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From the Editor's Desk

Prof. Ph. Ranjit Sharma
Director (Extension Education)

In a world where agriculture is the cornerstone of our existence, the need for sustainable farming practices has never been more critical. As an agricultural university, we recognize our responsibility to educate, inspire, and empower farmers to embrace a more sustainable approach to farming. This editorial is a call to action for both our agricultural community and farmers everywhere to prioritize sustainable agriculture for the sake of our future.

Sustainability in agriculture encompasses various aspects, from soil health and water conservation to crop diversity and responsible pesticide use. By adopting these practices, we can not only protect our environment but also increase the resilience and profitability of our farms. Healthy soil, for instance, is the bedrock of sustainable agriculture, as it ensures that our land remains fertile for generations to come. Utilizing crop rotation, cover cropping, and reduced tillage can significantly improve soil health. Diversifying crops and promoting native species not only safeguards against crop diseases but also contributes to the overall ecological balance. Integrated pest management can significantly reduce the reliance on harmful chemicals, benefiting both the environment and farmers' long-term health.

The Directorate of Extension Education, CAU Imphal is committed to providing the knowledge, resources, and tools needed to transition to sustainable practices. Through training, outreach, and partnerships, we aim to pave the way for a more environmentally responsible and economically viable agricultural industry. Farmers, too, play a crucial role in this journey. By embracing sustainable agriculture, they not only secure their livelihoods but also contribute to a healthier planet. We urge all farmers to seek out resources and training on sustainable practices, and to make a conscious effort to integrate them into their daily work. I hope the readers of the magazine will find the issue useful.

We wholeheartedly welcome our readers' feedback and valuable suggestions to continuously improve and serve better.

(Prof. Ph. Ranjit Sharma)
Chief Editor

SPECIAL ISSUE
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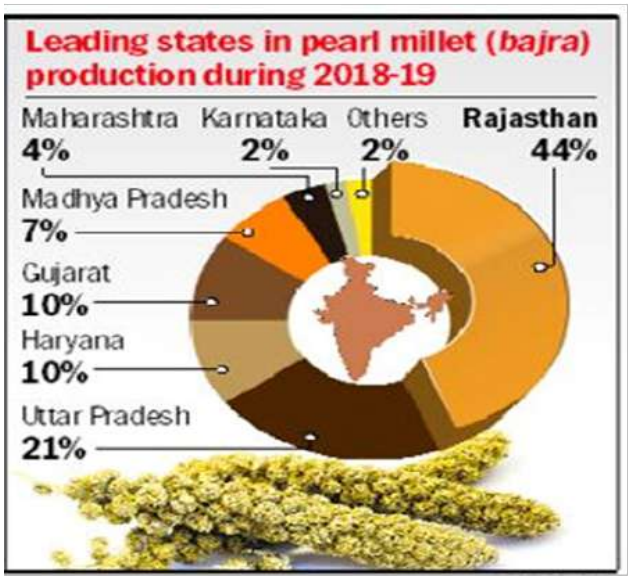
NUTRITIONAL PROPERTIES OF DIFFERENT MILLETS AND THEIR VALUE-ADDED FOOD PRODUCTS

Punabati Heisnam, Abhinash M., Kh. Stina, Chanchan M., Saurabh Sharma and Ng. Bidyapati
College of Agriculture, Central Agricultural University, Iroisemba, Imphal-West

Introduction and importance of millets

Millets are small-seeded grasses that have been integral to human diets in Asia and Africa for thousands of years (Devi *et al.*, 2014). In India, 15.3 mt of millets is produced from nearly 12.7 MH areas that constitute about 6 % of national food grain basket. Rajasthan has the highest area of 1371.93 thousand hectare with production of 1025.98 thousand tonnes follow by the state Maharashtra with the production of 935.18 thousand tones. Millets grains are especially valuable due to their adaptability to extreme environmental conditions like drought and low soil fertility, which makes them particularly well-suited for cultivation in arid and semi-arid regions (Gopalan *et al.*, 1989). Compared to other major cereals such as wheat and rice, millets exhibit greater resistance to pests and diseases, thereby minimizing the need for chemical pesticides and fertilizers. This resilience not only makes them a sustainable crop option but also supports environmentally friendly farming practices (Chandra *et al.*, 2016).



Source: FAO, Fig: Status of millets production in India

Millets are highly valued for their exceptional nutritional profile, being rich sources of dietary fiber, protein, and essential vitamins and minerals such as iron, calcium, and magnesium (Verma & Patel, 2013). These grains are especially notable for their abundance of B-vitamins, which play a critical role in energy metabolism and maintaining a healthy nervous system (Devi *et al.*, 2014). Additionally, because millets are naturally gluten-free, they serve as an excellent dietary alternative for those with celiac disease or gluten intolerance (Chandra *et al.*, 2016). Millets hold significance that goes beyond their nutritional benefits. Recently, there has been increasing recognition of their potential to combat food insecurity and malnutrition, particularly in developing nations (Verma & Patel, 2013). In addition to being nutrient-dense, millets are a crucial crop for millions of smallholder farmers, especially in areas that experience unpredictable climate conditions (Gopalan *et al.*, 1989).

Nutritional Properties of Different Millets

1. Sorghum (Jowar)

Sorghum

- **Carbohydrates:** 72-75 g/100 g
- **Protein:** 10-12 g/100 g
- **Fiber:** 6-9 g/100 g
- **Minerals:**
  - Iron: 4.1 mg/100 g
  - Calcium: 25 mg/100 g
  - Magnesium: 123 mg/100 g
  - Phosphorus: 289 mg/100 g
- Vitamins: Rich in B-vitamins, particularly niacin (B3) and thiamine (B1).

2. Pearl Millet (Bajra)

Pearl millet

- **Carbohydrates:** 67-71 g/100 g
- **Protein:** 10-12 g/100g
- **Fiber:** 8-12 g/100 g
- **Minerals:**
  - Iiron: 6-8 mg/100 g
  - Calcium: 42 mg/100 g
  - Magnesium: 130 mg/100 g
  - Phosphorus: 296 mg/100 g
- Vitamins: High in niacin (B3), thiamine (B1), and folate (B9).

3. Finger Millet (Ragi)

- **Carbohydrates**: 72-76 g/100 g
- **Protein**: 7-8 g/100 g
- **Fiber**: 3-4 g/100 g
- **Minerals**:
  - Iron: 3.9 mg/100 g
  - Calcium: 344 mg/100 g (one of the richest sources of calcium)
  - Magnesium: 137 mg/100 g
  - Phosphorus: 283 mg/100 g
- **Vitamins**: Contains B-vitamins, particularly niacin (B3) and folate (B9).


Finger millet

4. Foxtail Millet (Kangni)

- **Carbohydrates:** 60-63 g/100 g
- **Protein:** 12-14 g/100 g
- **Fiber**: 8-12 g/100 g
- **Minerals**:
  - Iron: 2.8 mg/100 g
  - Calcium: 31 mg/100 g
  - Magnesium: 131 mg/100 g
  - Phosphorus: 290 mg/100 g
- **Vitamins**: Rich in B-vitamins and a good source of antioxidants.


Foxtail millet

5. Barnyard Millet (Sanwa)

- **Carbohydrates**: 65-68 g/100 g
- **Protein**: 6-7 g/100 g
- **Fiber**: 13-14 g/100 g (highest among millets)
- **Minerals**:
  - Iron: 4 mg/100 g
  - Calcium: 11 mg/100 g
  - Magnesium: 119 mg/100 g
  - Phosphorus: 280 mg/100 g
- Vitamins: Contains a good amount of B-vitamins, particularly niacin (B3).


Barnyard millet

6. Kodo Millet (Kodri)

- Carbohydrates: 65-70 g/100 g
- Protein: 8-9 g/100 g
- Fiber: 9-10 g/100 g
- Minerals:
- Iron: 1.7 mg/100 g
- Calcium: 27 mg/100 g
- Magnesium: 119 mg/100 g
- Phosphorus: 188 mg/100 g
- Vitamins: Rich in B-vitamins, especially niacin (B3) and folate (B9).


Kodo millet

Health Benefits of Millets

- **Diabetes Management**: Due to their low glycemic index, millets help in managing blood sugar levels, making them beneficial for people with diabetes.
- **Heart Health**: The high fiber content in millets helps in reducing cholesterol levels and maintaining heart health.
- **Weight Management**: Millets are filling and help in weight management due to their high fiber content and low-calorie nature.
- **Digestive Health**: The fiber in millets aids in digestion and prevents constipation.

Value-Added Products from Millets

Millet Flour

- Used to prepare flatbreads (roti), pancakes, and porridge.
- Nutritional Benefit: Retains most of the fiber, protein, and minerals of the whole grain, making it suitable for gluten-free diets.

Millet-Based Breakfast Cereals

- Processed into flakes or puffed grains, often used in breakfast cereals.
- Nutritional Benefit: High in fiber and provides sustained energy release due to the complex carbohydrates.

Millet Snacks

- Extruded millet snacks, such as puffs or chips, are increasingly popular.
- Nutritional Benefit: Lower in fat compared to traditional snacks, with higher fiber and mineral content.

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Millet Pasta

- Millet flour is used to produce gluten-free pasta.
- Nutritional Benefit: Offers a healthier alternative to wheat-based pasta, with higher fiber and protein content.

Millet-Based Bakery Products

- Breads, cakes, and cookies made from millet flour.
- Nutritional Benefit: These products are higher in fiber and minerals compared to those made with refined wheat flour, offering improved satiety and nutritional value.

Fermented Millet Products

- Products like millet-based idli, dosa, and beverages (e.g., millet beer in Africa).
- Nutritional Benefit: Fermentation enhances the bioavailability of nutrients, particularly B-vitamins and minerals, and improves digestibility.

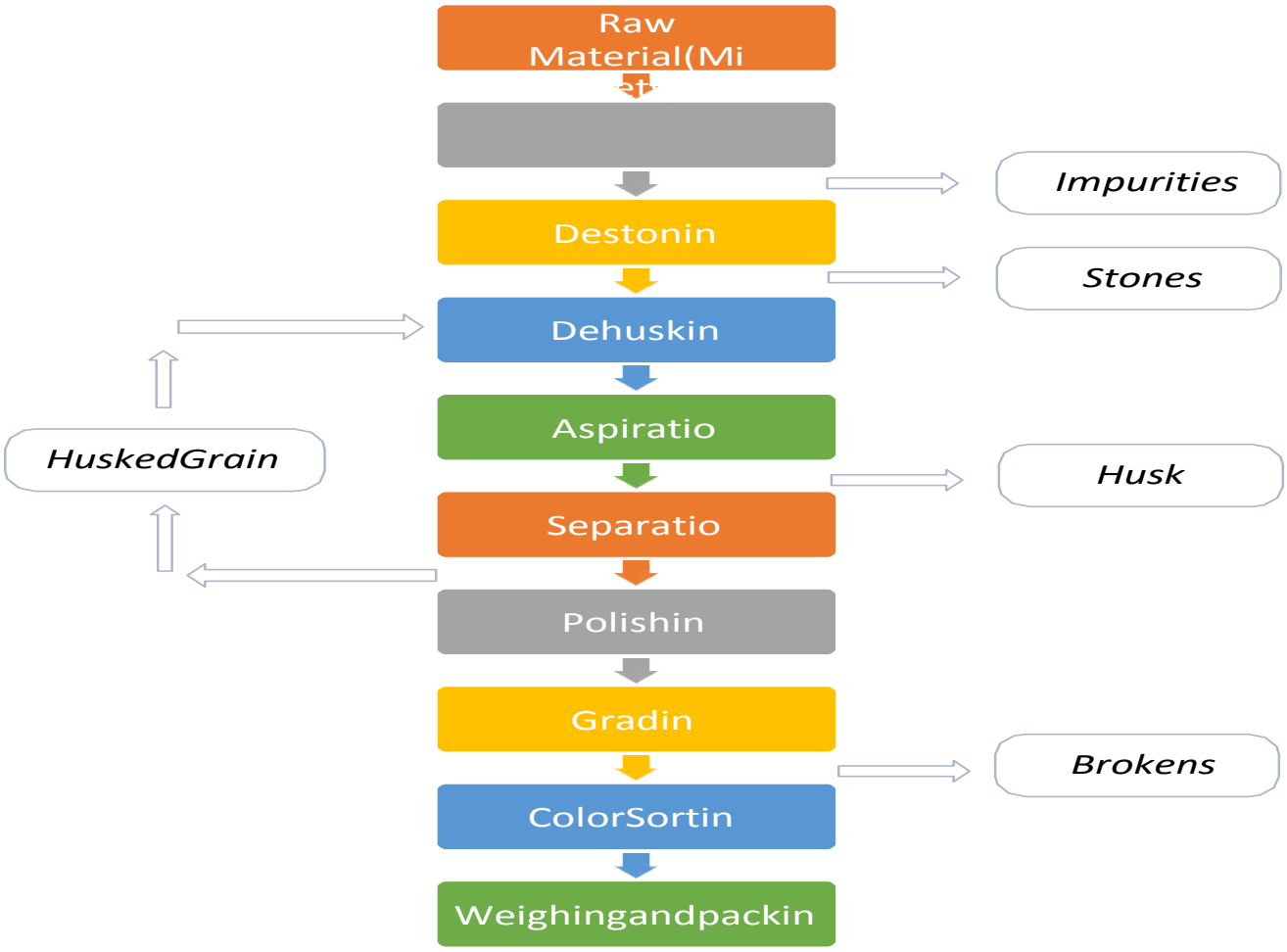

Fig: Flowchart showing the steps involved in primary processing/millingof millets

Conclusion

Millets are a versatile and nutritious group of grains that offer numerous health benefits. They are rich in essential nutrients like dietary fiber, protein, vitamins, and minerals, making them an excellent addition to any diet. The development of value-added food products from millets, such as flours, breakfast cereals, snacks, pasta, bakery products, and fermented foods, has expanded their culinary uses and made them more accessible to consumers. As research continues to uncover the health benefits and environmental sustainability of millets, these grains are poised to play an increasingly important role in global food security and nutrition.

BLACK TURMERIC: A MEDICINAL AND ENDANGERED CURCUMA SPECIES OF NORTHEAST INDIA

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Introduction

Turmeric, also known as "Indian saffron" has been valued as a source of medicine, a condiment and a color additive in South Asian countries, since time immemorial. Its importance was documented in Sanskrit, the ancient Indian language between 1700 and 800 B.C., in the Vedic age. While turmeric species have been cultivated all over the tropics, some species have also been reported from China, Australia and the South Pacific. India is one of the richest biodiversity countries where the North Eastern part of India is recognized as biodiversity hotspot. Among the different regions of North Eastern states major spices like chilies, turmeric, ginger, cardamom, bay leaf, and black pepper are grown. The turmeric and ginger are prominently cultivated in *jhum* fields as a cash crop (Pandotra *et al.*, 2013). About 40 species are indigenous to India, and black turmeric (*Curcuma caesia*) is one of the economically important species along with C. *aromatica*, C. *amada*, C. *aeruginosa*, C. *longa*, and C. *zanthorrizha* (Ravindran 2007; Nair 2013). Up to 110 species of turmeric have been reported from tropical Asia with greatest diversity from India, Myanmar and Thailand. *Curcuma caesia* Roxb belongs to the family of Zingiberaceae and genus *Curcuma.* This turmeric species is also known as black turmeric, kali haldi in Hindi, Yaingangamuba in Manipuri, Borangshaga in Monpa and BeiAchomba in Sherdukpen communities (Arunachal Pradesh). Black turmeric is a perennial herb with bluish-black rhizome and emits a characteristic sweet smell, due to the presence of essential oil. It has a bitter and hot taste with a pungent smell (Pandey *et al.*, 2003; Das *et al.*, 2013). Black turmeric can thrive well in moist deciduous forest areas in clayey soil. Mostly it is found in North-East and Central India, but it can also grow well in some parts of South India. With deep violet patches in its leaves, the plant has a height ranging from 0.5 to 1.0 m.C. *caesia* has been used since ancient times for the treatment of various ailments and diseases in the Indian community.*Curcuma caesia* Roxb species has been categorized as endangered due to drastic decrement of this plant in its natural habitat.

Medicinal Values

Black turmeric has been used for medicinal purposes in general healthcare particularly in rural areas since ages. It has been used by many tribal communities worldwide from centuries as spice, medicine and in spiritual practices. The black turmeric paste is believed to have anti-bacterial and anti-fungal properties and is also ingested to soothe an upset stomach and relieve digestive issues. Beyond wound healing, Kali Haldi paste is rubbed on sprains and bruises to temporarily relieve pain or placed on the forehead to reduce the severity of migraines. *C. caesia* extract is used for the treatment of asthma, cancer, inflammation, epilepsy, fever and allergies. In addition, the rhizomes and leaves of*C. caesia* were found to contain essential oils such as camphor, eucalyptol, tropolone, ledol and camphene, which are responsible for the aromatic odor. In the numerous pharmacological studies on *C. caesia,* the extracts of *C. caesia* possess anticancer, anti-asthmatic, anti-acne, anti-inflammatory and anti-microbial properties. The local tribes of Arunachal Pradesh use black turmeric for different medicinal purposes. The Adi tribe of Arunachal Pradesh uses fresh rhizome of black turmeric as anti- diarrhoetic whereas the Khamti tribe belonging to Lohit district of Arunachal Pradesh uses the paste of fresh black turmeric rhizome for treating scorpion and snake bite (Chadalavada *et al.*, 2017). Its rhizome is also used as a muscle relaxant and also possesses some anti-asthmatic activity. These rhizomes are traditionally used in treatment of stomachache, typhoid and wounds in tongue by the Monpa community of Dirang (West Kameng) in Arunachal Pradesh.

Bioactive Components in *C. Caesia*

Medicinal uses of the rhizome arise from the bioactive components. The Black turmeric is a very important source of potentially useful bioactive compounds for the development of new chemotherapeutic agents. The bioactive compounds vary within the species as well as from place to place owing to different agro climatic conditions and environment. The plant contains a good percentage of curcumin which possesses many curative properties. The multiple phtyoconstituents like curcumminoids, oil content, flavonoids, phenolics, amino acids, protein and high alkaloids, found in the rhizome, are responsible for the antimicrobial, antibacterial, antitumor, anxiolytic, antiinflammatory,

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Fig. 1: C. *caesia* plant

Fig. 2: Fresh rhizome of C. *caesia* plant

Fig. 3: Dried Rhizome

antiulcer, CNS depressant and antioxidant activities (Karmakar *et al.*, 2013; Devi *et al.*, 2015; Vineela *et al.*, 2017) (Table 1). Being a species of the genus Curcuma that has been known for its antimicrobial potential, black turmeric should be seen as an important source of plant based antimicrobials. Such species are likely to provide safer alternatives to the microbe-based antimicrobials which are increasingly reported for their side effects and drug resistance (Pandey *et al.*, 2015). It was also reported that in a field and market based survey, conducted in Dirang area of Arunachal Pradesh, this medicinal herb was recorded with economic benefits in the local communities due to its high market price (Approx. Rs. 3000-3500/kg).The local communities should be encouraged to generate income through cultivation of this plant species at commercial scale.

Table 1: Content of volatile oil, total curcuminoids and other bioactive components in Curcuma caesia (Karmakar *et al.*, 2013).

Parameter	Content in Rhizomes
Total Curcumin (mg/g dry wt.)	78.4±0.06
Volatile oil content (% v/w)	6.75±1.12
Total Phenol (mg/g dry wt.)	60±0.03
Flavonoids (mg/g dry wt.)	30±0.06
Alkaloids (mg/g dry wt.)	104.25±1.66
Soluble Protein (mg/g fresh wt.)	47.5±1.9

Conclusion

C. caesia is widely distributed throughout India. The usage of plant rhizome appears to have a broad spectrum of activity on several ailments. Rhizomes of the plant have been explored for antifungal activity, smooth muscle relaxant and anti-asthmatic activity, antioxidant activity, analgesic activity, locomotor depressant, anticonvulsant and muscle relaxant effects, anxiolytic and CNS depressant activity, anti-bacterial activity, anti-ulcer activity and many other miscellaneous activities. Several phytochemical studies have been reported but still it needs to progress. With the availability of primary information, further studies can be carried out like clinical evaluation, phytoanalytical studies and toxicity evaluation. The plant is pre-clinically evaluated to some extent; if these claims are scientifically evaluated clinically, then it can provide good remedies and help the mankind in various ailments.Besides having all the medicinal properties, black turmeric canfurther be used to uplift the economy of the rural community.

AN OVERVIEW OF REARING SYSTEM, DIFFERENT BIOMETRIC TRAITS AND PERFORMANCE OF MANIPURI CATTLE AT LIVESTOCK FARM COMPLEX OF COVSC & A.H., JALUKIE, NAGALAND

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Nagaland is a mountainous state, situated at the North-Eastern region of India, bordering Myanmar, having a total area of 16,579 square km approximately (2011 census). The state is rich in diverse indigenous tribes, with various festivals and cultures, and has housed various livestock and poultry species. The state has 78,296 nos. of cattle which contribute around 0.58% of all NE cattle population and 0.04 % of Indian total cattle population (Basic Animal Husbandry Statistics, 2020). The estimated milk production in the state was recorded to decrease from 74 thousand tonnes of milk, leaving a deficit of 43.67 thousand tonnes from 2018-19. Also, the per capita availability of milk is 97.99 gm/person. However, the beef production was found to be elevated from 973 mt. to 980 mt. The state has its own registered cattle breed Thutho cattle, which is widely distributed in districts of Kohima, Phek, Zunheboto etc. Shortly, the enthusiastic farmers or entrepreneurs have shown interest towards the cattle rearing and production to meet the necessity protein demand of the local people of Nagaland. Though there are no high yielding pure cattle breeds available in the state, the indigenous cattle serve the purpose of meat and milk production, also in draught purposes.

The Livestock Farm Complex (LFC) of the College of Veterinary Sciences & Animal Husbandry, Jalukie, and Nagaland was established in 2018. Initially, the farm housed 10 Manipuri cattle (2+8) which were brought from Manipur. At present, there are 25 nos. of cattle; and till date, there are 28 births, 5 died and 8 male calves have been sold to the local farmers. The indigenous cattle of Manipur which are more popularly known as Manipuri cattle are medium size, stout, hardy and a dual purpose animal. These cattle have not yet registered in NABARD; however, efforts are being made for the registration of Manipuri cattle. Morphologically, the cattle has a multicolored body coat which varies from black (12%), brown (76%), gray (4%) and spotted with black or white patches on the brown body (8%). The bullocks have medium hump with small horns (Pundir *et al.*, 2015). The cattle are well adapted to the climatic condition ofdifferent districts of Manipur and also at Jalukie, Nagaland. The Manipuri cattle are maintained primarily at LFC for educational purpose for the BVSc and AH students, and also, to conserve and maintain the genetic materials of the cattle.

In the present article, an attempt was made to study the rearing system, different biometric traits and performance of Manipuri cattle at the Livestock Farm Complex of the College of Veterinary Sciences & Husbandry, Jalukie, Nagaland.

