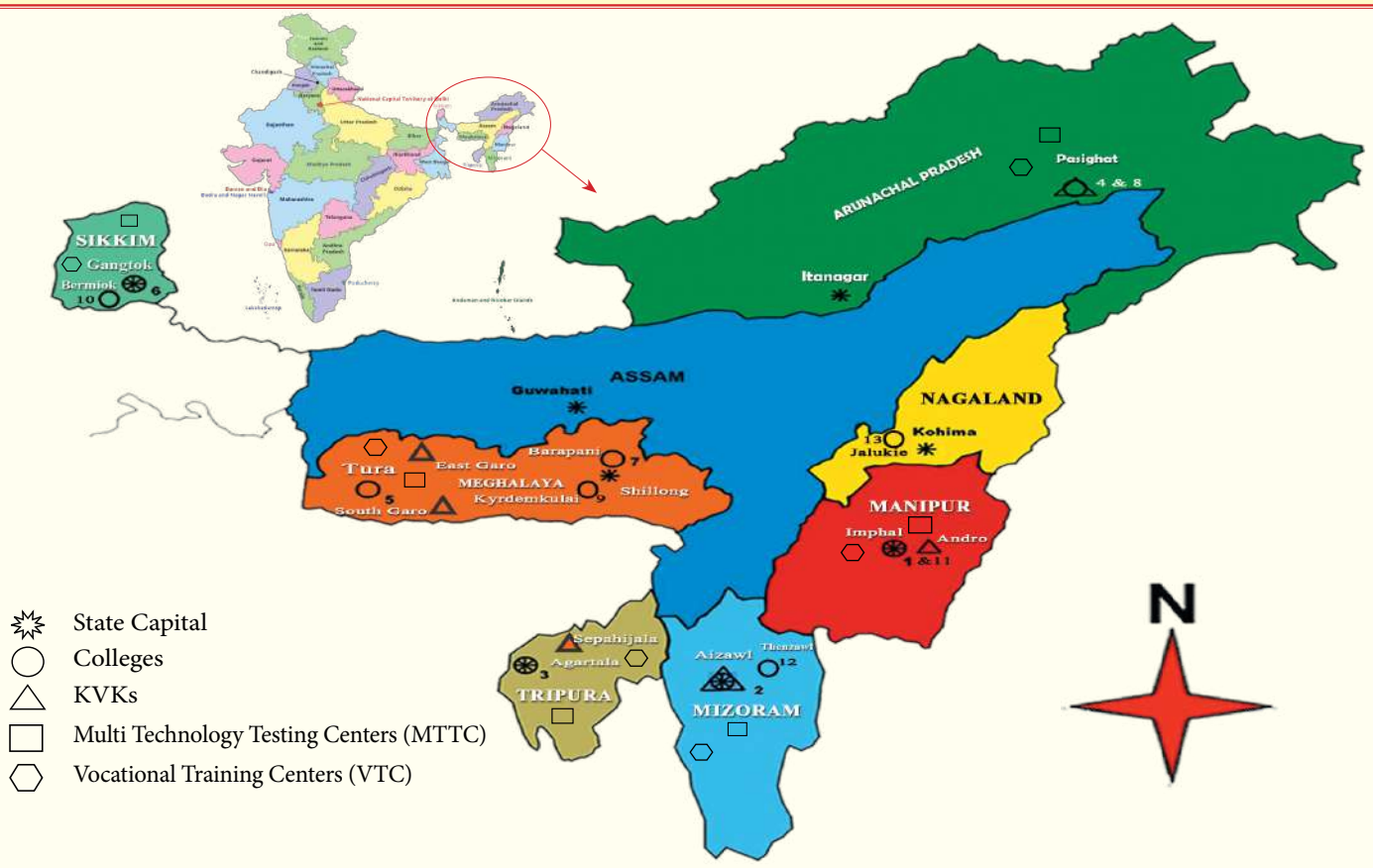


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