Rearing system

At LFC, the Manipuri cattle are housed, head-to-head system with provision of clean running water facility. They are let loose for open grazing at college grazing area for about 7-8 hours in a day. The shed has a length and breadth of around 50 ft. and 38 ft respectively with height of 12ft from the farm floor .The floor is completely made of rough concrete materials. The space requirement of the cattle is provided as per the standard standing space of medium sized cattle that is 6 ft. length and breadth of 3ft.

Feeding system

As the cattle are reared under open grazing system, minimal concentrate feed is provided and are mostly depend on grazing of locally available fodder plants and feeding on straw. The farm has well plantation of fodders plants such as napier, hybrid napier which is abundantly available in monsoon season and other fodder plants such as maize, Dhiancha, subabool etc. are also available seasonally for feeding the animal. The fresh fodders plants are harvested, chaffed in chaff cutter, mixed with salt and mineral mixture and are fed to cattle.

Health care management

Strict scientific health care management is followed at LFC cattle. Deworming and vaccination programmes are strictly followed as per the existing Nagaland state Government deworming and vaccination schedules. Vaccination against FMD is done after every half yearly. The feacal samples of cattle are sent to the

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Fig. (a): Manipuri cattle at LFC, COVSc & AH, Jalukie
Fig. (b): Grooming of cattle

Department of Veterinary Parasitology once in every4 months to examine the presence of parasitic eggs, and if necessary, specific drugs are given and re-examine the feacal samples to determine the effectiveness of the dewormer. Deworming with broadspectrum such as Fenbendazole, Albendazole etc. are used alternatively to prevent drug resistance. Generally, before the cattle are let loose for grazing, manual (hands with gloves)removal of hard ticks is done daily; however, depending upon the ectoparasitic loads, Butox application is done once in every 2 months. Till date, the diseases recorded at LFC are very less; however, tick infestation is very common, followed by pneumonia and few maggot infestations.

Fig: (c). Manipuri cattle at LFC, COVSc & AH, Jalukie, Nagaland

Table 1: Economic traits of Manipuri cattle at LFC are listed below:

Parameters	Value in range
Average milk production	0.5- 1 L per day
Average age at first calving	1672 days
Average lactation length in first calving	200 days
Average lactation length in second calving	237 days
Average milk yield in first lactation	178 L
Average milk yield in second lactation	188 L
Average dry period	395 days
Average body weight at birth	12-13 kgs
Average calving interval	460 days

Table 2: Age and sex wise different biometrics traits (cm) in Indigenous cattle of Manipur

Age of animal	Sex of cattle	Body length	Height at wither	Heart girth	Paunch girth	Ear length	Face length	Tail length without switch	Horn length
1-2	M	78.8	88.8	103.10	104.94	17.67	34.45	59.10	-
	F	76.55	88.23	103.64	101.10	17.88	32.83	58.50	-
2-3	M	87.89	91.30	110.64	108.12	19.11	36.40	63.23	6.81
	F	88.33	90.12	103.16	108.32	20.08	35.20	61.17	4.50
3-4	M	93.44	98.98	125.10	128.16	21.00	39.56	66.40	7.20
	F	95.91	95.45	127.66	127.18	18.36	42.11	65.03	6.30
4-5	M	100.82	103.82	138.82	134.74	21.80	40.03	71.75	8.50
	F	99.04	104.33	137.00	134.63	20.50	39.78	68.80	8.30
5-6	M	108.88	109.9	142.44	144.38	23.15	41.75	75.11	12.80
	F	103.00	107.23	141.50	142.44	24.01	40.66	73.00	12.15
6-7	M	111.23	121.44	153.30	147.16	24.24	43.14	82.26	14.60
	F	110.27	120.98	146.31	146.26	23.77	42.17	80.51	13.07
7-8	M	112.84	122.14	153.60	149.30	25.10	43.90	83.62	15.80
	F	112.61	123.36	148.90	147.28	24.42	43.00	81.11	14.00

In conclusion, the Manipuri cattle maintained at LFC of COVSc.& AH, Jalukie under free range grazing system, have disease resistance capability, shows uniformity in physical and morphometric characteristics and have overall good performance . They remarkably contribute towards the revenue generation of the farm. In future, further efforts and studies have to be conducted to improve the overall performance of the cattle through genetic improvement programs and promote scientific rearing system for conservation and genetic improvement of Manipuri cattle.

CULTIVATING SUSTAINABILITY: HARNESSING THE POTENTIAL OF AQUAPONICS

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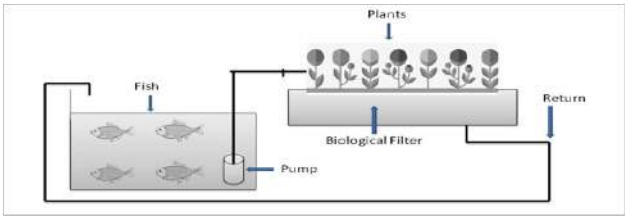
In a world where sustainability is paramount, the need for innovative and eco-friendly approaches to agriculture has never been more pressing. One such approach, aquaponics, is making waves in the field of food production. This article explores the boundless potential of aquaponics—a system that combines aquaculture and hydroponics—in creating a more sustainable future. By establishing a closed-loop ecosystem, aquaponics not only minimizes water usage and reduces the need for chemical inputs but also delivers higher crop yields in smaller spaces. Its economic viability and community empowerment aspects further solidify its role in the future of agriculture. This article showcases how aquaponics is a beacon of hope in our quest for a sustainable food system.

Keywords

Aquaponics, Sustainability, Closed loop ecosystem, environmental benefits, Community Empowerment

An Ecosystem in a Closed Loop

At the heart of aquaponics lies a beautifully intricate closed-loop ecosystem. Fish, typically species like tilapia, trout, or catfish, are raised in tanks, while above these tanks are grow beds filled with a growing medium, often clay pebbles. The magic happens when water from the fish tanks, rich in fish waste and nutrients, is channeled to the grow beds. It's here that beneficial bacteria step in.



These microorganisms convert the ammonia in the fish waste into nitrates, which serve as a nutrient source for the plants. The plants, in turn, filter and purify the water for the fish. It's a perfect symbiotic relationship that creates a sustainable ecosystem with multiple benefits.

The Environmental Advantages of Aquaponics

1. Water Conservation: Perhaps one of the most compelling reasons to embrace aquaponics is its water efficiency. Unlike conventional agriculture, which can be incredibly water-intensive, aquaponics recirculates water within the system, reducing water usage by up to 90%. This is especially crucial in arid regions and during water scarcity.
2. Reduced Chemical Inputs: Aquaponics eliminates the need for synthetic fertilizers, as the fish waste provides a natural source of nutrients for plant growth. This not only saves money but also prevents chemical run-off that can harm local ecosystems.
3. Space Efficiency: Aquaponics systems can produce higher crop yields in smaller spaces compared to traditional soil-based farming. This makes it a perfect fit for urban and peri-urban agriculture, reducing the carbon footprint associated with food transportation.
4. Year-Round Production: By allowing for controlled environments, aquaponics enables year-round cultivation. This is invaluable in regions with extreme climates and is a step toward achieving food security.

Economic Viability and Community Empowerment

Aquaponics is not only environmentally sound but also economically viable. It offers several advantages:

1. Increased Yield and Revenue: The efficiency of aquaponics systems can lead to higher crop yields, making it a financially attractive option for commercial growers.
2. Local Food Production: By enabling year-round production in urban and suburban areas, aquaponics contributes to the localization of food production. This has economic benefits as it reduces the dependence on long-distance food supply chains.
3. Educational and Community Building: Aquaponics systems have significant educational and community-building potential. They can be integrated into schools, community centers, and even rehabilitation programs, fostering a deeper understanding of ecology and sustainable agriculture.

Conclusion

Aquaponics is a game-changer in the world of agriculture. By mimicking natural ecosystems, it offers a path towards a more sustainable and resilient food system. In an era marked by climate change, water scarcity, and population growth, aquaponics represents an innovative solution. Its potential is boundless, and its impact on the future of agriculture is immeasurable. By embracing aquaponics, we can cultivate not only fresh produce but also a more sustainable future for generations to come. It is a beacon of hope in our quest for a truly sustainable food system.

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BLACK RICE (CHAKHAO): A RARE SUPER FOOD FROM MANIPUR

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Introduction

Manipur is one of the eight North eastern states of India and famous for diverse traditional rice (*Oryzasativa* L.) cultivars known for their cultural as well as nutraceutical values. The lesser known scented black rice of the state, locally called '*Chakhao*', meaning delicious rice in *Manipuri* language, has drawn attention of the scientific community in recent times owing to its higher nutraceutical properties such as antioxidant, anti-carcinogenic, fibre, vitamin and mineral contents. Historically, black rice was considered to be a royal delicacy and forbidden for common people in Asian countries such as China and Indonesia (Kushwaha, 2016). As the legend has it, in China during imperial period, common people were not allowed to store/cultivate black rice without the approval from authorities and hence, it was called 'forbidden rice' or 'imperial rice'.

This black rice (Chakhao) has recently got the GI tag (GI Reg. No. 602) in 2020, due to its unique aroma and attractive colour. This is a very popular black rice cultivar cultivated in all the states of North East India and constitutes around 10% of Manipur's total rice production. The origin of Chakhao in Manipur is believed to be linked with the first Manipur inhabitants, may be the Meiteis or the Buddhist monks in 400 BC. *Chakhao Poireiton* and *Chakhao Amubi* are the two main types of this rice cultivar.

The dark purple coloured outer bran layer and the unique aroma are the distinct characteristic features of Chakhao. The high anthocyanin content in the pericarp gives the rice dark purple colour which has antioxidant property. As the high-yielding variety of this black scented rice seeds got introduced, this could emerge as a gluten-free super food rich in fibre, vitamins and antioxidants.

Nutritional Value (per 100 g)

Total crude protein	12.15%
Total carbohydrate	72.43%
Amylose	8.27%
Total fat	4.8%
Ash	1.57%
Crude fibre	0.71%

Minerals

Calcium	24.06 mg
Magnesium	58.46 mg
Manganese	1.03 mg
Copper	4.30 mg
Cobalt	0.43 mg
Iron	23.34 mg
Total anthocyanin (Cyanidin 3-glucoside)	69.2-74.0 mg
Total phenolic (Gallic acid equivalent)	500 and 577 mg

Health benefits of Chakhao

1. It has high antioxidant quotient. Antioxidants boost immunity levels and help our body stave off various ailments and infections better. The antioxidants also help discard toxins from body.
2. The anthocyanins is said to be helpful for reducing

heart attack. It reportedly plays a role in preventing plaque build-up in artery walls. They are also helpful in lowering cholesterol levels in body.

3. Studies have revealed eating black rice can also help keep some dreaded ailments at bay. It may prevent onset of Alzheimer's disease. Though solid scientific evidence does not exist, a lot of users of black rice say its consumption helps prevent and cure certain types of cancer.

Socio-cultural values

There is close relationship between ethnic cultural practices of *Meitei*sand black rice cultivation. Black rice dish (*Chak*) is offered to the deities and ancestors in *Usob*(death ceremonies) and *Kang-pali*(religious festival); while it is served as dessert (*Kher*) in *Chakumba*(first rice-eating ceremony) by the *Meitei* people. Black rice is also used occasionally to prepare as *Ethe tan* (flatbread), *Kabok*(puffed *rice*), *Kabok-aafaba*(puffed *rice laddu*), flakes (*Chengpak*), *Utongchak*(rice cooked in bamboo stick) and *Yu* (alcoholic beverages). Traditional beer from the black rice called '*Chakhao-atingba*' is one of the most relished beverages among the *Meiteis*. However, black rice is not used as staple food as it takes more time for cooking and feels rubbery while chewing due to high fibre content. Pregnant women are traditionally served with black rice a few days before delivery. Black rice is also consumed in small quantities by persons affected with diabetes, condition locally called as *Ising-pukchatt*. The antioxidant and anti-carcinogenic properties of black rice have recently been recognized. Due to its cultural value and health benefits, black rice is sold in the local market at high prices (Rs. 150-200 per kg). Looking at the growing popularity not only in Manipur but also outside, the local agro-based industries have started making confectioneries of black rice and selling in the local markets. Like other rice varieties, black rice by-product (straw) is used as fodder and in preparing traditional shampoo (*Ootimasum*), and traditional soda (*Ooti*). The black rice straws are preferred as thatching material because of higher length and durability. Rice bran is another by-product used as livestock feed and husk in preparing farmyard manure. *Meitei*sbelieve that once a household starts cultivation of black rice, it is considered to be a taboo to abandon it before three years consecutive cultivation. Such a cultural belief had and has been helping in uninterrupted cultivation of black rice among the community but in recent times, due to changing socio-economic scenario, sometimes also deters few households to take up its cultivation. Though *Meitei* farmers prefer their own seeds, occasionally the seeds are also exchanged among the relatives and neighbours. Seed selection, storage and exchange play a vital role in conserving and maintaining the vigour of traditional landraces of the black rice. *Ningei, Kei,Kot* and *Apuachouba*are the traditional rice storage structures of the Meitei community which act like a seed bank at household level. The practice not only helps in maintaining the germplasm, but also in strengthening the social relationships.

Uses and processing opportunities

Being a potential source of anti-oxidative phytochemicals and useful ingredient for nutraceuticals, Chakhao rice extracts can also be used in medicinal purposes. Some of the nutraceutical compounds present which can be extracted economically from this rice are tocotrienols, gamma amino butyric acid, oryzanol, rice bran saccharine, lutein, zeaxanthin, butylate hydro anisole, phytosterol, etc. This rice extract can also be used as natural colour to efficiently substitute the toxic synthetic ones.

PACKAGE AND PRACTICES

Climate and Soil

A moderately cool climate is suitable for the cultivation of Manipuri Chakhao(black rice). It is very much suitable for cultivation in plateau and hilly places with medium and upland fields and a varied soil type like clay, clay loam are most suited.

Seed sowing and transplanting

For one acre of land the seed requirement for sowing is 24 kg in line transplanting method and 3 kg in SRI method of rice cultivation. The seed has a self-life of 6-8 months. So,sowing can be done in January (*rabi* crop) or can be stored for 4-5 months to sow during May-June (*kharif* crop). For better yield, transplanting in line or SRI method is recommended. The seeds are sown in a nursery for raising seedling and then transplanted to the field 21-25 days after sowing.

Cultivation in field

Manipuri Chakhao is a medium duration paddy crop taking 120 days for maturation. So, two crops can be grown in a year. The crop grows to a height of 4-4.5 feet. Growing organically makes this crop more authentic and valuable in terms of its unique values, demand and delicacy. So, use of vermicompost and biofertilizer as nutrients for the crop is advised in place of any chemical fertilizer. Its panicle initiation and grain filling are same as the common paddy. Black rice cultivation in general requires less labour inputs in terms of plough-

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ing, weeding and care compared to other rice varieties. According to the informants, no severe disease or pest attack has ever been observed on all the landraces of black rice whereas, other rice varieties are susceptible to pest and diseases such as rice bug, stem borer, thrips, green caterpillar, rots, leaf blight, and false smut. This could be attributed to high phenolic and anthocyanin contents in black rice landraces. With the agro-ecological values (such as stress tolerance and disease and pest resistance) and agronomic values (such as lesser labour, no application of fertilizer and pesticide), black rice cultivation helps *Meitei* farmers in yield optimization in marginal lands and maintaining crop diversity.

Harvesting and Yield

The paddy is harvested after 120 days of transplanting. It gives an average yield of 12-15 quintal per acre.

Future aspects

Chakhao is quickly making its place in the best cuisines internationally after having been long hidden and used only within homes of rural Manipur and surrounding states. More research needs to be done in black rice to strengthen sustainability by preserving the local black rice species of Manipur and can improve desirable traits in best rice varieties. Introduction of special rice (black rice, etc.) as main crop and awareness among the people can eradicate the malnutrition issues to some extent. Developing varieties with desirable agronomic and marketable traits can increase its wide adoption for cultivation purpose in different regions in India. Black rice 'Chakhao' is tolerant to drought stress and resistance to insect pests. Hence, it can be used to develop rice lines with improved grain quality, yield potential and antioxidant properties.

REGISTERED BREEDS OF LIVESTOCK AND POULTRY SPECIES OF NORTH EAST REGION, INDIA

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The North-Eastern region of India represents a huge diversity in animal genetic resources. The unique domestic species like yak, mithun and wild species like one-horn rhino and pygmy hog are the heart throb of this region and well known globally. This region of India lies between 21.5ºN to 29.5º N latitude and 85.5º E to 97.5º E longitude and comprise Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. It occupies about 8% of total land area and 4.54 % livestock population the country. The NER has 25 livestock breeds as per NBAGR 2023.

Table: Number of livestock and poultry breeds in India and North East Region of India.

Sl. No.	Species	India	North East, India
1.	Cattle	53	4
2.	Buffalo	20	1
3.	Sheep	44	2
4.	Goat	37	2
5.	Pig	13	7
6.	Horse & Pony	7	2
7.	Chicken	19	4
8.	Duck	2	1
9.	Yak	1	1
10.	Camel	9	0

CATTLE BREEDS

1. Lakhimi

Lakhimi cattle of Assam are distributed in entire state and reared for milk and draught purposes. Animals are small sized, horned and have relatively short legs. Coat colour is variable mainly brown and grey. Hump is medium in size and the backline is slightly curved. Udder is small and bowel shaped. Bullocks are excellent

for carting and ploughing especially in the muddy fields for paddy cultivation. Lactation milk yield ranges from 270 to 375 kg with an average 5.3% fat. Age at first calving ranges from 44 to 49 months.

2. Masilum

Masilum cattle are small size, well built and sturdy indigenous cattle are found in Hills of Meghalaya and reared by the Khasi and Janitia community. The Khasi language has words 'Masi' and "Lum" means cattle and

hills, so it is called as "Masilum". The predominant body colour varied from black, brown, and mixture of brown, grey and black. Average daily milk yield, lactation milk yield and lactation length are 2.72±0.45 kg, 456.42±10.53 kg and 168.56±9.28 days, respectively.

3. Thutho

Thutho breed of cattle is also known as "Ameshi", "Sheapi", "Chokru" and "Tseso" available in most of the districts of Nagaland. Animals are well adapted to hilly region and able to graze on hill slopes even during rainfall. This breed is mainly used for meat, draught and manure. Colour of the animals is black or brown.

Animals are medium in size with average body weight of 320kg (Male) and 280kg (Female). Their average age at first calving is 30 months with the average calving interval of 15 months. Cows are generally not milked however when milking they give daily milk yield of 0.5 - 1.0 litre/day with lactation length of 3-4 months.

4. Siri

Siri is a small sized zebu cattle distributed in Sikkim and Darjeeling district of West Bengal. They can graze on steep slopes in thick forests. Animals are either black with white patches or brown with white patches. Hump

is located cervico-thoracically which is covered with a tuft of long coarse hair. Udder is of small size with firm attachments. Milk yield varied from 2 to 6 kg per day with a fat content of 2.8 to 5.5% with the lactation length ranges from 7 to 9 months while the calving interval ranged between 420 to 490 days.

BUFFALO BREED

1. Luit (Swamp) buffalo

Luit is a medium size black coloured swamp buffalo mostly found in upper Brahmaputra valley of Assam and some parts of Mizoram, Manipur and Nagaland bordering Assam. Compact and strong built up body with light white stocking up to knees in both forelimb

and hind limbs are the characteristics of this breed. The lactation yields ranges from 385 to 505 kg. Bullock has excellent draught ability for carting and ploughing especially in muddy field for paddy cultivation.

SHEEP BREEDS

1. Banpala Sheep

Banpala is a typical dual purpose sheep breed is found in different parts of Sikkim and in neighbouring

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Western Bhutan and Eastern Nepal. They are medium sized with compact body covered with coarse wool, which is normally shorn twice a year. The coat colour is predominantly black and white. These animals produce about one kg of coarse wool per year with the average fibre diameter, fibre length and medullation percentages are 54.08±1.28 µm, 9.86±0.95cm and 90.87±2.8% respectively. The average adult (1-3 years old) body weight is 51.6±0.76 kg and 44.1±0.37 kg in males and females respectively. The average dressing percentage is 50% of the live weight.

2. Tibetan Sheep

Tibetan sheep is a medium sized animal distributed in Northern Sikkim and Kameng district of Arunachal Pradesh. They are mostly white with black or brown face; brown and white spots are also observed on the body. The fleece is relatively fine and dense with belly, legs and face devoid of wool. Tibetan sheep

produce excellent lustrous, carpet quality wool. The average staple length, fibre diameter and medullation percentage are 7.24±0.11 cm, 13.22±1.25 µm and 19.30±0.64% respectively. Animals are shorn twice a year with average greasy fleece weight per clip ranging from 400 to 900 gm.

GOAT BREEDS

1. Assam hill goat

It is a small size breed of goat, and is mostly found in the hilly terrain of North Cachar, Karbi-Anglong districts of Assam and also in the adjoining hilly tract of Meghalaya. They are well known for their good quality meat, higher rate of prolificacy and adaptability in low input poor management condition. Twining is very common in Assam hill goat. The average age at first eats and age at first kidding were 266 and 439 days respectively.

2. Sumi-Ne

It is a medium size goat also known as Nagaland long hair goat and is found in different parts of Nagaland. They are mostly reared in traditional open range system with almost zero inputs by the Sumi tribes of Nagaland. The estimated population of Sumi Ne goat is 4,500.

They are mainly reared for silky fibre production. Long silky fibres obtained from these goats are used by local people for making traditional items for socio-cultural significance.

PIG BREEDS

1. Doom

It is a medium size black colour pig mostly distributed in lower parts of Brahmaputra valley of Assam. The estimated population of Doom pig is about 3,000 only. They are comparatively larger than other local pig breeds of this region. They migrate in groups in scavenging system with a flock range of 90 to 150.

Pointed snout and thick line of coarse bristle on the crest region are unique body conformations of Doom pigs. The average age at first estrus and age at first farrowing are 202 and 340 days respectively.

2. Mali

Mali is native to Tripura, and is a black colored medium sized pig with pot belly. Medium to small bristles are ubiquitously distributed throughout the body. Animals are characterized with short erect ears lying

perpendicular to body axis and concave snout. Adult body weight averages about 68 kg in males and 71 kg in females. Average litter size: 5.15 (range 3-7) at birth and 4.46 (range 3-6) at weaning. Population size is approximately 45,000 – 50,000.

3. Manipuri Black

Manipuri Black pig is native of Manipur state and as the name indicates black in colour. Manipur Black pig is medium in size with flat belly and short legs. The head of these pigs is short, slightly concave with short ears, and short to medium snout. Hairs are predominantly black and sparse, Bristle production is very scanty and cutting has not been practiced. Adult body weight averages about 96.0 kg in males and 93.0 kg in females. Average litter size is 8.27 (range 6-11) at birth and 6.02 (range 5-9) at weaning.

4. Niang Megha

It is also known as khasi local pigs mostly distributed in Garo, Khasi and Jaintia hills of Meghalaya. The estimated population of Niang Megha pig is about 4.3lakh. They are well known for nesting behaviour before farrowing and strong mothering ability. Body


Female


Male

coat of this pig is covered with long and coarse bristles, which protect them from cold weather. Pigs attain sexual maturity at an early age. The average age at sexual maturity and age at first farrowing is about 197 and 326 days respectively.

5. Tenyi Vo

It is a small size black colour pig mostly found in Chakesang, Mao, Tuensang and Angami district of Nagaland. The name Tenyi Vo literally translates into the "Pig from Angami". This breed in Sema tribe is called Suho and amongst the Lotha tribe it is known as Votho. The estimated population of Tenyi Vo pig 60–70 thousand only. Early sexual maturity and good mothering ability are the characteristics of this breed.


Female


Male

The average at first estrous and age at first farrowing are 182 and 298 days respectively.

6. Wak Chambil

Wak Chambil is a small sized pig with round and medium pendulous belly. They are distributed in North Garo Hills, East Garo Hills, South Garo Hills, West Garo Hills and Southwest Garo Hills of Meghalaya. These pigs have small head and eyes, small erected ears, and short and pointed snout. These pigs have thick long hair on the eyebrows and over the forehead and neck. Pork of this breed has unique flavour and taste, thus it is utilized during special religious and ceremonial occasions. Adult body weight averages 32.0 kg in males and 29.0 kg in females. Average litter size is 5.8 (range 4-11) at birth and 4.52(range 3-8) at weaning.

7. Zovawk

It is a black colour pig with white spot on forehead and white patches on belly, and is mostly distributed in different parts of Mizoram. The estimated population


Female


Male

of zovawk pig is about 39,000. Concave top line and long bristles on midline are characteristics of Zovawk pig. The average age at first fertile service and age at first farrowing are 323 and 437 days respectively.

HORSE BREED

1. Manipuri pony

Manipuri pony also called "Meitei Sagol" is found mainly in Manipur and different parts of Assam. They are intelligent, extremely tough with tremendous

Female

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endurance and reared in semi wild system. It has 11–13 hands wither height with a good shoulder, short back and well developed quarters. They are extensively used for polo game throughout the world. They are also utilized for transportation, hunting and racing.

2. Bhutia

Bhutia is a small size mountain horse also known as "Bhotia pony or Bhote-Ghoda mostly found in Sikkim and Arunachal Pradesh. Short neck, large head with pronounced jaw and very strong short legs are the characteristics of this breed. Bhutia pony are well known due to their terrifying habit while moving they always keep to extreme edge of a mountain path to avoid the bumping against the cliff wall on the inner side as they used to carry luggage on either side of their body.

POULTRY BREED

1. Miri fowl

These breeds of chicken are mostly found in Dhemaji, North Lakhimpur, Sibsagar, Dibrugarh and Majuli district of Assam. The name of the bird itself is

derived after tribal people name called Miri or Missing tribe since the birds are reared by them. They are reared mostly for meat as well as eggs. The dressing percentage ranges from 65–74%. The average egg produced per year is around 60to 70.

2. Daothigir

It is a chicken breed mostly distributed in Kokarajhar, Bongaigaon, Barpeta, Dhubri and Nalbari districtsof Assam. The name of the breed is derived from the name of a plant in this region called Thigir (Dillenia indica). The colour of the flower is similar to the plumage colour of these birds. The shape of these flowers also resembles the comb of these birds. In Bodo language Dao means bird and hence these birds are known as Daothigir. It is a dual purpose breed for both egg and meat production. Annual egg production is about 60–70.

3. Kaunayen chicken

It is an indigenous chicken breed locally known Kaunayen/Kwakman/Koman mostly. It is found in valley of Manipur. The word Kaunayen is a combination of two Manipuri words namely 'Kauna' means kick/ fighting and yen means hen/ poultry. Elongated body with long neck and long legs are the characteristics of this breed. Kaunayen birds are mainly used in commercial purpose for cock fighting because of their martial qualities.

4. Chittagong fowl

These birds are locally known as Malay, and are mostly distributed in Meghalaya and Tripura bordering Bangladesh. They are comparatively larger than other breeds of chicken in this region. The average bodyweights of cock and hen are 3.5–4.5 and 3–4 kg respectively. They possess the characteristic features of a good game bird. Chittagong fowl are reared for both meat and egg production, and has cultural and economic significance.

DUCK BREEDS

1. Pati

Pati ducks are widely distributed in Brahmaputra and Barak valley of Assam. Plumage is dark brown in drakes with greyish black head; tail with black and white feathers. Ducks are solid brown. A white ring may or may not be present at neck in both sexes. Beak, feet and shanks are predominantly yellow in colour. Average adult body weight for Male and female are 1912±358.6 gm and 1800±301.2 gm respectively. The annual egg production of Pati duck is 60 to 80 eggs. Growth rate of desi duck are slower and their age at first egg is about 200-240 days.

YAK BREED

1. Arunachali

Arunachali yaks are medium sized bovines mostly found in the Brokpa and Monpa tribe in West Kameng and Tawang district. They are predominantly black with dense and long hairs hanging down the body and are docile in temperament. They have a convex head with horizontal ears and distinctly curved horns with pointed tips. The average milk yield is 0.98–1.04 kg milk/day with 7.45% fat and 11.5% SNF and the peak milk yield/day is 1.1–1.6 kg. The average ages of clipping of coarse hairs and down fibres are 12–18 months and 12 months, respectively, with average yields of 1.5 kg and 0.5 kg/clipping/animal, respectively.

Conclusion

North Eastern Region of India has huge animal genetic diversity. All the registered breeds of livestock and poultry from this region have unique characteristics and their utility. However, there are many more livestock and poultry species which has different phenotypic characteristics from the registered breeds. Those non descriptive species should be focused for characterization and documentation so that it can be registered as a new breed. Moreover, the population size of some of the breeds is very low. Therefore the conservation program for all the registered breeds is the need of the hours so as to maintain the purity of the breeds in the future.

GENETICS OF LEAF BLAST RESISTANCE- A FOCUS ON THE RICE LANDRACES OF NORTH EAST INDIA

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Abstract

Rice (*Oryza sativa*) is grown under highly diverse conditions including the hilly areas (hill rice) of North East (NE) India which is characterized by high soil acidity and metal toxicity, there is also occurrence of diseases like blast (*Magnaporthe oryzae*). The improvement of locally adapted landraces will help to increase the grain production as well as local demands. The landraces available in NE India still need to be documented for their genic and leaf blast status which will provide valuable information for the rice improvement program in NE India. Leaf blast resistance is known to be governed by major genes, but due to the evolution of the blast fungus, resistance of many genes were broken and there is a need to develop multiple gene deployment in a variety to make it durable and show resistance in long run. Hence understanding the genetics of this fungus and searching for suitable genes and their combinations becomes inevitable.

Introduction

In India rice is grown under highly diverse conditions. In North East (NE) India rice is predominantly cultivated in hilly areas under valley and upland rainfed

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conditions. During 2019-20, rice was grown in 3.2 million hectares in NE India producing 7.12 million tonnes. Rice blast caused by *Magnaporthae oryzae* is in its most devastating form in the upland hill rice grown areas of Meghalaya(Annegowda *et al.,* 2021). Each year, rice is destroyed by blast disease which can feed sixty million people who otherwise go into starvation(Nalley *et al.,* 2016). NE India is a hotspot for rice blast disease which causes yield loss from 30-100%(Puri *et al.,* 2009). Excessive rain and relative humidity of NE India causes significantly higher incidence of leaf and neck blast in rice resulting in massive economic losses. The most sustainable technique for increasing rice production would be to breed appropriate rice varieties by utilising landraces and indigenous cultivars of these regions.

Mode of action of the blast fungus

The blast fungus produces conidia, which lands on moist leaves, infects, establishes, and spreads the disease as leaf, panicle, and neck blast. There are two lines of defence mechanism in rice plants against blast fungus. Firstly, there are some pathogens associated molecular patterns (PAMPs) in the pathogen which are recognized by pattern recognition receptors (PPR) in the outer cellular membranes of plants and provides pattern triggered immunity (PTI) that are governed by defence related (DR) genes. However, PTI functions as a weak and non-specific resistance mechanism. Secondly some effectors like avirulence (*Avr*) proteins are secreted by pathogen that are recognized by nucleotide binding leucine rich repeats (NBS-LRR) which are mostly regarded as resistance (R) genes. An effective protein interaction between the *Avr* protein and R genes offers effector- triggered immunity (ETI) against the pathogen. Based on gene-for-gene (Flor, 1971) hypothesis, for all the R genes in rice there is a corresponding *Avr* gene in the blast fungus and an interaction between them render resistance. Till date more than 120 R genes and 77 DR genes had been identified for blast resistance in different rice cultivars (Annegowda *et al*., 2021). As an 'arms race' the pathogen producing PAMP, *Avr* gene and the host genetic material including DR, R genes, its derived proteins and the interaction mechanisms has evolved over time (Figure 1). Around 30 R genes have been cloned in rice, among them genes like *Pigm*, *Piz*, *Piz-t*, *Pi1*, *Pi2*, *Pi5*, *Pi9*, *Pi33*, *Pi40* and *Pi54* were known to offer broad-spectrum resistance to leaf blast; few genes like *Pb1*, *Pi25* and *Pi64*, confer resistance to panicle blast(Ning *et al.,* 2020). Majority of the identified R genes show complete resistance to leaf blast at seedling stage. There is a wide variability within the *M. oryzae* fungus and new virulent races evolve quicker and break the resistance within 3-5 years of cultivating the same variety. Reports have shown that combination of multiple partial R genes and related QTLs (Quantitative Trait Loci) were efficient in achieving durable and long-term broad-spectrum resistance against several races of blast fungus.

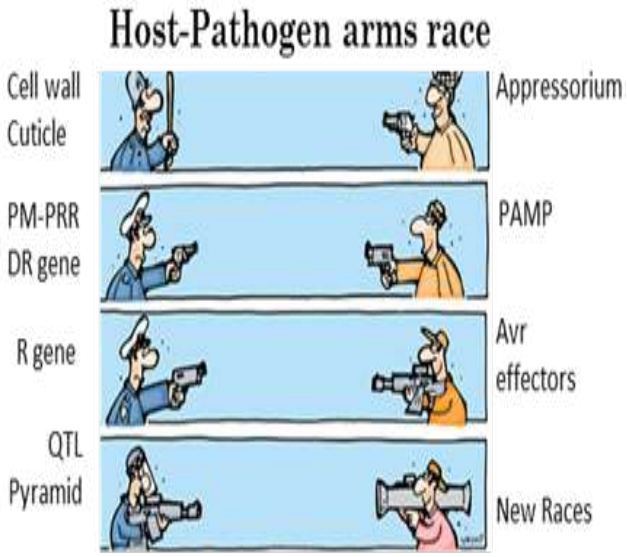

Fig. 1: An arms race between the host plant and the pathogen

Grain yield improvement in rice

With disease resistance improving the grain yield is also crucial. Grain yield in rice is a quantitative trait governed by associated traits like number of filled grains per panicle, panicle number, grain weight, size etc. Eightyseven yield related genes(Abbai *et al.,* 2019) were identified in rice and molecular markers were also developed for some of the genes. It is indispensable to utilize the available molecular markers in marker assisted selection to develop modern rice varieties with improved grain yield. Combining the suitable grain yield and blast resistance related markers will help us identify the ideal haplotype required to combat the adverse conditions specific for the region.

Blast screening under natural conditions

Blast screening is generally performed under natural lowland and upland conditions of north eastern hill regions of Meghalaya. Scoring is done generally at 45 days and 60 days after transplanting in 0-9 scale or 0-5 scale, where '0' means completely resistant. Artificial isolation and inoculation of the blast fungal cultures can also be performed.

Identified genes and landraces to be associated with blast resistance

Till date 140 R genes have been identified in rice for blast resistance of which thirty-six have been cloned and functionally annotated, the information's are obtained from Oryzabase, (2023) and from The Rice Annotation Project, (2023). Based on some the studies conducted in NE India the following information are compiled. Majority of the genes from chromosome 12 showed resistance to leaf blast. RM 206 linked with blast resistance gene Pi54, RM1337 and RM7102 colocalize in Pi20t gene showed association with tolerance and susceptibility against leaf blast. The gene Pi9 was found effective for leaf blast resistance under field and artificial inoculated conditions Genes Pi5 and Pi54 were found to be associated with leaf blast resistance. RM247 (Pita)showed association with neck blast. Pita, Pi9, Pib and qPbm showed some degree of association with neck blast resistance. *Pita* and *Pib* genes were also associated with nodal blast.Laljangli, Shasharang and Kasalath were some of tolerant landraces whereas landraces like Chakhao Poireiton, Jwain, Mynri, Kala Joha were susceptible to leaf blast.

Conclusion

The information of the genes that were identified to establish resistance for leaf blast in rice can be used for selecting genotypes suitable for the blast affected regions of North East India. Some of the landraces like Laljangli is tolerant to leaf blast which can be used in breeding programmes to develop tolerant varieties with high yield. The landraces available in NE India still needs to be documented for their genic and leaf blast status which will provide valuable information for the rice improvement program in NE India.

GENETICALLY MODIFIED ORGANISMS (GMOS): BANE OR BOON

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Introduction

Genetically improved crops and animal breeds produced in the last 2-3 decades as a result of biotechnological research have steadily increased their productivity and quality of the produce. However, this has not happened in aquaculture sector because aquaculture biotechnological research is lagging behind. Only less than 1% of world fish production comes from genetically improved fish stocks.

An organism that has a foreign or modified gene integrated in its genome using the *in vitro* genetic techniques of genetic engineering is called a "transgenic" or "genetically modified organism" (GMO). The GMOs are also referred as "living modified organism" (LMO) by the world-level Cartagena Protocol on Bio-safety and the Convention on Biological Diversity of 1992. In the Cartagena Protocol, following definitions were used: "Living modified organism" means any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology; "Living organism" means any biological entity capable of transferring or replicating genetic material, including sterile organisms, viruses and viroids; "Modern biotechnology" means the application of: *a. In vitro* nucleic acid techniques, including recombinant deoxyribonucleic acid (DNA) and direct injection of nucleic acid into cells or organelles, or *b.* Fusion of cells beyond the taxonomic family, that overcomes natural physiological reproductive or recombination barriers and that are not techniques used in traditional breeding and selection. All the three terms, "transgenic", "GMO" and "LMO" are treated as synonymous and both allotransgenic and auto transgenic aquatic species are considered.

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Tran genesis is the process of introducing an exogenous gene (transgene) from one organism to another, so that the new organism will exhibit the new trait that the transgene codes. Although this technique might sound simple, it is far from so: it involves the modification of the very molecule of life, the DNA; it means crossing species barriers created by nature over evolutionary time scales. Even though this process has been made possible in recent years we are far from understanding it and there are significant risks that need to be considered when altering the very foundations of life.

The first recorded instances of production of transgenic aquatic species are rainbow trout and goldfish. Since then, over 35 species have been genetically engineered in research laboratories. Revolutionary progress in genetic engineering in the 1970s made it possible to isolate eukaryotic genes. The first batch of transgenic fish was produced in China in 1984. This consists of fast growing common carps. First transgenic fish was produced at MKU in 1991 by Pandian. In January 1996, for the first time in history, genetically engineered salmon named **"***aquadvantage salmon***"** was grown in a commercial hatchery in Loach Fyne Scotland. In USA 2002, transgenic medaka has been produced for assessing the environmental hazards. In 2002, Sehgal *et al.* (college of animal sciences, Zhejiang University, Hangzhou) isolated, cloned and characterized growth hormone genes from grass carp. In July 2003 the world's first glowing transgenic fish, nicknamed 'night pearl' was displayed at a Bio Taiwan Exhibition in Taipei. The developers injected the green fluorescent gene of jellyfish into the colorless freshwater fish glowing in the dark.

In developing effective and sustainable exploitation of fish populations, the systematic use of currently available battery of genetic techniques is still relatively underdeveloped. But there is increasing recognition that combining well-established techniques such as, the selective breeding programmes with appropriate molecular techniques should yield valuable results in aquaculture. Of the range of molecular techniques available, some may be considered as "platform technologies" and of these; transgenics is one of the most significant for aquatic species. The production of appropriate transgenics (in some cases combined with other forms of genetic improvement) offers considerable opportunities for more efficient and effective aquaculture across a wide range of species.

The value of GMOs in agriculture is widely accepted as the area sown to transgenic crop species worldwide exceeds 60 million hectares and this area is increasing steadily year by year. However, both in terrestrial and aquatic animal species, even though many GMOs have been produced experimentally, the techniques have not been commercialized yet. Asian scientists were the first to initiate research in transgenic fish and since then Asia is the hub of transgenic research. Though Dunham (1999) and Carr (1999) have initiated commercial production of transgenic aquatic organisms in New Zealand, Scotland and Cuba, there are no further reports on large-scale production of aquatic GMOs from these countries. However, considering the drive leading to large aquaplosion in countries like China, it is inevitable that commercial production of aquatic GMOs will not be long in coming.

The benefits of GMOs to fish farmers in India, the nature and range of aquatic GMOs, the problems associated with the use of GMOs, the present status of guidelines and regulations imposed on the research on transgenic fish and other social frameworks surrounding them. We conclude with a set of recommendations aimed at the best practice to handle aquatic GMOs in India.

Why are GMOs produced?

When boundless quantities of genetic variation exist within species, why do we wish to transfer genes between species? The short answer is time. Why go through the process of selection for a trait when we can take the gene from another species and drop the trait directly into our organism's genome? Selective breeding is still preferable where the trait is not too difficult to achieve this way, but genetic engineering is really the only commercially feasible way of bridging large gaps between an organism's natural characteristics and what the aqua culturist wants. For example, much of the Himalayan region is too cold for aquaculture of Indian major carps. Artificial selection might eventually produce a cold-tolerant strain but only after many generations of careful breeding, which would be beyond the scope of an aquaculture business. Modifying the Indian major carps to produce the antifreeze protein from winter flounder could extend their range instantly. The main reasons for genetic manipulation of species used in aquaculture are directly connected to improved output/input ratios.

Targets are desirable in aquaculture; work has been focused primarily upon following points:

a. To enhance growth and or efficiency of food conversion.
b. To increase tolerance to/of environmental variables such as temperature and salinity.
c. To produce new colour variants of ornamental species.
d. To enhance commercially significant flesh characteristics.
e. To control reproductive activity and / or sexual phenotype.
f. To increase resistance of species to pathogens/ parasites.
g. To modify behaviour, *e.g.* aggression.
h. To control fertility and /or viability.
i. To produce novel medicinal substances with fewer animal welfare problems than when mammals are used.
j. Decrease dress out percentage
k. Utilize low cost diet
l. Tailor fish for market: External appearance, flesh colour, flavor and texture and fatty acid composition

How GMOs are produced?

Production of GMOs is a multistage process, which can be summarized as follows:

a. Identification of genes of interest;
b. Isolation of these specific genes;
c. Amplifying the gene to produce many copies;
d. Associating the gene with an appropriate promoter and poly-A sequence and insertion into plasmids;
e. Multiplying the plasmid in bacteria and recovering the cloned construct for injection;
f. Transference of the construct into the recipient tissue, usually fertilized eggs;
g. Integration of gene into recipient genome;
h. Expression of gene in recipient genome;
i. Inheritance of genes through further generations.

GMOs in aquatic species

One area of intensive research with GM fish has aimed to increase food production by modifying the expression of growth hormone (GH). They range from a doubling in weight, to some fish that are almost 100 times heavier than the wild-type at a comparable age. This research area has resulted in dramatic growth enhancement in several species, including salmon, trout and tilapia. Other sources indicate an 11-fold and 30-fold increase in growth of salmon and mud loach, respectively, compared to wild-type fish.

There are also a number of phenotypes for which transgenics offer considerable potential include growth hormone, Antifreeze protein, salinity tolerance, sterility, feeding behaviour, predator avoidance, nutritional physiology and energetics, control of sexual phenotype, disease resistance to specific pathogens and behavioural modifications (Devlin, 2004). One particularly interesting possibility is that of modifying the genome to allow greater production of omega-3 fatty acids. There is, as yet, little concrete data which can be reported but clearly these are very promising areas of work which could bring substantial benefits to aquaculture.

The first transgenic animal to be produced was mouse. The first recorded instances of production of transgenics in aquatic species were those of Maclean and Talwar (1984) in rainbow trout and Zhu *et al.* (1985) in goldfish. Since then, many species have been used to produce GMOs as shown in Table 1. The list represents an amalgam of species significant in aquaculture including species amenable to laboratory culture and those with short life cycles used particularly for studies of gene action etc., which form the baseline for better understanding and hence for better production in aquaculture.

At least 35 species of fish are currently being genetically engineered around the world, including trout, catfish, tilapia, striped bass, flounder, and many species of salmon. These fish are being engineered for traits that allegedly will make them better suited for industrial aquaculture, such as faster growth, disease resistance, larger muscles, and temperature tolerance. The genes engineered in these experimental fish come from a variety of organisms, including other fish, coral, mice, bacteria, and even humans.

The second transgene is inserted from the ocean pout. Pout have antifreeze proteins in their blood so the transgene allows the GM salmon to survive near-freezing waters and continue their development all year round. It effectively acts like an "on" switch for the hormone. The wild type salmon takes 24 to 30 months to reach market size (4–6 kg) whereas the producers of the GM salmon claim it requires only 18 months for the GM fish to achieve this.

Table 1: Aquatic species in which GMOs have

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BEEN INDUCED

Common name	Scientific name	Trait
Atlantic salmon	Salmo salar	GH: Growth Hormone; AFP: Antifreeze Protein; HGH: Human Growth Hormone; BGH: Bovine Growth Hormone; CSGH: Coho Salmon Growth Hormone; YpGH:Yellowfin Porgy Growth Hormone; CAT: Chloramphenicol Acetyl Transferase; TiGH: Tilapia Growth Hormone; RTGH: Rainbow Trout Growth Hormone; RGH: Rat Growth Hormone
Coho salmon	Oncorhynchus kisutch	
Chinook salmon	Oncorhynchus tshawytscha	
Tilapia	Oreochromis spp.	
Medaka	Oryzias latipes	
Zebra fish	Brachydanio rerio	
Common carp	Cyprinus carpio	
Channel catfish	Ictalurus punctatus	
African catfish	Clarias gariepinus	
Rainbow trout	Oncorhyncus mykiss	
Cutthroat trout	Oncorhyncus clarki	
Goldfish	Carrassius auratus	
Northern pike	Esox lucius	
Loach	Misgurnus anguillicaudatus	
Sea bream	Sparus aurata	
Red Sea Bream	Pagrus major	
Blunt snout bream	Megalobrama amblycephala	
Nigorobuna	Carrassius auratus grandoculis	
Milk fish	Chanos chanos	
Walleye	Stizostedion vitreum	
Rohu	Labeo rohita	
Singhi	Heteropneustes fossilis	
Others		
Brine shrimp	Artemia franciscana	
Seaweed	Laminaria japonica Undaria pinnatifida	
Sea urchin	Strongylocentrotus purpuratus Paracentrotus lividus Arbacia lixula	
Abalone	Haliotus rufescens	
Surf clam	Mulinia lateralis	

In November 2015, the FDA of the USA approved the GM Aqua Advantage salmon created by AquaBounty for commercial production, sale and consumption. It is the first genetically modified animal to be approved for human consumption. The fish is essentially a GM Atlantic salmon with two transgenes inserted. One is from a Chinook salmon (*Oncorhynchus tshawytscha*) which allows the GM salmon to produce GH all year round for faster growth as the wild-type Atlantic salmon produces the hormone for only part of the year. Aqua Bounty argue that their GM salmon can be grown nearer to end-markets with greater efficiency (they require 25% less feed to achieve market weight) than the Atlantic salmon which are currently reared in remote coastal fish farms, thereby making it better for the environment, with recycled waste and lower transport costs. The time scale for GMOs in salmon to be commercialized would be 15 years and that for tilapia would be five years from 1995 (OECD, 1995).

Glo Fish is patented technology that has graced American kids' aquariums since 2003. The tiny fish look much like any other aquarium tetra, barb, or zebra fish, but when placed under a black light, Glo Fish, well, glow. The fish were originally created and patented for scientific research at the University of Singapore. But a Texas company, Yorktown Technologies, obtained rights to market the fish, seeing their potential as pets. Available in neon colors like Star fire Red, Electric Green, and Sunburst Orange, they were created by transferring genes from sea corals and jellyfish to give the fish fluorescent properties.

Why are some people against GMOs?

Potentially useful transgenics fish strains have been developed in different parts of the world, but their widespread use in aquaculture currently has not yet occurred because of social issues and the concerns associated with the potential effects that GM fish may have on natural ecosystems. While significant speculation regarding the negative effects of transgenic fish is prevalent, very little empirical data currently exist which may be used to resolve the debate (Devlin, 2004). The most important areas of risks, which need to be considered in the use of transgenics, are human health, biodiversity, animal welfare and poor communities. In each of these categories, there exists a multiplicity of pathways by which effects could, in principle, be brought about.

Most important areas of risks which need to

BE CONSIDERED IN THE USE OF TRANSGENICS ARE:

1. Human health
2. Biodiversity
3. Animal welfare
4. In each of these categories there exists a multiplicity of pathways by which effects could, in principle, be brought about. Rational and responsible assessment of risk requires that the following properties are all considered:

Human health

About 98 percent of the dietary DNA from fish including GMOs is degraded by digestive enzymes relatively quickly but use of viruses (disarmed or otherwise) as vectors, might increase the risk factor significantly as these are organisms which are adapted to integrating into host genomes and some represent risk factors for cancer induction. Induction of leukemia by using retroviral vectors was reported in transgenic mice and in a child undergoing gene therapy using a retrovirus (Beardmore and Porte, 2003). Another risk will lie in the use of novel proteins or other molecules produced by the transgenic organisms. Either in the native form or following modifications in the human body, such molecules could be inimical to human health (*e.g.* through allergies); hence it would seem sensible to avoid the use of such substances. Other potential risks may lie in incorporation of transgenic DNA into the genomes of resident gut micro flora or a change in the pathogen spectrum of the transgenic fish leading to it hosting a new pathogen, which happens to be also a human pathogen.

Biodiversity/ecological concerns

The primary ecological concerns regarding utilization of transgenic fish are the loss of genetic diversity and loss of biodiversity and reduction in species richness. An evaluation of this is complex, encompassing a wide range of biological processes and field study, including genetics and ecology. The extent of aquatic diversity is also both extremely large and relatively poorly understood, thus making the task of estimating the risks to aquatic biodiversity at all of its levels from the use of GMOs (or indeed, any genetically distinctive strain used in aquaculture) is monumentally large. Aquaculture has a further problem in that the unintended escapes of genetically distinct farmed fish are unpredictable and often large in numbers. Large-scale escapes of farmed fishes are reported from different parts of the World and it is clear that escapes of these magnitudes pose considerable problems to the ecosystem. It is difficult to predict the long-term impact of these modified fishes (if established in nature) on the aquatic diversity. If the GMOs are fertile and if escaped, they can breed with the wild stocks of the same species, leading to the spread of transgene in natural populations, despite low juvenile viability.

Animal welfare

The direct or indirect effects of transgenesis upon the welfare of fish GMOs in aquaculture are poorly understood. Fishes as living organisms with highly developed nervous systems and with a range of behavioral phenotypes, qualify for welfare consideration. Researchers reported changes in colouration, cranial deformities and opercular overgrowth and lower jaw deformation in coho salmon transgenic for AFP and GH. After one year of development, anatomical changes due to growth of cartilage in the cranial and opercular regions were more severe and reduced viability was evident. However, systematic data on the incidence of abnormalities in fish GMOs as those described by Devlin *et al.* (1995) are not available and this is probably because animal welfare is not recognized as an issue in relation to the use of GMOs. If GMOs are to be used in aquaculture, concerns on this issue will need to be properly addressed.

RATIONAL AND RESPONSIBLE ASSESSMENT OF RISK REQUIRES FOLLOWING PROPERTIES ARE ALL CONSIDERED:

(i) Source of the DNA of the target gene;

(ii) Source of the non target DNA segments of the construct used;

(iii) Site(s) of incorporation of the transgene within the recipient genome;

(iv) Product of the transgene;

(v) Interaction of the transgenic product with other molecules in host and consumer;

(vi) Possible molecular changes in transgene product during processing;

(vii) Pleiotropic effects of transgene;

(viii) Tissue specificity of transgenic expression;

(ix) Numbers of transgenic organisms capable of interacting with natural systems.

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GMO Labeling

Consumer concerns have triggered a discussion on the desirability of labeling GM foods, allowing an informed choice. The different attitudes of the consumers in EU and USA have led to marked differences in national labeling requirements. The US Food and Drug Administration do not require labeling of GM foods per se, but only if the transgenic food is substantially different from its conventional counterpart. The EU, by contrast, requires labeling of all foodstuffs, additives and flavours containing 1 % or more genetically modified material.

GMO research in India

The first Indian transgenic zebra fish was generated in 1991, followed by first triploid transgenic *Brachydanio rerio* in 1995, using borrowed constructs from foreign sources. To construct transformation vectors for the indigenous fishes, growth hormone genes of rohu *(Labeo rohita)* and catfish, *Heteropneustes fossilis* were isolated, cloned, sequenced and confirmed in prokaryotic and eukaryotic systems. A vector was made with grass carp β-actin promoter driving the expression of r-GH. The sperm electroporation technique was standardized to ensure 25% hatchling survival and 37% presumptive transgenics. Southern analysis confirmed genomic integration in 15% of the tested individuals.

Transgenic rohu and singhi grew faster than the respective controls and converted the food at a significantly higher efficiency. At Centre for Cellular and Molecular Biology (CCMB), Hyderabad, autotransgenic *Catla catla* and *Labeo rohita* were generated using the growth hormone gene constructs (both cDNA and genomic DNA) fully developed from these species, thus giving a "Swadeshi" touch to the entire experiment (Majumdar, 2002, pers. comm.; CCMB 2002). Efforts are on way to isolate and characterize salt-resistant genes from marine environment in a collaborative project between Central Institute of Fisheries Education (CIFE) Mumbai and CCMB, Hyderabad. Similarly, attempts have been initiated at M. S. Swaminathan Research Foundation, Chennai, Central Marine Fisheries Research Institute (CMFRI), Kochi, National Bureau of Fish Genetic Resources (NBFGR) and Central Institute of Fisheries Technology (CIFT), Kochi to isolate and characterize salt tolerance genes from mangrove plants like *Avicenia* sp., sea grasses and marine microbes.

CCMB fish are auto-transgenic, meaning the genes inserted into a fish's genome are a mashed-up

cocktail of its own genome. If and when the trials proceed successfully, CCMB plans to tie up with the Andhra Pradesh fisheries department to scale up production. However, if bio-safety tests need to be carried out, the wait could get longer.

Size does matter: A GM rohu (top) alongside the normal, average-sized version.

Bio-safety framework in India: Rules and institutions

The Ministry of Forests and Environment, Government of India has also framed rules and procedures for handling GMOs, including fishes. In 1986, the Government of India enacted the Environment (Protection) Act (EPA) to protect and preserve the environment and to minimize the risks from pollutants, and contaminants as well as GMOs. The *Gazette of India* clearly defines the Competent Authorities and their structural composition for handling all aspects of GMOs and their products.

There are six competent authorities, as stated below, and among them, the first three were constituted by the Department of Biotechnology, Ministry of Science and Technology, and the fourth by the Ministry of Environment and Forests:

(i) The Recombinant DNA Advisory Committee (RDAC) monitors the developments in biotechnology at national and international levels,

(ii) The Review Committee on Genetic Manipulation (RCGM) monitors safety aspects of on-going projects and activities involving genetically engineered organisms.

(iii) The Institutional Bio safety Committee (IBSC) keeps track of the identified investigators, and the status and results of their experiments.

(iv) The Genetic Engineering Approval Committee (GEAC) is responsible for approval of activities involving large scale use of GMOs in research, industrial production and applications.

(v) State Biotechnology Coordination committee (SBCC), and

(vi) District Level Committee (DLC) has powers to inspect, investigate and take suitable action in the case of violations of the statutory provision.

The Indian bio-safety regulatory framework, comprising the 1989 Rule ("Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms, Genetically Engineered Organisms or Cells") and the guidelines issued by the Department of Biotechnology (DBT) under the Ministry of Science and Technology in 1990, 1994 and 1998, cover the entire spectrum of activities relating to genetically modified organisms including fish. This includes "research involving genetically modified organisms, as well as genetic transformations of green plants, recombinant DNA (rDNA) technology in vaccine development, and large-scale production and deliberate/accidental release into the environment of organisms, plants, animals and products derived from rDNA technology". Production facilities such as distilleries and tanneries that use genetically modified organisms are also covered under this.

Another key addition in the 1998 guidelines is the requirement to generate data on comparative economic benefit of a transgenic organism. The 1998 guidelines call for a demonstration that a transgenic organism is both "environmentally safe and economically viable" before large-scale field trials are attempted. Thus, in agronomic evaluation if the transgenic crop to determine the cost-effectiveness and economic advantage to farmers is seen as an integral component of the transgenic crop approval process, along with the bio-safety evaluation. This is equally applicable to Indian aquaculture scenario also, where the fish culture practices are mostly in semi-intensive pattern.

However, it must be indicated that most of these committees have framed rules and guidelines, especially for agriculturally important plants and hygienically important pathogens; as experiments in transgenic animals, including fish are yet at a developmental stage in country and India has to go a long way before such products are developed for commercial applications (Pandian, 2001).

Future of GMOs

Future of transgenic technology with respect to aquaculture development is promising not withstanding some technical problems. The gene transfer efficiency needs further improvement. Continuous efforts are necessary to isolate and identify novel useful genes and suitable promoters of fish-origin to regulate the expression of the transgene in a tissue-specific manner at an appropriate level. DNA microarray technique in particular is likely to become a powerful tool for this purpose. Methods should be developed to control the number of copies of a gene to be incorporated and its location of integration in the chromosomes. The physiological, nutritional and environmental factors that will maximize the performance of transgenic individuals should be determined. Bio-safety issues of transgenic fishes also need very careful attention. For framing/updating regulations affecting GMOs, accurate and complete information must be used.

Annual world landings of aquatic resources have increased more than fourfold during the last fifty years. The larger share of this production came from the capture fishery sector which has been overexploited, leading to decline of fish diversity. An analysis revealed that about 20% (~1800 species) of the world's freshwater species are severely threatened. On the other hand, aquaculture provides greater scope for increasing fish production. Thus, transgenic as a growing discipline will have an important role to play in the future for increasing aquaculture productivity and would help in reducing the fishing pressure on natural resources.

Use of sex-reversed / sterile triploid auto transgenic fish, combined with secure physical containment may reduce interaction between transgenic and wild con specifics sufficiently to allow safe use of GM fish strains in aquaculture situations. In Indian context, transgenic aquatic organisms would be a boon and the increase in fish production will improve the nutritional standard of the people. The economy will be diversified raising employment opportunities.

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GYPSOPHILA: BABY'S BREATH

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Introduction

Gypsophila paniculata popularly called Baby's breath belongs to the family Caryophyllaceae. It is native to Eastern Europe and now it's grown all over the world. . It is grown in open field as well as in poly houses. Flowers are produced in large inflorescences usually in profusely branched panicles. There are mainly two forms of Gypsophila cultivated in the world the annual*Gypsophila elegans*and the perennial *Gypsophila paniculata*. The perennial form, *G. paniculata* 'Bristol Fairy' is in high demand in both international and local markets. There are several new cultivars available in recent days such as Cosmic, Tango, Xlence-Bloom, Cassiopiea, Bridal Veil and Danniger.

Gypsophila flowers are mainly used as cut flowers as well as fillers in floral arrangements and bouquets especially with roses. New trends in floristry favoured by celebrity and designer florists; incorporate gypsophila into trendy table arrangements and wedding bouquets consisting of nothing more than *Gypsophila* and little foliage.

Soil and climate

Gypsophila is a long day plant and flowering is induced under 13-14 hours light. Crop requires light intensity of 55000 to 70000 lux at plant level. Optimum humidity for plant growth and flowering is 70 to 75%.

If the crop is grown outdoors, good shelter is necessary. Hot dry winds or untimely rainfall will cause browning of flowers. Hence, protection of the crop is necessary. During the rainy season, a simple roof of either plastic or acrylic material will protect flowers from rain and weather. Shade may also be desirable if the intensity of sunlight is more.

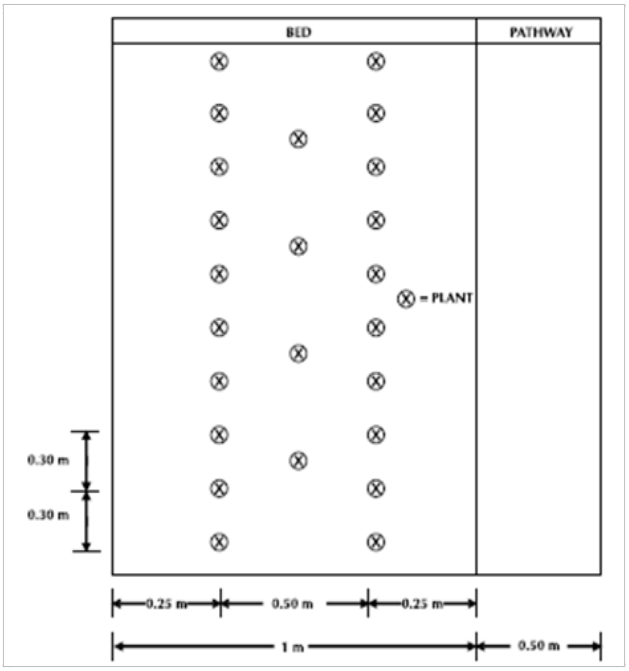
Gypsophila paniculata demands well drained, porous soil with pH 6.0 to 6.5 and Ec below 0.7ms/cm, Poorly drained soils may create a problem of *Phytophthora* root rot.

Propagation

In recent days, Gypsophila is commercially propagated through tissue culture but, alternatively, it can also be propagated through seed or terminal cuttings.

Layout and planting

Gypsophila can be grown on raised beds having dimensions of 100cm width, 30 cm height and 50 cm between the beds (pathway) with convenient length. The ideal planting density is approximately 4-5 plants per sq. m. Plants are placed in double rows, with 50 cm between the rows and 30 cm between the plants. Single plant for every alternate plant in the middle of the row is recommended.



Support system

Support netting should be fixed within 3 weeks of planting before pinching. First net of size 20x20cm is placed at 30 cm from the base of the plant. Second net of the same size should be installed at 45 cm if required. Side string at 60cm should be tied at both sides of bed to avoid crop lodging in beds and if necessary, again at 100cm. Shoots that grow out into the aisles should be regularly trained back inside the side wires.

Pinching

Pinching is done when the plants are 15cm high by removing the central tip portion. This results in a more uniform development of the remaining shoots. The shoot is pinched at 5th or 7th node.Pinching should be done in the morning hours (before 9 am) when

the plants are fresh and fully turgid.Immediately after pinching it is essential to spray the crop with fungicide; Captan or Blitox @ 1gm/l to avoid fungal infection from the exposed parts. Application of GA3 at 4 days after pinching @ 250 ppm is recommended for enhancing the stem length.

Fertigation

Fertigation in any crop mainly depends upon the soil fertility status. A general fertigation formula could be

- 19:19:19 @ 1 gm/l from 1st week to 3rd week
- 19:19:19 @ 1.5 gm/l from 3rd week to 6th week
- 16:8:24 @ 1.5 gm/l from 6th week to till harvest.
- Calcium nitrate ($CaNO_3$)@ 1 gm/l till 3rd week and 1.5 gm/l from 3rd week onwards till harvest. Magnesium nitrate (Mg(NO3)) @ 1 gm/l from first week till harvest along with other micronutrients at weekly intervals.

Irrigation

Irrigation mainly depends upon the prevailing weather and existing soil conditions. Use overhead irrigation for the first week after planting; keep soil at field capacity level. As the plant grows, slightly reduce the irrigation intervals based on the weather. Irrigation should be stopped at the time of pruning. Restart irrigation after pruning and increase it gradually to 100% field capacity as leaves appear.

Pruning

Pruning is performed after every flush of production to lower the plant height to 5-10 cm. Pruning should be done in the morning hours.Immediately after pruning, it is essential to spray the crop with fungicide; Captan or Blitox @ 2gm/l to avoid fungal infection from the exposed parts.

Harvesting and postharvest care

Gypsophila should be harvested when 50-60% of the flowers on the stem are open.Delay in harvesting causes browning of the flowers. After harvesting, flowers can be stored for 5 to7 days insidea chamber at a temperature of 5-10 °Cand high relative humidity 90%.

The stems are graded in shade in lengths of 80, 70, 60 and 50 cm.They are generally bunched with 5 stems per bunch and sleeved five bunches per sleeve. Growers will need to check on bunching and packing requirements with the auction house or exporter they supply.Gypsophila has a relatively short vase life if improperly handled. It is sensitive to both ethylene in the environment and ethylene produced by the stems itself.

Yield

Gypsophila produces 8-10 stems per plant per flush.

Pests

Leaf miner and thrips can infest the crop if proper cultural practices are not followed. These can be easily controlled by spraying Azadirachtin @ 2 ml/l in earlier stages. In severe incidence, leaf miner can be controlled by spraying, abamectin @ 0.5 ml/l and for thrips, fipronil @ 1.5 ml/l or spinosad @ 0.25 ml/l.

Diseases

Powdery mildew and alternaria leaf spot are commonly observed in gypsophila. Powdery mildew can be controlled by maintaining the humidity and by spraying haxaconazol @ 1 ml/l. Alternaria leafspot can be controlled by spraying captan or COC @ 2g/l.

Gypsophila in bouquets


Gypsophila in table piece arrangements


Gypsophila bunch @ 10 stems/ bunch


Gypsophila growing under polyhouse

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POULTRY REARING WITH SCIENTIFIC MANAGEMENTAPPROACH AT COVSC.& A.H., JALUKIE, NAGALAND

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Introduction

Production of chicken for meat and eggs is growing into the largest component of the poultry industry in India. India is in 6th position in poultry meat production and 3rd in egg production as per the latest livestock production statistics of India (Singh, 2020). The total poultry population in North East region is round 36.46 million with 27.79 million fowls and 8.67 million ducks (Anonymous, 2023). Low input backyard farming with deshi birds is the mainstream of poultry production prevailing in north- east states in India particularly Nagaland. The organized poultry sector in Nagaland consist of only 1.64% broiler and 0.80% layer to meet the demand of egg and meat requirement of the state. The COVSC.& A.H., Jalukie, Nagaland under the department of Livestock Farm Complex reared poultry with the aim of conducting various research works and model for sustainable poultry farming for income generation of the farmers and other entrepreneurs. The source of DOC isICAR, Medziphema, Nagaland and COVSC.& A.H., Jalukie. Various breed of chicken like Vanaraja, Shrinidhi, Rainbow rooster, Necked neck and Vencobb are reared at COVSC.& A.H., Jalukie.

Brooding

The brooder house were kept warm before the arrival of the chicks on arrival they were provided with stressvit by dissolving in water. The DOC of 100 number of Vanaraja were kept under electric hover by maintaining the temperature of 98.5 ^{0}F and after every week 0.5^{o}F is reduce until it reach 75^o F for 3 wks. Brooder guards were placed around the brooder areas to avoid straying of chicks and for proper heat distribution and removed after one week. Waterer and feeder were provided as per the requirement.

Fig 1: Weighing of DOC Fig 2: Brooding of chicks

Housing system

Birds were housed under intensive system by rearing i.e. under deep litter system by using dry saw dust of about 3-5" as litter materials in the initial stage. Litter were raked thrice in a week and change the fresh one which is generally done once in every 3-4 months depending upon the litter wetness. In general a handful of litter is taken and by squeezing them, if cake formation is observed it indicate the litter to be changed. The bird were kept at the following given space.

Age	Deep litters (ft^2)
0-8	0.60
9-18	1.25
18- till the marketing	2 - 2.50

Fig. 3: Litter Management

Provision of Nest Boxes:

1. Nest boxes were provided for layers.
2. Nest are lined up near side of the shed away from the sun ray.
3. Wood shavings were placed on the floor of the nest box to protect the eggs against breakage and to produce clean eggs.

Feeding schedule

During the course of rearing,godrej brand feed were given to the birds, each bag content net weight of 50 kg of feed.Initially the chicks were fed with pre-starter ration for around 10 days, followed by starter feed upto8thwks of age. When the birds are 9thwks of age they were fed with 30% locally available feed ingredients along with cheaply available broken rice, rice polish, fish meal, salts, minerals mixturesetc,. mixed with grower ration. The feed were formulated as per BIS 2007 feeding standards (listed in below table). Clean wholesome water was provided twice in a day in clean waterer. Feeder and waterer were kept clean before every used. The required quantities of feeder and waterer were provided. The birds were fed with the following feed components.

Age (wks)	Crude protein (%)	Metabolisable energy (Kcal/kg)
0-8	22	2700
9-20	16	2600
21- till the marketing	18	2700

Fig 4: Feeding of poultry

Fig 5: Locally available poultry feed

At 20th week of age, the birds attained maturity. Brown eggs were laid on an average of 10% egg production at 20th week and gradually attained 75-80% on 35-40th weeks of age. The calculated FCR was recorded to be 2.8.

Moulting

It is a natural physiological process for the birds to renew old feather at the end of the first year of laying. The time and duration of the first annual moulting are important points in distinguishing the poor and good layers. Early moulter are usually poor layers whereas late moulter are good layers and complete moulting quickly. Some of the differential points between good and poor layers are listed below.

Part	Laying	Not Laying
Pubic Bone	Soft And Flexible, Well Spread, Distances 2-3 Fingers	Blunt , Rigid & Close Together (Takes 2 or Less Fingers
Vent	Large, Oval, Dilated and Moist	Small, Shrunken & Dry
Abdomen	Well Developed, Soft and Pliable	Contracted, Hard and Fleshy
Comb	Large, Glossy, Red and Warm	Shrivelled, Dry, Dull and Scaly.
Ear Lobes And Wattles	Smooth, Soft	Rough, Dry

Health management

During the course of rearing the birds suffered from vent pecking for which the affected birds were isolated and treated with antibiotic and application of himax at the injured areas, the whole flocks were supplemented with mineral and protein. Other problem which encountered were coccidiosis which was diagnosed after faecal examination at the Veterinary Parasitology department of the college, for which Amprolium with other supplementary like ORS, tetracycline, stressvit were give as per the recommended doses. Feeding of aloe vera plant after every 2 months were also found to improve overall performance of the birds.Strict biosecurity measures were followed within and outside the farm premises.

Fig 6 :Coccidial oocysts

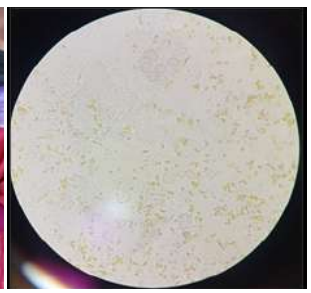

Fig 7 : Vent Pecking

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Other management

Debeaking was done at the farm at the age of 12- 14 weeks by electric debeaker. The upper beak were cut to two-thirds and the lower beak to one-third. The cut portion were cauterized by touching the surface with the hot plate. Stressvit was provided in drinking water after the day of debeaking. Adjusted the feeder and drinker height after the shortened beak.

Fig8: Debeaking with electric debeaker

Conclusion

Rearing of poultry at LFC of COVSc AH is stillgoing on.As these birds are specially developed to suit to backyard system of rearing, further studies are to be carried out with incorporation of locally available feed ingredients to study the performance of birds reared under intensive and natural system of management at Livestock Farm Complex of COVSc. & AH, Jalukie, Nagaland.

PRACTICAL AND HOLISTIC APPROACH TO INTEGRATED FARMING UNDER NEH REGION IN ONE HECTARE OF LAND

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Introduction

Integrated Farming System (IFS) is a farming system that originated in China and is now being adopted worldwide. It is also known as mixed farming, which integrates piggery, poultry, fishery, duckery, crop production, and other systems that benefit each other. It involves two or more enterprises simultaneously that supplement each other, where one farming component supports the other. An example of integrated farming can be fish and livestock cultivation along with other general farming practices that supplement each other. Hence, IFS is associated with reducing external inputs and increasing output at the same time. In this topic, we will discuss the practical and holistic approach of integrated piggery farming combined with aquaculture and horticulture in a one-hectare area of land.

Construction of piggery

The piggery sty should be constructed on the embankment of the pond. The floor must be slanted slightly towards the drainage gutter in the ratio of 1:72. The gutter should be connected to the pond. Provision for diversion from drainage canal to manure pit may be provided where the waste can be stored during algal bloom in the pond to regulate waste flow. Algal bloom is a phenomenon that occurs when a heavy deposit of nitrates from animal waste is accumulated in stagnant water bodies, which is detrimental to aquatic organisms by limiting oxygen supply. If not checked for a prolonged period, algal bloom may lead to the suffocation and death of fish under severe conditions. To avoid such a phenomenon, a built-in shutter must be provided in the drainage canal to regulate the release of organic matter of animal origin. To prevent algal bloom, an optimum of 10 adult sow units can be raised to provide the dung requirement for a 1500-square-meter area (40 ft × 400 ft pond area) of pond or 550-600 kg of pig dung per week. From a practical point of view, to avoid contamination of pond water with organic matter, a pig sty should be located in one corner of the pond. The side wall of the sty should be a brick wall of 1.0 meters in height; the wall should be a garden wall to facilitate proper ventilation. The space requirement for 10 adult pigs with followers is 1700 sq. ft. (10 ft×170 ft). Area of 1700 sq. ft. includes grower, finisher, and farrowing pen. The roof of the sty may be made using

corrugated tin sheets, asbestos, or thatch. Feeding and drinking troughs are to be constructed inside the pen. Pellet feeding is the preferred pig feeding system.

Preparation of pond and manuring

The pond should be dried and cleaned in the case of older ponds, before introduction of fingerlings, but this is not required in a freshly dug fish pond. The depth of the pond should not be more than 1.5 meter. Lime @ 50 kg quick lime and manure @ 2300 kg of cow dung should be applied respectively to 1500 square meter area (40 ft×400 ft pond area) of pond. Liming is essential for removal of any unwanted weeds and wild fishes if any, while manuring favours the growth of zooplanktons and phytoplankton for the newly introduced fingerlings. Fingerlings should be introduced only after 15-20 days of liming and manuring.

Management practices necessary to be followed in a farm include:

1. Timely removal of algal blooms and weeds, if necessary.
2. Removal of wild carnivorous species of fish
3. Timely liming of pond: depending upon the pH of pond water. The pH of pond water should not be acidic or alkaline, as in both cases it is detrimental to fish health. Fish becomes stressed at the pH range between 4.0-6.5 & 9-11. Ideal pH of pond water should be in the range of 6.5- 9. Timely liming is very important as normal pond water is slightly acidic (pH 5.65)
4. Stocking of fingerling: Stocking density varies from species to species, but generally it ranges from 30,000-50,000 fingerlings per hectare. In a pond area of 1500 cu.meter10, 000-12,000 fingerlings are an ideal number, as overstocking effects their growth and performance.
5. Feeding: feeding can be pellet feeds or GNC or MOC
6. Harvesting and marketing: fish can be harvested six months interval or can be reared for a year, depending upon the frequency of harvesting it will range from 500-600 grams or above 1.0 kg.

Economics of Integrated farming (Model outline)

General Assumptions:

i. Amount or Price used in economic calculations may vary from place to place.

ii. Assumptions on feed consumption is based upon scientific study

iii. Economics presented here is for information only (Actual economics will be region specific)

iv. It is assumed that the adult pig at the time of purchase is sexually matured and ready for service.

A. Capital investment

a) Land: 1.0 Hectare, available (Assumption)

b) Purchase of 10 adult female pigs and 1 boar @ Rs 10000/- Per Pig = Rs 1,10,000/-

c) Construction of pig sty for 10 pigs and 1 boar @ Rs 200Per ft^2 area: Pig sty $1700ft^2$ × 400 = Total Rs. 3,40,000/-

d) Digging of 2250 M^3(50M × 30M × 1.5M) fish pond and preparation = 1,50,000/-

e) Cost of 50 ducklings and their feeds: 10,000/- (Approx), investment in feeds will be negligible as they will forage (Ducks helps in aeration of fish pond hence, beneficial for this IFS model)

f) Construction of farm house and Store room: 0.00/- (Assumed it is available with the beneficiary, if model unit is constructed in his land) (If already available, then construction is not required)

g) Equipment for piggery and fishery operations @ Rs 50,000/- (Approx)

h) Miscellaneous expenditure @ Rs. 1,50,000/- annually

Total capital investment: Rs. 8, 10,000/-

B. Recurrent expenditure:

a) Feeds (Pigs): Cost of feeds for 10 adult pigs and piglets for 3 years @ 3 kg and 150 gram daily for piglets for 60 days per batch @ Rs 30/ kg feed = Rs 9.17 lakhs *(Cost of feeding is calculated based upon current market rate on pellet feeding, the cost can be reduced by inclusion of locally available feed ingredients without affecting the nutrient requirement)*

b) Purchase of fish fingerlings and feeds: Cost of purchase and feeds for 10,000 fingerlings for 6 months assuming each fingerlings costs Rs. 3 and each fish consuming on an average 10 grams of feeds daily for 3 years = Rs 12.60 lakhs

c) Labour : Family labour

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d) Cost of medicines/ treatment/ liming for 3 year: Rs 0.90 lakhs

e) Miscellany and other operational expenditures for 3 years: Rs 1.50 lakhs

Total recurrent expenditure: Rs. 24.17 lakhs

Total Expenditures: A+B= Rs 32.27/-

(Thirty two lakhs twenty seven thousand) only

C. GROSS SALE RECEIPT FOR FIRST YEAR.

i. Sale of piglets: Assuming each sows gives birth to 8 piglets with farrowing index 2.0 selling each piglets @ Rs 4000/- (rate as per local market) = Rs. 5,76,000/-

(For sale of piglets, mortality of 10% has been included for economic calculation)

ii. Sale of Fish: Assuming a mortality of 40 % of 10000 fingerlings 4000 kg selling @ Rs 200/kg of fish= Rs 8,00,000/-

Budget and economic calculation for 1st, 2nd and 3rd year

Sl.No.	Particular	1st year (in Lakhs)	2nd year (in Lakhs)	3rd year (in Lakhs)	Total (in Lakhs)
Fixed investment					
1.	Land (available)	0	0	0	0
2.	Construction of farm house and store room(Assumed it is available with the beneficiary, if model unit is constructed in his land)	0	0	0	0
3.	Construction of piggery and fishery	4.90	0	0	4.90
4.	Purchase of farm equipments	0.50	0	0	0.50
5.	Purchase of parent stock pigs & ducks	1.20	0	0	1.20
6.	Miscellaneous expenditure	1.50	0	0	1.50
Total A		**8.10**	**0**	**0**	**8.10**
Recurrent investment					
1.	Purchase of fish fingerlings	0.60	0.60	0.60	1.80
2.	Purchase of feeds for pigs,	2.80	2.80	2.80	8.40
3.	Purchase of feeds for piglets	0.21	0.28	0.28	0.77
4.	Purchase of feeds for fish	3.60	3.60	3.60	10.80
5.	Cost of medicines & treatment	0.30	0.30	0.30	0.90
6.	Miscellaneous operational expenses	0.50	0.50	0.50	1.50
Total B		8.01	8.08	8.08	24.17
Total financial outlay (A+B)		15.90	7.80	7.80	32.27
Gross sale return					
1.	Sale of piglets	5.76	7.20	7.20	20.16
2.	Sale of fish	8.00	8.00	8.00	24.00
3.	Sale of vegetables and poultry (duck)	0.50	0.50	0.50	1.50
Total gross return C		14.26	15.70	15.70	45.66
Net profit		-1.64	7.90	7.90	13.39
Monthly income (in rupees)		-0.13	0.66	0.66	

(For economic calculation expenditure from horticultural unit is NOT included,)

D. TOTAL NET PROFIT AT THE END OF 3RD YEAR OF OPERATION AMOUNTS TO= RS 3.39 LAKHS

(From second year of operation capital investment of 8.1 lakhs will not be included and the litter index of piglets will be increased from 2.0 to 2.5 and gross return from sale of piglets alone will increase to 7.2 lakhs from Rs. 5.76 lakhs. *Hence, net profit from subsequent year will be higher compared to first year as capital investment will be nil or negligible from second year)*

Type of fish suitable for integration and their stocking density

Fish like grass carp, silver carp and common carp are suitable for integration with pigs. Stocking density of 10,000 fingerlings per hectare of pond area is suitable. A fish production of 6,000 kg/ha could be achieved under a stocking density 10,000 fish fingerling/ hectare during a period of six months.

Advantages of integrating piggery with fishery and horticulture

Pig rearing can be very well integrated with fish production this system has numerous advantages of which few are mentioned below:

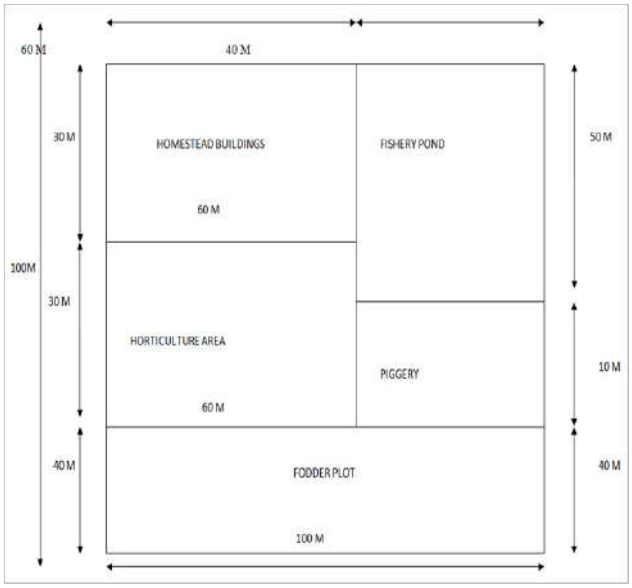
1. Pig dung acts as a fertilizer; it increases the biological productivity of the pond, which helps in producing phytoplankton and zooplankton. Hence, the application of extra fertilizer to fish ponds and supplementary feeding can be reduced.
2. The pond muck that gets accumulated in the pond bottom due to the constant application of pig dung can be used as fertilizer for horticultural crops grown over the pond embankments.
3. Integrated farming has multidimensional approaches that are environment friendly and sustainable in the long run.

Precautions

1. If the number of adult pigs is more than 30 per hectare of pond area, then excess dung washing should be stored in a manure tank, as too much dung will lead to algal blooms in the bond, thereby suffocating the fish during the night and early morning.
2. In case of algal bloom, the pond water will appear greenish, during which dung waste should be diverted to a manure tank for storage.
3. Liming the pond should be proper, and fingerlings should be introduced only after two to three weeks of liming and fertilizing.

Fig. 1. On piggery and fish production (Side view)

Fig. 2. Back view of piggery cum fish production



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RAINFALL-RUNOFF MODELLING FOR AN UNGAUGED WATERSHED USING GIUH APPROACH

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Introduction

Understanding of rainfall-runoff relationship is required when we deal with the importance of available water resources of a catchment area. The process of transformation of rainfall to runoff is highly complex, dynamic, non-linear, and exhibits temporal and spatial variability. Rainfall runoff modeling becomes a vital area in the field of hydrologic studies. It helps in various activities of water resource development and management such as flood control, irrigation scheduling, design of irrigation and drainage works, design of hydraulic structures and hydro-power generation. Majority of the watersheds in the underdeveloped countries are ungauged or poorly gauged stations. Due to non-availability of hydraulic gauging stations, it becomes a difficult task for hydrologist to develop an accurate surface runoff estimation from ungauged watershed. Linking of the geomorphologic parameters with the hydrological characteristics of watershed can provide an understanding of the hydrological behaviour of different watersheds, especially for the ungauged ones. To describe linkages between the hydrological characteristics and the geomorphologic parameters of a watershed, the concept of geomorphologic instantaneous unit hydrograph (GIUH) is introduced. The GIUH approach is applicable for ungauged or scantily gauged catchment wherein rainfall data are available but runoff data are not available. The GIUH approach is more advantageous than the conventional IUH methods. Digital Elevation Model (DEM), Slope Map, Drainage map can be developed for a watershed using SOI topo map and applying Arc GIS software. Watershed geomorphologic characteristics were estimated using DEM, Slope maps etc. developed for the watershed. The estimated geomorphologic parameters were used to calculate the IUH. Ultimately, a unit hydrograph (UH) for the watershed was developed.

GIUH Model

The concept of the GIUH was introduced by Rodriguez-Iturbe and Valdes. The formulation of GIUH is based on probability density function (*pdf*) of the time history of a randomly chosen drop of excess rainfall arrived to the trapping state of a hypothetical basin. The GIUH model produces a triangular IUH, which specifies the shape of the IUH by its peak. Rodriguez-Iturbe and Valdes (1979) derived the peak and time to peak for the IUH as a function of Horton's order ratios and are given as;

$$q_p = 1.31(R_l)^{0.43}\left(\frac{V}{L_\Omega}\right) \quad (1)$$

$$t_p = 0.44\left(\frac{L_\Omega}{V}\right)\left(\frac{R_b}{R_a}\right)^{0.55}(R_l)^{-0.38} \quad (2)$$

$$t_b = 2.67t_p \quad (3)$$

Where,
q_p = Peak flow in the unit of inverse hours (h^{-1});
t_p = Time to peak (h);
t_b = Base time in hours (h);
R_l = Horton's Length Ratio;
R_b = Horton's Bifurcation Ratio;
R_a = Horton's Area Ratio;
V = velocity (m/s);
L_Ω = Length of the highest order stream (km);

The geomorphologic parameters *viz.* R_l, R_b and R_a for a given watershed may be obtained based on the Horton's empirical laws as; $R_l = L_{(i+1)}/L_i$; $R_b = N_i / N_{(i+1)}$; and $R_a = A_{(i+1)} / A_i$. Here, $i = 1, 2, \ldots, i\text{-}1$, L_i, $L_{(i+1)}$ = the average length of the streams of the respective order i and $(i+1)$; N_i ,$N_{(i+1)}$ = total number of channel of the respective order i and $(i+1)$; A_i, $A_{(i+1)}$ = the average area drained by the streams of the order i and $(i+1)$ respectively.

For the calculation of dynamic parameter velocity in equation (6), Kirpich's formula given in equation (4) was combined with velocity relationship given in equation (5). The dynamic parameter velocity uses the mean slope and length characteristic of the watershed as shown in equation (6). The dynamic parameter velocity and the calculated geomorphologic parameters were used in the above equation (1), (2) and (3) in order to obtain the peak discharge, time to peak and base time for the triangular IUH.

$$t_c = 0.01947L^{0.77}S^{-0.385} \quad (4)$$

$$t_c = \frac{1}{60}\left(L/V\right) \quad (5)$$

$$V = 0.8562\,L^{0.23}S^{0.385} \quad (6)$$

Where, t_c= Time of concentration (min); L = Length of the channel from headwater to the Outlet (km); S = Mean slope of the watershed in m/m; V = dynamic parameter velocity in m/s;

Estimation of geomorphologic parameters

In order to estimate the geomorphologic characteristics for a watershed, incorporation of ArcGIS is required. ASTER DEM was combined with SOI topo map by using Global Mapper DEM. With DEM as input data the geomorphologic characteristics of the land surface was evaluated. Later, watershed delineation was performed and stream networks for the watersheds were generated. Stream ordering for the watershed is done in the ArcGIS environment using Strahler's stream ordering network using different tools in the ArcGIS tool(Strahler, 1957). Fig. 1 and Fig. 2 respectivelyshow the ordered drainage network and the slope map of Jiri Watershed of Manipur.

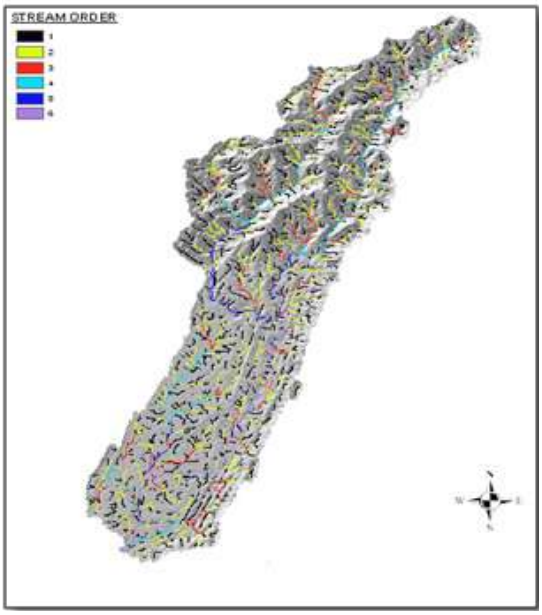

Fig. 1 Ordered drainage network of Jiri watershed

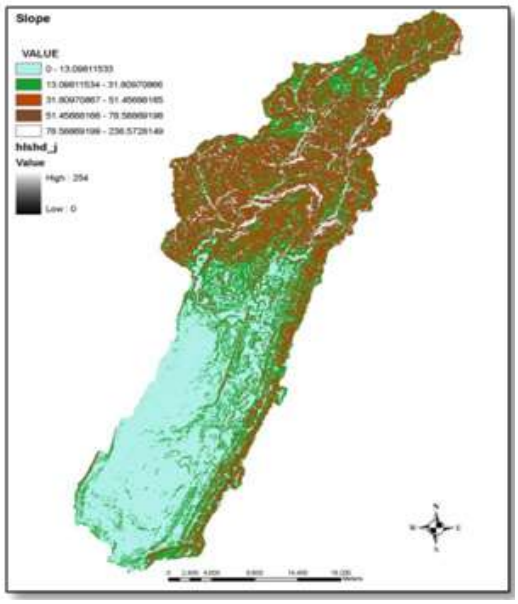

Fig. 2 Slope map of Jiri watershed

The watershed parameters viz. Area ratio (R_a) Length ratio (R_l) and Bifurcation ratio (R_b) for the watersheds were computed graphically by plotting average areas drained, average length and stream number against the stream orders and absolute slope value for the best fit lines as estimated. The stream numbers, stream length and area drained by the streams of the respective orders (1^{st}, 2^{nd}, 3^{rd},…., 6^{th}) were extracted with the help of the hydrology tools available in ArcGIS. Likewise, for the Area ratio, the area drained by the streams of different orders were derived for respective stream orders under certain steps in ArcGIS interface and extracted from the Attribute table. The details of the stream numbers, average length and average area for streams of various orders of study area were tabulated in Table 1.

Table 1: Required details of count, average length and average area drained by various stream orders for a watershed

Stream order	Count	Average Length (km)	Average Area (Sq. km)

The geomorphologic parameters viz. (R_b),(R_a)and(R_l) were calculated using equations described in the earlier sections for the main watershed. These values were then computed graphically by plotting stream numbers, mean stream length and mean stream area versus order of the streams and estimating absolute values of slopes of the best fit lines. The length of the highest order stream i.e. the sixth order stream (L_Ω) was measured. The required geomorphologic parameters are listed in Table 2.

Table 2 Required details of geomorphologic characteristics for a watershed

Watershed	Area-Ratio (R_a)	Length Ratio (R_l)	Bifurcation Ratio (R_b)	Main Stream Length (L in km)	Highest Order Stream Length (in km)	Area (A in km²)	Mean Slope (S in m/m)

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The geomorphologic parameters obtained in the above analysis have been applied for the estimation of time of concentration using Kirpich's formula. To estimate the time of concentration using Kirpich formula, length of the main stream and mean slope value were used in equation (4). The dynamic parameter velocity were obtained by the combination of equations (4) and (5).Using the dynamic parameter velocity and the geomorphologic characteristics given in Table-2, equations (1) and (2) were used to compute peak flow rate () and time to peak () as developed by Rodriguez-Iturbe and Valdes (1979) assuming a triangular instantaneous unit hydrograph (IUH). Equation (3) was used to obtain IUH time base. Using these three evaluated parameters viz. peak flow rate, time to peak and base time, the geomorphologic instantaneous unit hydrograph was derived as shown in Fig. 3.

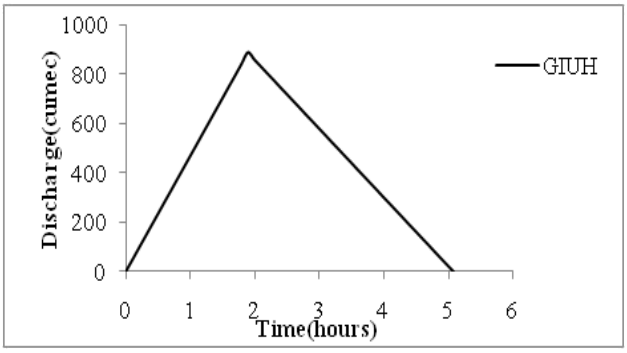

Fig 3: Geomorphological instantaneous unit hydrograph

Development of Unit Hydrograph (UH) from GIUH

Unit hydrograph can be obtained from Instantaneous unit hydrograph for a finite duration. Derivation of a UH of specified duration from the IUH was accomplished by using the following technique. For deriving a 1-hr unit hydrograph, the IUH ordinates so obtained were lagged by 1-hr and the two IUHs were summed up. This sum represented the runoff from 2 unit of excess rainfall. To obtain the required unit hydrograph, the ordinates was divided by 2. The unit hydrograph derived were of immense value in the study of the hydrology of a catchment. They are of great use in (i) the development of flood hydrographs for extreme rainfall magnitude for use in the design of hydraulic structuresand agricultural/ industrial practices (ii) development of flood forecasting and warning systems based on rainfall and (iii) extension of flood-flow records based on rainfall.

Conclusion

The GIUH model has been applied to an un-gauged catchment and the model has been developed for estimation of unit hydrograph. For estimation of geomorphologic characteristics, GIS technique has been used since estimation of the parameters can be handled with GIS more accurately and efficiently which otherwise as compared to conventional methods. The DEM, stream network and slope map etc. were useful for hydrological and geological studies of the watershed. R-R modelling for the watershed provides information about water availability in the watershed and was useful for simulation of flood events, design of hydraulic structures and agricultural/industrial practices.

AFRICAN SWINE FEVER: A MAJOR CHALLENGE TO FARMER'S SOCIO-ECONOMIC STABILITY

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INTRODUCTION

African swine fever (ASF) is a highly contagious fatal disease of pigs, both wild and domestic, that manifests as a haemorrhagic fever and can kill up to 100% of affected pigs. The disease was first detected in Kenya (East Africa) in the early 1900s and has since spread to various part of the globe, including Europe, Asia, and the Americas. The World Organisation for Animal Health (OIE) lists African swine fever as a Notifiable disease. The disease is indistinguishable in the field from classical swine fever but the manifestations are more severe in character. Domestic pigs of all ages and breeds are highly susceptible. But fortunately, the ASF virus cannot be transmitted from pigs to humans neither direct contact with infected pigs nor eating pork originating from infected pigs. In India, the first outbreak of ASF was recorded/ reported in January, 2020 in the North Eastern States of Assam and Arunachal Pradesh.

ETIOLOGY

The disease is caused by the ASF virus(ASFV) of genus Asfivirus and is the only member ofthe Asfarviridae family. It is a large icosahedral, enveloped virus that contains alinear, double-stranded DNA genome having length between 170 to 190 kbp in size. The virus can survive for several weeks or months in the blood, faeces and tissue of infected animals. The virus can also survive for extended periods in contaminated feed as well as frozen, fresh or uncooked meat. Although ASFV is very resistant to inactivation in the environment, many lipid solvents and commercial dis infectants based on phenolic and iodide compoundsare effective and can inactivate the virus at pH < 4 and pH >1.

ECONOMIC IMPACT ON PIG FARMING

The economic impact of ASF on pig farming is profound. Direct losses include the death of pigs,culling of infected and at-risk animals, and the costs associated with implementing control measures such as disinfection, biosecurity enhancements, and compensation to farmers. Indirect losses arisefrom trade restrictions, market disruptions, and decreased consumer confidence in pork products.

Direct Economic Losses

1. **Mortality and Culling**: The high mortality rate of ASF leads to significant losses in pig populations. Farmers often have to cull entire herds to prevent the spread of the disease, resulting in immediate financial losses.
2. **Control Measures**: Implementing control measures such as quarantine, disinfection, and enhanced biosecurity incurs substantial costs. Farmers must invest in new equipment, facilities, and training to comply with biosecurity protocols.
3. **Compensation**: Governments may provide compensation to affected farmers, but this is often insufficient to cover the full extent of the losses. In some cases, compensation may not be available at all, leaving farmers to bear the financial burden.

Indirect Economic Losses

1. **Trade Restrictions**: Outbreaks of ASF often lead to trade restrictions and bans on pork exports from affected regions. This results in lost revenue and market access for pig farmers and the broader pork industry.
2. Market Disruptions: ASF outbreaks can disrupt supply chains, leading to fluctuations in pork prices and availability. This volatility can negatively impact farmers' income and livelihoods.
3. Consumer Confidence: Public concern over ASF can lead to decreased demand for pork products, further exacerbating economic losses for farmers and the pork industry.

SOCIO-ECONOMIC IMPACT ON FARMERS

Beyond the immediate economic losses, ASF has significant socio-economic implications for farmers. These include loss of livelihoods, increased poverty, mental health challenges, and social instability.

Loss of Livelihoods

Pig farming is a primary source of income and employment for millions of smallholder farmers worldwide. ASF outbreaks can wipe out entire herds, leaving farmers without a means of income. The loss of livestock forces farmers to seek alternative livelihoods, which may not be readily available or as profitable. This can lead to increased poverty and food insecurity in rural communities.

Increased Poverty

The financial burden of dealing with ASF can push farmers into debt and poverty. Smallholder farmers, who often lack access to credit and insurance, are particularly vulnerable. The costs associated with culling, control measures, and loss of income can be overwhelming, leading to long-term financial instability.

Mental Health Challenges

The psychological impact of ASF on farmers cannot be underestimated. The loss of livestock, income,and the stress of managing outbreaks can lead to mental health challenges such as anxiety,depression, and even suicide. The stigma associated with ASF and the fear of future outbreaks can also contribute to ongoing mental health issues.

Social Instability

ASF can lead to social instability in farming communities. The economic hardships faced by farmers can strain social relationships and contribute to conflict over resources and support. Communities that rely heavily on pig farming may experience increased migration as farmers seek alternative livelihoods elsewhere.

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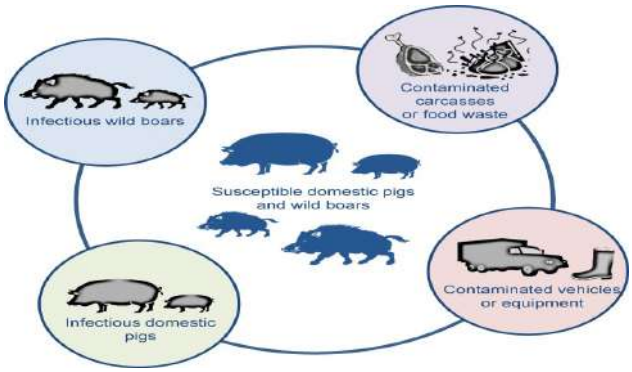
TRANSMISSION AND SPREAD OF ASFV

ASF virus is transmitted through

i) directly during contact between infected and susceptible pigs, by consumption of the meat from infected pigs

ii) by contact with material or objects (bedding,feed, equipment, clothes and footwear,vehicles) contaminated by virus containing matter such as blood, faeces, urineor saliva from infected pigs.

iii) by the bites of infected soft ticks (*Ornithodorosmoubata*), as such ASF virus is the only known DNA arbovirus



Transmissionroutes of the ASF virus.Source: https://pubmed.ncbi.nlm.nih.gov/29486878/

CLINICAL SIGNS

There are different forms of clinical presentations of ASF, namely, per acute, acute, subacute, and chronic associated with virulence of virus (Yoo *et al).*

- **Peracute form**:
  - High fever (up to 42°C), anorexia, lethargy, and sudden death within 4 days and some pigs may show respiratory signs due to high temperature.
- **Acute form**:
  - Characterized by high fever (40-42°C), with mortality rate reaching up to 100% within 4-9 day's post-infection.
  - The infected pigs show anorexia, lethargy, inactive, and bunch up together.
  - Bluish-purpled areas/hemorrhagic spots on ears, abdomen, hind legs, and generalized reddening of skin (chest, abdomen, tail, and leg)
  - Blood from nose/mouth, and bloody feces.
- **Subacute form**:
  - The clinical signs exhibited are similar to acute form of disease but less marked. Illness may last for 30-45 days. Most cases recover after intermittent fever up to 1 month.
  - Mortality may vary from 30% to 70% and pigs may die after 20 days after infection.
- **Chronic form:**
  - loss of weight, reddening of skin, growth retardation in growing pigs, irregular peaks of temperature, joint swellings, and respiratory signs.
  - Recovered and infected pigs both by high and low virulent virus act as persistent carriers which transmit the disease in disease-free zones.
  - Reproductive failures like abortion stillbirths, mummification weak piglets, etc.

DIAGNOSIS

As ASFV infection is very difficult to differentiate from Classical Swine Fever Virus (CSFV) infection either by clinical or post-mortem examination. Hence, it is essential to confirm the ASFV infection through laboratory diagnosis only. The laboratory diagnostic techniques are directed to detect the agent or immune response to agent. The samples to be sent for laboratory diagnosis are blood, serum, and tissues (spleen, lymph nodes, bone marrow, lung, tonsil, and kidney).

Detection of the agent

i. Virus isolation: Primary leukocyte culture or porcine bone marrow cells are commonly used for isolation of virus.

ii. Hemadsorption Assay Detection (HAD) test: Virus isolation in macrophages and HAD is the gold standard for identification of ASFV required for the first detection of ASF in disease-free regions or in the primary outbreak areas.

iii. Fluorescent antibody test (FAT): Directly can be used on field samples or those inoculated at the laboratory. Alone can serve as only presumptive diagnostic test along with clinical sings and typical lesions of ASFV.

iv. Real-time PCR: The technique is highly sensitive and less time-consuming and even can be used on samples which are not fit for virus isolation or antigen detection assays. The OIE recommends to follow quantitative PCR using real-time PCR primers and probes.

Photo Credit: USDA APHIS Foreign Animal Disease Diagnostic Laboratory at the Plum Island Animal Disease Center

Detection of immune response to agent or serological tests

The serological tests are the most commonly used diagnostic tests because of their simplicity, relatively low cost, and less specialized equipment's are needed.

The ELISA is frequently used to screen largenumbers of samples because it is easily automated. The indirect ELISA which is suitable for testing both serum and plasma. However, positive samples should be confirmed by indirect FAT (IFAT), indirect immunoperoxidase test (IPT) or immunoblotting. Different types of ELISA (competitive or blocking) commercially available are being used for the detection of antibodies against ASFV infection.

TREATMENT

At present, no treatment is available to extend satisfactory result against this disease.

PREVENTION AND CONTROL

- ✓ Persons/labours handling the infected pigs should take all biosafety precautions such as wearing of protective equipment such as aprons, spectacles, gloves, and gumboots and should not visit the other sheds.
- ✓ Disinfection of vehicle tyres and shoes with 2%sodium hypochlorite or potassium permanganate solution immediately after use and various commercial products of disinfectants are available in the market.
- ✓ Isolation, restriction of movement and sanitation (cleaning and disinfection) has controlled the spread of ASFV.
- ✓ Rapid culling of all infected and in-contact pigs and proper disposal of cadavers, litter, and waste food is essential. All these things should be buried deeply in the vicinity over layered with lime and salt.
- ✓ Movements of infected as well as susceptible pigs should strictly be prohibited.
- ✓ Disinfection may be carried out with 2% sodium or calcium hypochlorite/sodium hydroxide or a detergent-based virucidal agent),if tick population is high, one can use acaricide depending on the need.
- ✓ Farm utensils should be cleaned with detergents and washed properly.
- ✓ Creating awareness among the animal health workers about the disease, training them in early recognition, collection, and dispatch of suspected clinical samples, and intimation to the nearest dispensary are important steps in the field of health-care system.
- ✓ No commercial vaccine is available against this disease. However, number of vaccines have been

tried. They are killed virus vaccine (Stone and Hess, 1967), Egg adapted vaccine, Lapinized vaccine and tissue culture vaccine.

The current eradication programconsists of the following:

- Depopulation of herds with clinical disease
- Serologic surveillance of all sows and boars in every herd
- Improvement of sanitary conditions of housing
- Improved hygiene (safe disposal ofmanure, vehicle disinfection, insect and rodent extermination)
- Veterinary control of all swine livestock transfers (with individual identification of every animal moved for finishing orbreeding purposes)
- Health certification of every animal usedfor herd replacement
- Destruction of every seropositive animal
- Formation of mobile veterinary fieldteams exclusively dedicated to supportthe program

GOVERNMENT AND INSTITUTIONAL RESPONSES

Governments and international organizations play a crucial role in managing ASF outbreaks and mitigating their socio-economic impact. Effective responses require a combination of surveillance, bio-security, trade policies, and support for affected farmers.

Surveillance and Biosecurity

1. **Surveillance**: Early detection and rapid response are critical to controlling ASF outbreaks. Governments must invest in surveillance systems to monitor pig populations and detect outbreaks promptly.
2. **Biosecurity**: Enhancing biosecurity measures on farms is essential to prevent the spread of ASF. This includes proper hygiene practices, controlling the movement of animals and people, and implementing quarantine measures.

Trade Policies

1. **Trade Restrictions**: While necessary to prevent the spread of ASF, trade restrictions should be carefully managed to minimize economic impact on farmers. International cooperation and transparent communication are key to balancing disease control with trade considerations.
2. **Compensation and Support**: Governments should provide adequate compensation and support to affected farmers. This includes financial assistance, access to credit, and training in alternative livelihoods. Support programs should be designed to help farmers recover and rebuild their livelihoods.

Research and Development

1. **Vaccine Development**: Investing in research to develop a vaccine for ASF is crucial. A vaccine would provide a long-term solution to controlling the disease and reducing its socio-economic impact.
2. **Innovative Solutions**: Research into innovative solutions for ASF control, such as improved diagnostics, bio security technologies, and sustainable farming practices, can help mitigate the impact of the disease.

CONCLUSION

African Swine Fever is a formidable socio-economic threat to farmers worldwide. The disease & high mortality rate, lack of a vaccine, and ability to persist in the environment make it a challenging problem to address. The economic impact of ASF on pig farming is profound, with direct losses from mortality and culling, and indirect losses from trade restrictions and market disruptions. Beyond the financial losses, ASF has significant socio-economic implications, including loss of livelihoods,increased poverty, mental health challenges, and social instability.

Effective management of ASF requires coordinated efforts from governments, international organizations, and the farming community. Surveillance, bio security, trade policies, and support for affected farmers are essential components of a comprehensive response. Investing in research and development, particularly in vaccine development, is crucial for finding a long-term solution to ASF.

SOCIOECONOMIC BENEFITS OF COMMERCIAL TREE SPECIES IN FOREST NURSERY OF NE REGION

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Introduction

The expansion of land is necessary to meet the basic needs of the rapidly growing human population. The tree planting initiative is gaining more momentum every year. This is crucial to ensure that the entire nation has a good and prosperous existence in the years to come. There is a need to revive degraded forests and wastelands with the help of this large scale plantation. Nurseries can help communities build social capital, technical competence and leadership skills while providing income opportunities for nursery operators. Small-scale (or smallholder) forestry has gained popularity in the last decade (Larinde & Santus, 2014). Against this backdrop, it has become much more important for commercial seedling production facilities to attract people. In recent decades, people have increasingly realized the importance of growing trees, shrubs and grasses around their property, whether it is a house, a farm or a garden. It is believed that they serve to prevent environmental hazards, increase energy production and beautify the environment, among other things (Ajewole, 2001). Nurseries for seedling production can be divided into private and public. The method of seedling production has a greater impact on the cost and survival rate of seedlings than the average forest plantation. Reducing the cost of forest planting can help overcome the financial constraints of the public sector (Hamzehpour et al. 2006). This is true for both the financial benefits and the environmental benefits, and, therefore, it is a wise decision for company owners to open ornamental plant farms. Ornamental plants bring considerable revenue and income to the state and citizens. The urban forest nurseries were dominated by entrepreneurs, NGOs and governments. The majority of participants were entrepreneurs. Trays, seedbeds and pots were used for seedling propagation The urban forest nurseries used seeds and vegetative methods such as budding, grafting and cuttings as propagation strategies. Nurseries are raised and tree seedlings distributedin urban forests. Urban forest nurseries were the main suppliers of seedlings. But the nurseries had problems with operations (Mudyiwa *et al.*, 2015). Productive planting of seedlings is essential for plantations and can only be achieved if nursery procedures are carefully followed. The survey was conducted by visiting the three nursery sites in the states of Arunachal Pradesh, Meghalaya and Mizoram, including interviewing and distributing questionnaires to the nursery managers. The questions asked revolved around the following points: Types of species raised. The survey was conducted to select the tree species which are in good demand in the market and have economic value, have good germination capacity, have good survival rate and have optimum growth.

Socio-economic contribution

The aim of the study was to investigate the socio-economic contribution of private commercial ornamentalplant and forest nurseries to livelihoods. The study will inventory the plant species in the study area and assess the contribution of nursery to the socio-economic livelihood of the people in the study area. This study was conducted in the nurseries of Tuirial, Aizawl District Mizoram, Bajengdoba Range in Meghalaya and Namsai Range in Arunachal Pradesh. The study population consists of the operators of forest and ornamental nurseries and the users of the products from these nurseries. The results of the reconnaissance revealed that the production in three nurseries focused on the production of varieties of species for multipurpose, ornamental, production and conservation purposes.

Site Selection

The study was conducted in three forest nurseries, namely, Nursery 1: Tuirial Nursery, Aizawl district

Mizoram (92°30'- 92°60' E - longitude and 21°58'-24°85' N latitude), Nursery 2: Campa & state plan Nursery, Bajengdoba, Meghalaya (20.1° N and 26.5° N latitude and 85.49° E and 92.52° E longitude) and Nursery 3: Pihu Nursery Namsai, Arunachal Pradesh (95.45 to 96.20 E longitude, 27.30 to 27.55 N latitude). The importance of small forest nurseries, such as ornamental nurseries, for economic growth cannot be overemphasized (Ton, 1963). These small nurseries exist to generate profits through the production and distribution of goods and services. People in Tuirial, Aizawl district of Mizoram, Bajengdoba area of Meghalaya and Namsai area of Arunachal Pradesh are familiar with the economic and environmental impacts of private commercial forest and ornamental nurseries. However, there is a lack of basic information on the operations of nurseries in these states. The current unemployment crisis in the region makes it necessary to utilize the available opportunities to solve the problems. This requires basic information about the opportunities available.

Data Collection

The primary data for this study was collected through interviews with all selected nursery managers and users of seedlings from these nurseries. Information on the socio-economic contribution of these nurseries to the livelihood of the population was collected and recorded through semi-structured questionnaires and personal observations in the selected districts. The results were then compiled and analyzed.

Results and discussion

The private tree nurseries were located throughout the accessible forest area of the states. After an inventory of the plant species available in these ornamental/ forest nurseries, it was found that thirty-four (34) different species were present in the nurseries surveyed. These were categorised in the manner shown in Table 1. In accordance with the results presented in Table 1, the nursery in Meghalaya (Nursery No. 2) had the largest number of plant species accessible in the nursery selected for the study, followed by the nursery in Aizawl (Nursery No. 1). From the results in Table No. 2, the following plants were present in the three nurseries studied: Lolipomaarjun, Indian rose, neem, rain tree, Malabar neem, Ceylon olive and gamari. Lolipoma was widely distributed, most probably due to the strong demand from the rural population who cultivate it for economic reasons as a source of raw material for multifunctional use, but also for protection and as an additional source of income. The widespread distribution of various ornamental plants can have a positive effect on the financial situation of nurseries. Ornamental nurseries offer financial benefits to a country and have the potential to have a positive impact on social and economic well-being, but are rarely utilised due to a lack of knowledge about their cost-benefit analysis. The presence of dominant species in nurseries can be explained by the high demand for them and the ease of propagating their seedlings. In addition, people use these species extensively for purely aesthetic reasons due to their visual appeal. Trees such as the true hemp and the lipstick palm (Table 2) were only available in limited quantities (less than 400) and exclusively at the Tuirial nursery. According to the owners of the nursery, the limited availability was due to a lack of demand in the market, as people could easily obtain them from their immediate surroundings. Moreover, this trend most likely reflects the low interest of the public and society in plantation forestry. The distribution of koko, Japanese cedar, asoka tree, shisham, chir pine and brown pine was similar to that of shisham. The difficulty in producing seedlings and the long gestation period were the main reasons for the low availability in nurseries (Adams, 1999). The relative abundance of the species is explained by the data presented in Table 2. The result shows that Lolipoma, Arjun, Indian rosewood, Neem rain tree, Malabar, Ceylon and Gamari tree were the most abundant in the nurseries with an average of at least 1000 seedlings. These are the species that were most in demand in the region. False hemp, lipstick palm and sago palm were less common and were only found in a few nurseries. This was because they were generally freely available and relatively easy to obtain. As they are very adaptable, people were also able to grow some of the seedlings themselves.

Socio-Economic Benefits of Commercial Nursery

Babalola (2008) argued that the planting of ornamental trees and shrubs is gaining acceptance because

many people in urban areas practice horticulture to earn a living. The author further stated that the tree population in the city is mainly influenced by the popularity of the species, the purpose and the function that the tree is supposed to fulfil. The result shown in Table 3 illustrates the employment structure in the tree nurseries studied. The main factor influencing nursery staffing is probably the size of the nursery. In addition, some nurseries were relatively small in terms of size or scale of production, resulting in a limited number and variety of species available for sale. Apart from the aforementioned sources of income, the labour and material inputs that represented production costs for nursery entrepreneurs were also sources of income for the suppliers of these inputs (Sergent, 1993). This means that nursery operators' production costs include labour and other materials such as compost, wood crisps, sharp sand, polyethylene bags, and transportation costs. The production costs for seedlings, for example, are the cash flow that goes to the employees and material suppliers. Small private market gardens are self-employed enterprises that can contribute to income generation and socio-economic growth of a state (Larinde&Santus 2014). The result of employment potentials is shown in Table 3. The result showed that 39 people were employed in nurseries. Of these, 11 were permanent employees, while 28 were temporary employees.

The data in Table No. 3 shows that seedling production provides employment opportunities for people. The ornamental plants produced by the nurseries were also sold to various groups of people: Farmers, civil servants and institutions such as churches, schools, businessmen, etc. for various purposes.

Out of twenty (20) respondents interviewed, it was reported that 47 % seedlings were utilized for beautification, 38% for multipurpose uses, 9 % for protection of the environment and 6 % involves to any of the against degradation forces (Table 4).

Table1:Distribution of the Available Plant Species within Nursery selected in three selected sites in Mizoram, Meghalaya and Arunachal Pradesh

S. No.	Botanical Name	Name of the Nurseries		
		Nursery 1 (Tuirial Nursery (Aizawl District)	Nursery 2 (Campa + State Plan Nursery)	Nursery 3 (Pihu Nursery, Namsai)
1.	Albizialebbeck	-	-	*
2.	Aquilariaagallocha	**	-	
3.	Azadirachindica		***	*
4.	Bischofiajavanica	*	-	-
5.	Cassia fistula	-	**	-
6.	Chukrassiatabularis	-	***	-
7.	Cryptomeria japonica	-	-	*
8.	Cryustostachirenda	-	-	*
9.	Cycus revolute	-	-	*
10.	Dalbergiasissoo	-	-	*
11.	Delonixregia	*	***	-
12.	Diosperosembyopterus	-	***	-
13.	Duabanga grandiflora	*	***	-
14.	Elaeocarpus serratus	-	***	-
15.	Eucalyptus spp	-	-	*
16.	Ficusbenjamina	*	-	*
17.	Gmelinaarborea		***	-
18.	Jakarandamimosifolia	*		-
19.	Largerstromiaspeciosa		**	-

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20.	Mesuaferrea	**	***	*
21.	Michaeliachampaca	*	***	-
22.	Oroxylumindicum	*	-	-
23.	Pinusroxburghii	-	-	*
24.	Platicladusorientalis	-	-	*
25.	Podocarpusneriifolia	*	-	-
26.	Polyalthialongifolia	-	-	*
27.	Pongamiapinnata	-	***	*
28.	Samaneasaman	*	***	
29.	Syziziumcumini	*	**	*
30.	Terminalia arjuna	-	***	-
31.	Terminalia chebula	-	***	-
32.	Terminalia myrocarpa	-	-	**
33.	Tetramelesnudiflora	*	-	-
34.	Xyliaxylocarpa	**	-	-

Key: - Absence of species.
*Small Quantity (1-400 seedlings).
** Moderate Quantity (401-999 seedlings).
***Large Quantity (1000 & above seedlings).

Table 2: Mean Population Distribution of Seedling Species in surveyed three Nurseries

Order	Botanical Names	Common Names	Number each Seedling in the Nurseries	Availability in Number of Nurseries	Mean Number of Seedlings in the nurseries
1.	Chukrassiatabularis	Lolipoma	2000	1	2000
2.	Terminalia arjuna	Arjun	4920	3	1640
3.	Mesuaferrea	Indian rose chestnut	4400	3	1467
4.	Azadirachindica	Neem	4000	3	1333
5.	Samaneasaman	Rain tree	2350	2	1175
6.	Diosperosembyopterus	Malabar ebony	1100	1	1100
7.	Elaeocarpus serratus	Ceylon Olive	1000	1	1000
8.	Gmelinaarborea	Gamari	2000	2	1000
9.	Delonixregia	Flame Tree	2900	3	967
10.	Xyliaxylocarpa	Jambu, Burma Iron-wood	950	1	950
11.	Cassia fistula	Golden shower	900	1	900
12.	Saracaasoca	Ashoka	900	1	900
13.	Michaeliachampaca	Champak	2560	3	853
14.	Duabanga grandiflora	Khukan	1690	2	845
15.	Oroxylumindicum	Indian trumpet tree	750	1	750
16.	Ficusbenjamina	Weeping fig	1400	2	700
17.	Largerstromiaspeciosa	Pride of India	700	1	700
18.	Pongamiapinnata	Indian beech	1400	2	700
19.	Aquilariaagallocha	Agarwood	600	1	600
20.	Jakarandamimosifolia	Jacaranda	500	1	500

21.	Bischofiajavanica	Bishopwood	480	1	480
22.	Averrhoa carambola	Starfruit	450	1	450
23.	Syziziumcumini	Jamin	1300	3	433
24.	Eucalyptus spp	Bluegum	310	1	310
25.	Platicladusorientalis	Thuja	300	1	300
26.	Podocarpusneriifolia	Brown Pine	300	1	300
27.	Pinusroxburghii	Chir pine	280	1	280
28.	Dalbergiasissoo	Shisham	270	1	270
29.	Polyalthialongifolia	Asoka tree	245	1	245
30.	Cryptomeria japonica	Japanese cedar	230	1	230
31.	Albizialebbeck	Koko	225	1	225
32.	Cycus revolute	Sago palm	220	1	220
33.	Cryustostachirenda	Lipstick palm	215	1	215
34.	Tetramelesnudiflora	False Hemp	200	1	200

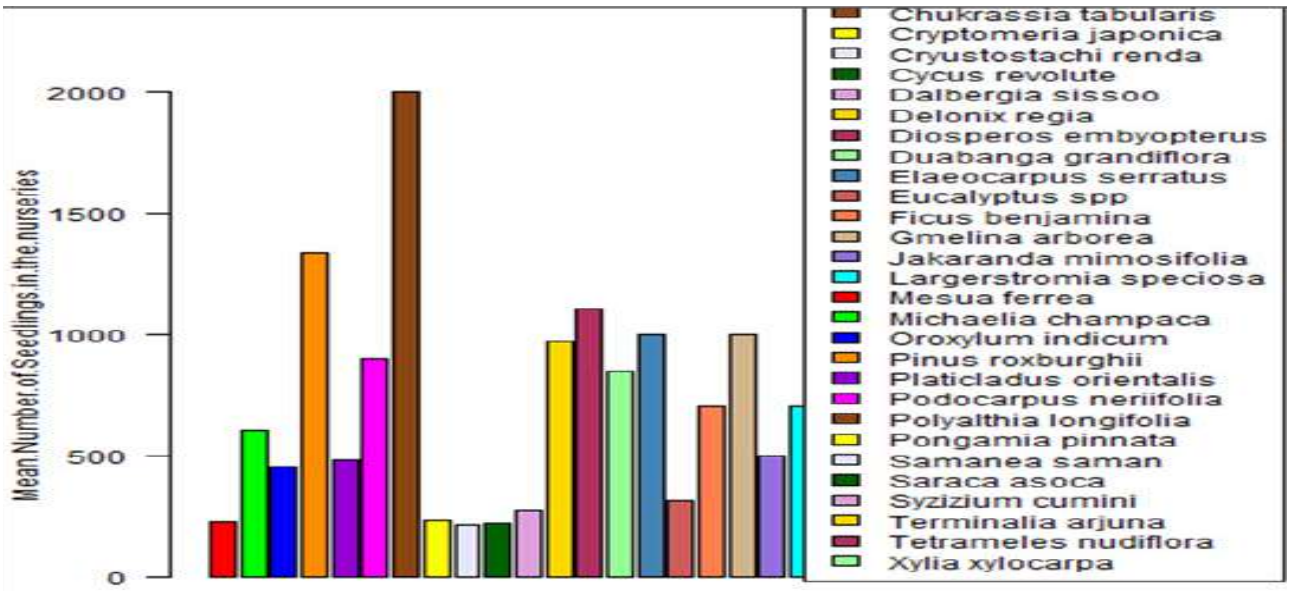

Figure 1: Mean Population of the species distributed among the studied nurseries

Table 3: Employment Structure of studied Nurseries

Name of Nursery	Permanent Appoint-ments	Temporary Appoint-ments	Total
Tuirial Nursery	3	6	09
Campa& State Plan Nursery	5	15	20
Pihu Nursery	3	7	10
Total	**11**	**28**	**39**

Table 4: Utilization of Seedlings instudies

UtilityPurpose	Frequency	Percentage
Beautification	16	47.0
Protection	03	09.0
Production	02	06.0
Multipurpose	13	38.0
Total	34	100

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Conclusion

This study was carried out to ascertain the seedling species diversity of forest nursery in three states of Mizoram, Meghalaya and Arunachal Pradesh. The study adopted survey method to generate data on the number of total seedling available for sale and the comparative inventory was prepared. This was accomplished through questionnaire administration and interviews with respondents. The result revealed that twenty (34) different seedling species were available from the three Forest Nursery in studied site. Chukrassisa, Terminalia ,Mesua tree were most prevalent while Albizia, Cycus, Cryustostachi were less prevalent. The socio-economic contributions of these nurseries to the people included source of income, employment and revenue generation to government. About 39 persons are employed in these nurseries. Other benefits were environmental protection, beautification and decorative services. The study recommended that nursery operators should expand their production frontiers and particularly of the native seedling species, which were under supplied. This will improve their profit margins and also create more employments for the people; the environment will also be protected. The study further recommended that the populace be encourage towards increased involvement in the establishment of more nursery and tree planting. Evidence from the findings of this study led to the lusionthatv the Ornamental/ Forest nursery contribute effectively to the economic, social and ecological wellbeing of the people in thearea. In fact, there are empirical figures to these evidence son-incomes, revenue, and employment. Other benefits were environmental protection, beautification and decorative services. All the interviewees ascertained that 100% of the nursery owners agreed with the hypothesis that nursery operations were near-efficient economically, socially and ecologically.

Pictures of few species reported in the nurseries

Ficusbenjamina

Polyantha longifolia


Palm species

Chinese thuja

Azardirachindica

Cryptomera japonica


Syziziumcumini


Cycus revolute


Eucalyptus spp.

CITRONELLA – GREEN MOSQUITO REPELLENT

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Insect-borne diseases are a worldwide health problem, especially in tropical and subtropical climates. People of North East India, living in tropical climate are also infested with several diseases associated with insects such as malaria, dengue, etc. caused by mosquitoes out of which malaria is a principal cause of illness and death in countries where the disease is endemic. To repel the mosquito people uses many synthetic repellents which are hazardous to health especially amongst the children. Constant and indiscriminate use of these synthetic repellents causes adverse effect on the user.

Though some chemical based mosquito repellents has a remarkable safety profile, but they are toxic for the skin as it causes rashes, swelling, eye irritation, asthma and low blood pressure etc. In connection to this issue, The US Environmental Protection Agency (USEPA) has registered citronella, lemon, and eucalyptus oil as insect repellents due to their low toxicity, high efficacy, and customer satisfaction (Yadav *et al.,* 2014)

Citronella *Cymbopogon nardus*is a perennial clumping grass that emits a strong aroma which has many applications in aromatherapy, pharmaceuticals, and in different industries. It has an antiseptic, antifungal, deodorant, insecticide and as well as stimulant medicinal properties. Citronella grass which is being cultivated successfully in North East India has many potential for further formulation and development of eco friendly consumer products.

At the grassroot level the information regarding health hazard related to the constant used of synthetic mosquito repellent such as liquid, creme, coil, balm etc. is required to be provided with the alternative. Now, it is imperative to develop eco friendly and safe mosquito repellent especially in Garo Hills district of Meghalaya where the co-endemic for *Plasmodium falciparum* and *Plasmodium vivax* and, *P. falciparum* was recorded as the predominant mosquito associated infection (> 82%) in the region. (Vas Dev, 2010).

To address the issue,an eco friendly, safe, convenient and portable mosquito repellent was formulated in the form of incense sticks/agarbatti. To formulated the product, citronella leaves from the Hajongpara, Mellim village of South West Garo Hills district of Meghalaya were collected. The leaves were dehydrated in shade as sun drying was found to loss of fragrance from citronella leaves. After drying they were cut into small pieces with scissor and coarsely grinded in a grinder and kept in an air tight container to avoid any loss of fragrance. The required materials for making the mosquito repellent incense sticks namely carbon powder, jiggit or joss powder, gum powder and bamboo sticks were used. Valuable ingredient i.e. citronella leaves and citronella oil were applied at the time of drying of incense sticks. The mosquito repellent incense sticks with length of 19 cm has burning duration of one hour twenty minutes. The developed products have undergone trial and testing and evaluation.The protocol for preparation of mosquito repellent incense stick was disseminated among the farm women through different hands on training programme.

The efficacy study of the eco friendly mosquito repellent gives the direction towards creation of small entrepreneurs. It may be a good source of income for small scale industry in rural as weel as urban areas and help in generation on employment.

Visit at Citronella farm Mellim, Hajongpara SWGH, Meghalaya

Training on Eco friendly mosquito repellent formulation

Eco friendly mosquito repellent Incense sticks

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FISHERIES AND AQUACULTURE IN MANIPUR: PRESENT SCENARIO, CHALLENGES, AND PROSPECTS FOR SUSTAINABLE DEVELOPMENT

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Abstract

The domestication of fish has been one of the significant ventures by people for their livelihood since the start of fish culture. The northeastern state of India, like Manipur has huge fisheries potential being located in the Indo-Burma biodiversity hotspots, characterized by rich flora and fauna, including fishes. The present study reveals the fisheries resources with their production and growth rate in Manipur. In the past 15 years, fish seed production trends have increased consistently, though states target production is not achieved yet achieved. With the development of technology, the paradigm of the advanced form of cultured practices from traditional farming is needed to be adopted to achieve the target production of fish in the state. The, challenges and constraints faced by farmers in fish production in Manipur as well as, various development work and promotion by the government to sustain fish production in the state are also discussed.

Keywords: Fish seed production, Indo-Burma biodiversity hotspots, fisheries, growth rate.

Introduction

Manipur is a small landlocked state situated in the Northeastern part of India, having total geographical area of 22,327 sq. km, with a small oval-shaped central valley located between 92°58´23.422" East to 94°43´35.553" East longitudes and 23°49´45.530" North to 25°42´1.456" North latitudes. The state is surrounded by three other states of India, namely Nagaland (in North), Assam (in West), and Mizoram (in South), and upper Myanmar to the South-East. Literally, Manipur means the "land of jewel" and Pandit Jawaharlal Nehru, former Prime Minister of India, described it as the "Jewel of India" due to its potential resources and beautiful scenery. Manipur has 16 districts, viz., 1) Bishnupur, 2) Chandel, 3) Churachanpur, 4) Imphal East, 5) lmphal West, 6) Jiribam, 7) Kakching, 8) Kamjong, 9) Kangpokpi, 10) Noney, 11) Pherzawl, 12) Senapati, 13) Tamenglong, 14) Tengnoupal, 15) Thoubal and 16) Ukhrul. Except the Bishnupur, Imphal East, Imphal West, Kakching, and Thoubal, which form the central valley with an average altitude of 775 m, and area of 2238 sq. km, the state comprises hilly terrain with peaks rising to 3000 m above the mean sea level. It has a sub-tropical temperate climate and recorded 1137.1 mm of rainfall in 2019. The major source of fish in Manipur is coming from the Loktak Lake (the largest freshwater lake in North- Eastern India) Moreover, Manipur stood 3rd place among the top fish consuming states of India with 14.1 kg per capitaper year during 2019-2020 (Handbook, 2020).

Fishery resources of Manipur

Manipur shared a small part of the Indo-Burma region's biodiversity hotspots with other states and countries which have a rich biodiversity, including freshwater fishes, due to its rich freshwater resources, including criss-cross river systems, low-lying waterlogged areas, vast and dotted lakes, rice fields, canals, ponds, and tanks (Dorothy *et al.*, 2018; Basudha *et al.*, 2022) The state has potential fisheries resources (shown in table 1), including an estimated total area of 63,616 ha. The estimated total area is mainly contributed by wetlands (39,124 ha, 62%), rivers/streams (16,677 ha), waterlogged (3525 ha), and aquaculture ponds (2643 ha) (Handbook, 2020). Due to the availability of freshwater resources, the state is exclusively prevalent in freshwater fish production. Different methods of fish culture practices have been undertaken in the state, from traditional fish culture to advanced techniques of fish culture, viz., biofloc technology where exclusively isolated control fish production with heavy intervention and stocking density to achieve enough fish production for consumption locally. Fisheries and aquaculture are a livelihood for many people in the state.

Table 1. Potential water resources in Manipur

Sl. No.	Potential resources	Area (in ha)/ Length (Km)
1	*Potential water bodies suitable for fisheries and aquaculture	56,461.05
2	The total length of Rivers & canals (Km)	15,688
3	Small reservoir (5 Nos.)	960
4	Medium and large reservoir (one no. only)	1182
5	Tanks and ponds	11,622.80
6	Beels/ Ox-bow lakes/ Derelict water	24,433

Source: **Department of Fishery, Government of Manipur; Handbook on Fisheries Statistics (2020), Department of Fisheries Ministry of Fisheries, Animal Husbandry & Dairying Government of India.*

Fish species diversity

The total number of fish species recorded in Manipur is 281 (Umeshet al., 2012). Several important native fish species reported in Manipur, including *Aspidoparia ukhrulensis, Barilius lairokensis, Chela khujairokensis, Glyptothorax manipurensis, Glyptothorax senapatiensis, Garra abhoyai, Sisor barakensis, Botia berdmorei, Pseudecheneis ukhrulensis, Schistura fasciata, S. manipurensis, S. kangjupkhulensis, S. prashadi, S. sikmaiensis S. tigrinum, S. reticulata, S. khugae and S. minutus*, etc. According to Khomdram *et al.* (2014), Manipur has 139 ornamental fish species, whereas Umesh *et al.* (2012) reported 185 species (including exotics), of which 45 are also used as food fish. For instance, various economic importance ornamental as well as food fish species are reported in Manipur such as Ngakha meingangbi (*Puntius manipurensis*), Belun Paibi (*Devario acuticephalus*), Ngapemma (*Trichogaster labiosa*), Khabak (*Bangna devdevi*), Phabounga (*Puntius chola*), Ching ngakra (*Pterocryptis barakensis*),Ngakijou (*Lepidocephalichthys berdmori*), Ngatup (*Schistura kanjupkhulensis*), Sarengkhoibi (*Botia berdmorei*), Ngarang (Devario aequipinnatus), etc.

Fish production of Manipur

The total fish production of Manipur during 2019-20 is estimated to be 32,000 tonnes (Handbook, 2020). The trends of inland fish production in Manipur may be looked over from 2004-05 to 2019-20, covering a 15 years long period (Figure 1). Inland fish production was 17,800 tonnes in 2004-05, and this was increased to 32,000 (14,200 tonnes more than during 2004-05) tonnes in 2019-20 (Figure 1). During 2017-2018, inland fish production in the state peaked, accounting for 33,000 tonnes (Figure 1). After that, the production has fallen slightly for the last two years, i.e., 32,000 tonnes each during 2018-19 and 2019-20. This may be due to the impact of the Covid 19 pandemic. However, the estimated fish requirement in the state was 52,000 tonnes in 2019-20 against the state-owned production of 32,520 tonnes, indicating a 19,480 tonnes shortage needed to import from other states for domestic consumption (Economic Survey Manipur, 2020-21).

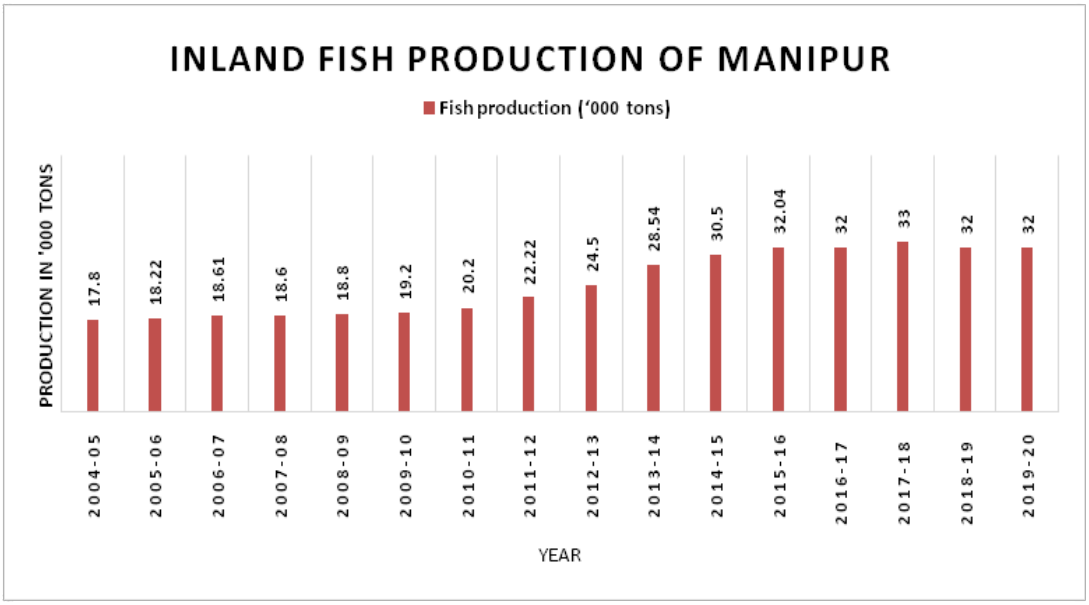

Fig. 1 Inland fish production in Manipur. Source: Handbook on Fisheries Statistics (2020)

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The growth rate of fish production of Manipur

The growth rate of fish production in Manipur has significantly increased from 1.14% in 2004-05 to 5.04% in 2015-16 (Figure 2). Interestingly, the highest growth rate was recorded in the year 2013-14, with 16.48%. However, the negative value growth rate was reported in 2016-17 and 17-18, accounting for -0.12% and -3.12%, respectively (Handbook, 2020).

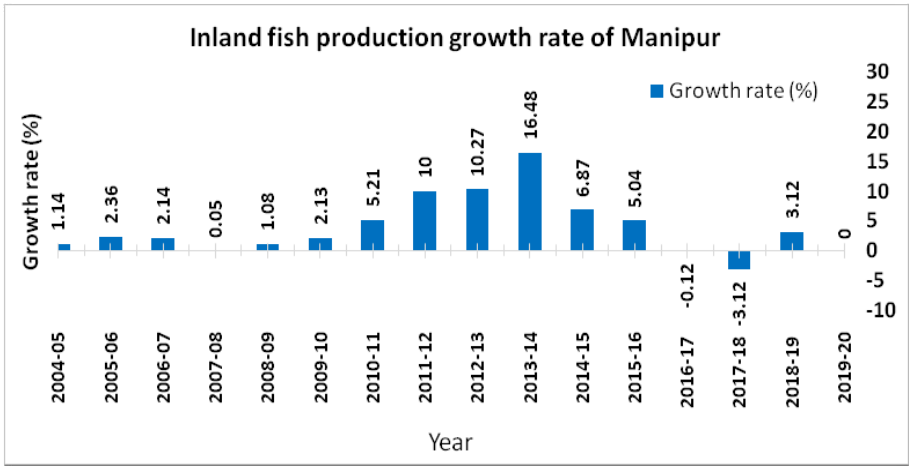

Fig. 2 Inland Fish production growth rate of Manipur. Source: Handbook on Fisheries Statistics (2020).

The fish production from marginal fish farms is dominant compared to small, medium and large farms (Singh *et al.*, 2018). In Manipur, aquaculture of Indian major carps (IMC) and exotic carps like grass carp, silver carp, common carp and other commercially important species tilapia and pangasius are widely cultured and are contributed to inland aquaculture production (Singh *et al.*, 2018). In addition, with the introduction of induced breeding, the quality seed production of indigenous such as *Anabas testudineus, Bangana dero, Clarius batrachus*, and *Osteobrama belangeri* have become popularized and started domesticated due to its high market price and demand (Basudha *et al.*, 2017; Basudha and Singh, 2021).

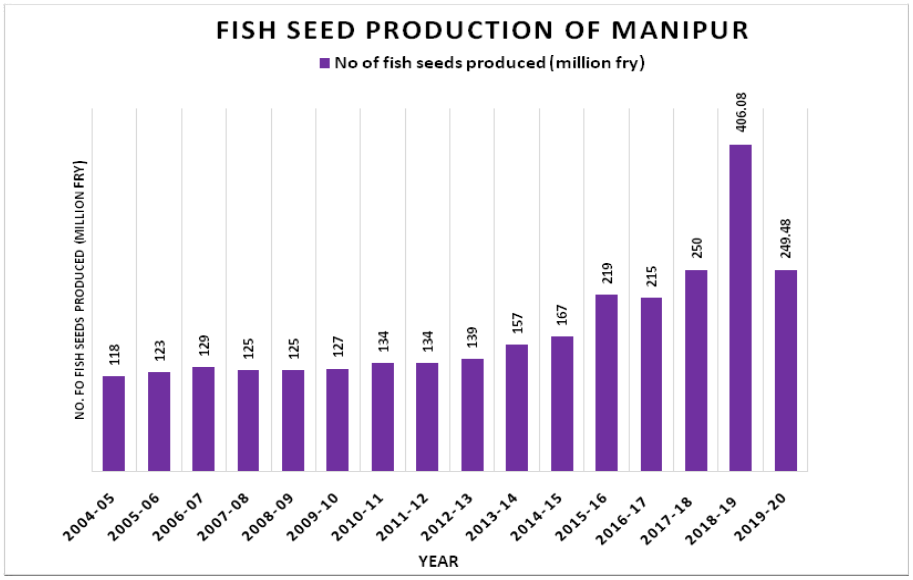

Figure 3. Fish seed production of Manipur. Source: Handbook on Fisheries Statistics (2020)

Fish seed production of Manipur

High-quality fish seed production is one of the most important factor for sustainable aquaculture and fisheries to increase fish production. The successful application of induced fish breeding, which provides high-quality fish seeds to the farmers for culture throughout the country, has allowed India to rank second in fish production behind China. India developed more than 1,500 hatcheries throughout the nation, producing more than 32 billion carp fry (Ngasotteret al., 2022). To increase the state's fish production, the government in Manipur is paying attention to creating and distributing high-quality fish seeds to fish farmers. While, 118.00 million fry was produced during 2004-05,fish seed production in the state had consistently increased by 2019-20 (Figure 3), with a peak production of 406.08 million fry recorded during 2018-19(Figure 3) (Handbook, 2020).

The state has a limited number of functional hatcheries and only 18 numbers of Government fish seed farms to produce fish seeds for self-reliance (Department of Fisheries, Manipur). With the support of the Department of Fisheries and other institutes, trained farmers have produced fish seed in the state. However, fish seed had been imported from other states, including Assam, West Bengal, Tripura, etc., because of high demand and scarcity in the state.

Status of the government scheme and other development work for the fisheries sector

The state and central government have taken up various schemes and projects to improve fish production in Manipur. According to the Economic Survey, Manipur (2020-21) report, the following schemes have been implemented in the state during 2017-18 with financial support from different institutes or organizations such as NEC, NFDB, ICAR etc. :

1) Development of water-logged area (CSS),

2) Culture of Pengba (RKVY);

3) Development of Water-logged Area (RKVY),

4) Construction of new ponds (NEC),

5) Blue Revolution, Establishment of Fishery Estate (NEC),

6) Development of Aquaculture (CSS)

Moreover, the State Department of Fisheries has taken up a project entitled, "Development of Reservoir Fisheries in Manipur" to increase table fish production in the state and other National scheme including:

(a) National Welfare Fund for Fishermen scheme: Under this scheme, Housing Scheme and Accident Insurance Scheme are provided financial assistance to the selected poor fishermen for the construction of their low-cost dwelling houses, tube-wells, community tanks, etc., and to cover the risk associated with fishery activities for the active fishermen.

(b) Under the Reservoir Fisheries Development programme sponsored by the National Fisheries Development Board, Hyderabad, the Department had released 50 lakhs of fish fingerling during 2014-15. Besides, during 2016-17, fish fingerlings were released in Loktak Lake (12.5 lakhs), Thoubal Dam Reservoir (6 lakhs nos.) Khuga Dam Reservoir (1 lakh nos.) and Khoupum Dam Reservoir (1 lakh nos.), respectively.

(c) Rastriyas Krishi Vikas Yojana (RKVY): The following schemes were proposed under the RKVY such as (a) Mass scale production of state fish 'Pengba' (for 180 units) for culture of 'Pengba' species (b) Development of Waterlogged/ Swampy areas (for 125 units) for renovation/ reclamation of ponds (c) Procurement of pelletized fish feed for use in pens/ cages (for 48 nos. of cages and 30 pens) for the year 2017-18.

(d) Blue Revolution (Neel Kranti Mission): Under this mission, programme was implemented to benefit four progressive farmers for hatchery and 23 farmers for rearing units during 2017-18. Under the Blue Revolution, 16 farmers from Imphal West and Thoubal Districts benefited from completing each one-ha unit pond construction for inland fisheries.

(e) Doubling of Farmers' Income by 2022: The Department of Fisheries has completed data collection of fish farmers from 9 districts with a progressive total of 2,276 fish farmers as the target group to double the income of the farmers.

The development of fisheries in NE India including Manipur is being greatly aided by organisations, namely the National Fisheries Development Board (NFDB) and Marine Product Development Authority (MPDA) of India, in addition to commercial financing institutions. Similar to this, the Department of Fisheries (DoF) and relevant NGO's are also making significant contributions to the development of fisheries in the state (Singh *et al.*, 2018).

Challenges and constraints in fish production in Manipur

Fish farmers have faced several challenges and constraints (Table 2) in fish production in Manipur (Salam *et al.*, 2020; Devi *et al.*, 2014), such as administrative, technological, economic, social, infrastructural, culture, and extension constraints.

Table 2. Challenges and constraints in fish production in Manipur

Categories	Item of Constraints
Technological constraints	Lack of knowledge about scientific fish culture
	Difficult to identify quality fish seed
	Difficulties in technical operations
	Technology not suited to the existing environment
	High price and shortage of manure, feed (oil cake and rice bran), and fertilizers
	Lack of awareness and training programme

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Economic constraints	Non-availability of credit and funds from institutional source
	Lack of financial support
	Insufficient marketing facilities
	High cost of inputs
	High wages & labour cost
	Inappropriate use of available resources
	Scarcity and untimely availability of good quality fingerlings and their high price
Administrative constraints	Poor implementation of the fisheries development scheme
	Lack of government support
	Inadequate extension contact
	Lack of training facilities relating to new technology
Social constraints	Lack of financial support
	Inadequate family labour
	Lack of family encouragement
	Poaching & poisoning
	Illiteracy
Infrastructural constraints	Lack of facilities for water and soil testing
	Lack of drainage during the rainy season
	Non-availability of seeds in time
	Shortage of labour
	Inadequate financial institution
	Poor transportation facilities
Extension constraints	Lack of mass media exposure
	Lack of farm publication
	Ineffective communication
	Lack of extension services, Lack of contact with competent fishery extension personnel
	Lack of need based training program
Culture constraints	Less fish growth
	Extent of weed infestation
	Lack of water sources
	Lack of fish feed in market
	Distance from the farm

Source: Devi et al. (2014); Salam et al. (2020)

Future Prospects and Strategies for sustaining fish production in Manipur

The future of more fish production in Manipur is highly dependent on technical how-know of the advanced fish culture technique adopted by the farmers through the utilization of potential fisheries resources to achieve a target production. Young and experienced farmers can increase overall production by adopting vertical growth, species diversity, and system diversification strategies. It is possible to adopt breeding and culture techniques for various groups of standardized freshwater species, such as Indian major carps (IMCs), minor carps, barbs, catfish, pabda, climbing perch, and murrels, to scale up output (Ngasotter *et al.*, 2020). Further, techniques like intercropping minor carps in traditional major carp culture and catfish monoculture, or their polyculture with major carps and monosex tilapia culture can be successful (Das *et al.*, 2019). Several techniques can be used to increase fish production and productivity, including multiple stocking and multiple harvesting, wastewater aquaculture (Chatla *et al.*, 2020), shallow/rain-fed ponds for producing stunted fingerlings, and integrated, intensive, and semi-intensive farming systems (Katiha *et al.*, 2005). The majority of the fish farms are still run using conventional fish farming methods. As a result, more fish farms must be subjected to scientific farming. To enhance sustainable production, integrated fish farming, such as the culture of fish with paddy, piggery, apiculture, poultry, horticulture, etc., should be encouraged.

Conclusion

The fisheries sector in Manipur needs to be uplifted by introducing species diversification and adopting emerging high-yield culture practices. Various indigenous fish breeding and culture should be encouraged by providing subsidies and technical how-know to the farmers to improve fish production in the state. The future of sustainable fish production in Manipur will be highly dependent on encouraging youth in this field. Besides, responsible culture practice in fish production needs to be regulated and encouraged for safe fish production. The government must address the various constraints and issues to improve sustainable fish production in the state by providing the necessary infrastructure and other inputs for aquaculture.

OVERVIEW OF HAEMORRHAGIC SEPTICAEMIA AND BLACK QUARTER IN CATTLE: FOCUS ON SOUTH GARO HILLS, MEGHALAYA

Rupam Bhattacharjya, Athokpam Haribhushan & Karam Amarjit Singh
KVK, South Garo Hills, Meghalaya, CAU, Imphal

Cattle in South Garo Hills, Meghalaya, are susceptible to several infectious diseases, including Haemorrhagic Septicaemia (HS) and Black Quarter (BQ). These diseases pose significant threats to livestock health and local agriculture. Understanding their etiology, symptoms, treatment, and management is crucial for effective control and prevention.

Haemorrhagic Septicaemia (HS)

Etiology: Haemorrhagic Septicaemia is caused by *Pasteurella multocida* serotypes B and E. This bacterium thrives in warm and humid climates, which are prevalent in Meghalaya, especially during the monsoon season. The infection often spreads through contaminated water or feed.

Symptoms:

- **Acute Onset:** Rapid onset of illness, often within a few hours.
- **Fever:** High fever is common.
- **Respiratory Issues:** Difficulty breathing, nasal discharge, and coughing.
- **Swelling:** Swelling in the throat and neck area.
- **Hemorrhages:** Presence of bleeding from the nose or mouth.
- **Death:** High mortality rate if untreated, often leading to sudden death.

Treatment:

- **Antibiotics:** Treatment with broad-spectrum antibiotics such as oxytetracycline or penicillin can be effective if administered early.
- **Supportive Care:** Ensuring adequate hydration and nutrition helps support recovery.
- **Anti-inflammatory Drugs:** Non-steroidal anti-inflammatory drugs (NSAIDs) can help reduce inflammation and fever.

Management:

- **Vaccination:** Regular vaccination is the most effective way to prevent HS. Vaccines should be administered as per the recommended schedule.
- **Hygiene:** Maintaining cleanliness in cattle housing and feed storage to reduce contamination risks.
- **Monitoring:** Regular health check-ups to identify and treat any potential outbreaks early.

Black Quarter

Etiology: Black Quarter, also known as Clostridial Myositis, is caused by *Clostridium chauvoei*. This bacterium is commonly found in soil and affects cattle when they ingest or come into contact with contaminated materials. It is more prevalent in areas with poor pasture management and during wet conditions.

Symptoms:

- **Sudden Onset:** Rapid progression of the disease.
- **Lameness:** Swelling and pain in the muscles, often in the hind limbs.
- **Fever:** High body temperature.
- **Swelling:** Dark, swollen areas in the muscle tissue, often with a characteristic foul odor.
- **Shock:** In severe cases, cattle may show signs of shock and collapse.

Treatment:

- **Antibiotics:** Treatment with high doses of antibiotics like penicillin can be effective if given early.
- **Supportive Care:** Providing supportive care and anti-inflammatory drugs can help alleviate symptoms.
- **Surgical Intervention:** In some cases, surgical intervention may be necessary to remove necrotic tissue.

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Management:

- **Vaccination:** Regular vaccination against *Clostridium chauvoei* is crucial for prevention. A booster vaccination is typically recommended annually.
- **Pasture Management:** Proper management of pastures to minimize soil contamination and ensure clean feeding practices.
- **Early Detection:** Promptly identifying and isolating affected animals can prevent the spread of the disease.

Conclusion

In South Garo Hills, Meghalaya, the management of Haemorrhagic Septicemia and Black Quarter in cattle requires a combination of vaccination, proper husbandry practices, and timely treatment. The Krishi Vigyan Kendra (KVK), South Garo Hills has been instrumental in this regard. KVK continuously provides vaccination services to various villages within the district at regular intervals, ensuring broad coverage and reducing the incidence of diseases. These proactive measures not only help in controlling outbreaks but also support farmers in maintaining the health and productivity of their livestock.

By leveraging the resources and expertise provided by KVK, alongside effective vaccination programs and good management practices, farmers in South Garo Hills can mitigate the impact of HS & BQ and protect their cattle from this severe disease. For ongoing support and guidance, local veterinary services and agricultural extension officers remain valuable resources.

HYDROPONICS SYSTEM ON NORTH EAST REGION OF INDIA- A GREAT PROSPECTS

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Agriculture is undergoing a transforming journey marked by technical innovation, sustainability and adaptation to global challenges. Hydroponic is shaping the future of agriculture.Hydroponics is a method of growing plants in nutrient solutions with or without the use of an inert medium to provide mechanical support such as dirt vermiculite, rockwool, peat moss, sawdust, coir dust, coconut fiber/wood fiber, and other similar materials.The term hydroponic comes from the Greek terms 'Hydros', which means water, and 'Ponos' which means labor, and translates to "water job". Professor William Gericke invented the term hydroponics in the early 1930s to describe the growing of plants without their roots.The plants that are grown hydroponically do not require soil rather they can be grown in water along with the nutrient solutions, which is a medium to provide basic support to the plants and their roots. A plant needs only three things: Water, Air, and Food. This system makes it very easy for the plants to obtain these three without needing to fight any soilborne diseases. The plants or crops need not be grown in a huge area. They can be grown very easily in greenhouses where the area is comparatively less than an open garden.Since hydroponics takes much less water and nutrients to grow, it could be possible in the future for people in harsh environments with little accessible water to grow their plant-based food. Hydroponics is not only used on earth, but has also proven itself in plant production experiments in space.

History of Hydroponics

1. Hanging Garden of Babylon in 600 BC – Growing plants in water.
2. KeibulLamjao National Park in Manipur.
3. The Hanging Garden of Chinese 1,200 BC – Marco Polo documented floating Chinese gardens during his travel through China.
4. First man-made hydroponic solution – John Woodward, a fellow of the Royal Society of England grew plants in a mixture of soil and water which was the first scientific hydroponic nutrient solution.
5. Hydroponic technology was used in World War II: The US Force built one of the first large hydroponic farms on Ascension Island in the South Atlantic, followed by additional hydroponic farms on the islands of Iwo Jima and Okinawa in the Pacific, using crushed volcanic rock as the growing medium. Also, they used gravel as a growing medium in farms at Wake Island, West of Hawaii. These farms helped to feed the troops with the supply of fresh vegetables. The US Army and AirForce built large hydroponic facilities in Habbaniya, Iraq, Bahrain, the Persian Gulf, and Chorus in Japan, among others.
6. Looking into the success of hydroponic in World War II several large commercial hydroponic farms were built in Florida. However, due to poor construction and management, many of these farms were unsuccessful.
7. The first concept of photosynthesis was in 1792 and great scientific breakthroughs from 1800 to 1920s in the field of plant physiology and plant nutrition led to "Nutriculture" as hydroponic was called at that time. Between 1925-1935, extensive development took place in converting the laboratory techniques of nutriculture to large-scale crop production.
8. 2000 onwards: Like manufacturing, Agriculture tends to move toward higher-technology, more capital-intensive solutions to problems. Hydroponics is highly productive and suitable for automation. However, the future growth of controlled environment agriculture and hydroponics depends greatly on the development of systems of production that are cost-competitive with those of open-field agriculture. Hydroponics is a technical reality. Such production systems are producing horticultural crops where field-grown fresh vegetables and ornamentals are unavailable for much of the year. The development and use of controlled environment agriculture and hydroponics have enhanced the economic well-being of many communities throughout the world.

Principle of Hydroponics System: Hydroponics operates under a very simple principle: provide plants exactly what they need when they need it. Hydroponics administers nutrient solutions tailored to the needs of the particular plant being grown. They allow you to control exactly how much light the plants receive and for how long. pH levels can be monitored and adjusted.

Categories of hydroponics:

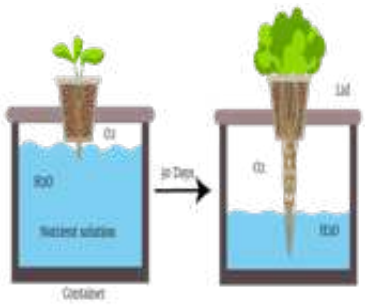
There are 2 categories of Hydroponics:

i) **Passive Hydroponic:** This uses capillary and wicking action to supply the plants in the system. This system requires an inert porous medium like perlite, rock wool, etc. In this system, the plants are suspended above a reservoir.

ii) **Active Hydroponic:** Active relies on the pump or other devices to move the nutrient solution from the reservoir to the roots actively. This is more nutrient efficient as this allows the nutrient solution not absorbed by the roots to return to the reservoir.

Types of hydroponic system

i) Kratky Method



In this method, the plants are placed in net cups along with substrates like rock wool, cocopeat, etc., and are suspended above a reservoir of water containing essential nutrients held by a lid. In this, the plant's roots are partly submerged in the solution and partly exposed to air. As the plants grow the water level decreases and a gap is created. This 'air gap' is important as this is where the plants will respire. So, as time goes on, the plants are still able to take up enough nutrients, water and oxygen.

ii) Wick System

This method works on the same principle as the oil lamp. It uses a soft fabric string (cotton or nylon) as a wick. This wick helps in absorbing water and

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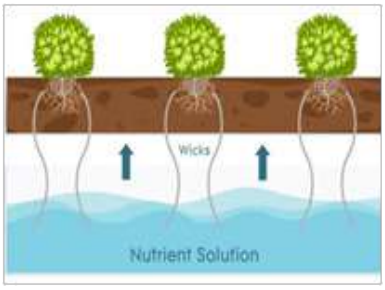
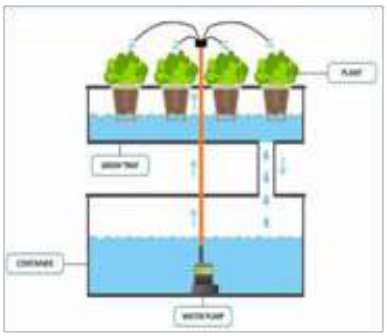
nutrients from a solution and helps in supplying to the plant. One end of the wick is inserted in the substrate where plants are placed and the remaining end hangs into the reservoir. The liquid will flow up the wick to the substrate until the substrate is damp. As the substrate dries up the wick will begin to soak the solution.



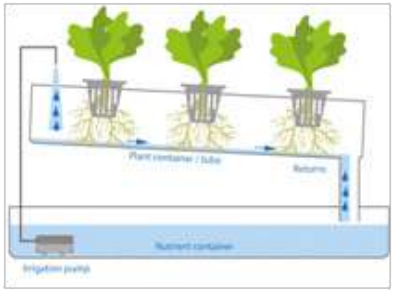
iii) Drip System

In this method, the water and nutrient solution are provided to the root system using drip irrigation. The nutrient solution is pumped up from the reservoir through tubing to the top of the growing substrate, from where the solution drips out from the tube to the growing substrate and drains down to soak the roots and the substrate to the bottom of the container where it flows downhill through an opening to the reservoir.



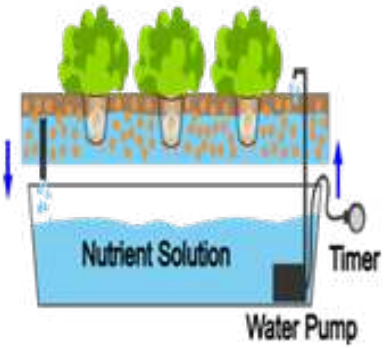
iv) Nutrient Film Technique (NFT)

In this method, the grow tray or channel is kept at a certain angle to allow the nutrient solution to flow down toward the nutrient return pipe. The roots of the plant hang down and absorb nutrients from the shallow film of solution and absorb the nutrients from. The thin film of nutrients allows the plants to be watered but not entirely soaked. This also allows the upper part of the roots to remain dry and have access to oxygen.



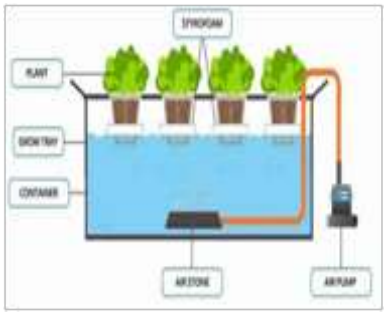
v) Ebb and Flow (Flood & Drain)

This method involves periodic flooding and draining of the nutrient solution. In this system, a timer is used to control the water-pumping cycle. When the timer is on, the pump starts pumping the nutrient solution. The nutrient solution then flows up to the grow tray soaking the plant's roots. An overflow tube is attached to maintain the level of water in the grow tray and prevent overflowing of the solution. When the timer goes off, the pump is halted and the solution flows back to the reservoir via the drainage system.



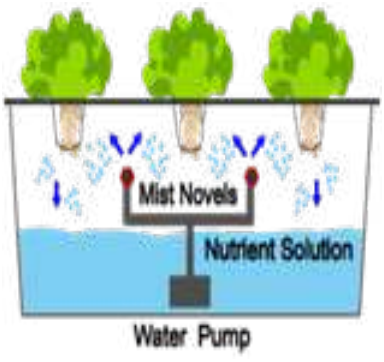
vi) Deep-Water Culture (DWC)

In this method, the plants are held with Styrofoam and the roots are submerged in a well-oxygenated nutrient solution reservoir where the roots will be in the solution 24 hours a day. The oxygen is provided with the help of an air pump which is kept running 24 hours a day too.



vii) Aeroponics

In aeroponics, the plants are planted on suitable substrates and dangled in the air. The roots are sprayed periodically with a nutrient solution or aerosol of nutrients with the help of specifically designed misting devices.



Different components of the hydroponics system:

1. Planting materials:
2. Water
3. Water reservoir
4. Hydroponics nutrients
5. Growing medium
6. Growing tray
7. Seeds
8. Net cups.
9. pH meter

Seeds: Growing hydroponically does not require any special seeds. Thus, all types of seeds can be grown.

Growing substrate: The growing medium for hydroponics is a material that is used to support the plant's roots and a medium to sow the seeds.

Main Qualities of a Growing Medium

We can't use any solid as a hydroponic growing medium. It does need to have some basic qualities in order to be functional:

- It must be inert
- It needs to have a porous structure; the nutrient solution needs to penetrate the medium which then works as a "pantry", a food and water reserve for your plants.
- It needs to be penetrable by the roots; so, either foam-like materials, pebbles, or fibers will be suitable for this function.
- Ideally, it should also have a close to-neutral pH
- The medium you choose will affect changes of temperature,pH, and TDS is also important
- Finally, it should be easy to clean and wash.

1. Growstones:

A mix of recycled glass and calcium carbonate is another popular hydroponics growing medium. These are unevenly shaped (yet not sharp to the touch), lightweight, and porous, making them an effective hydroponic grow medium, providing beneficial moisture and aeration to the root zone. Growstones are not considered a reusable hydroponic grow medium, because plant matter tends to remain inside the pores of these stones, which makes them unsafe to re-use in future growing endeavors. All things considered, the inherent properties of grow stones make them one of the top choices as a hydroponic grow medium

2. Rockwool

Rockwool is a popular grow media used in hydroponics, composed of rock (granite or limestone) which is heated, melted, and spun to form long, thin fibers. On the upside, Rockwool makes a great seed-starter medium, is porous, sterile, retains moisture, and generally provides similar benefits as other grow media. On the downside, rockwool is non-degradable, which means it essentially lasts forever. Additionally, Rockwool has a high pH level and requires soaking before use. The dust from rockwool can be harmful to humans, so caution is advised. That said, 4Rockwool has a good track of being an effective grow medium for hydroponic growing.

3. Oasis cube

Oasis cubes are used as a hydroponics growing medium for starting plants. In recent years, many hydroponic growers have shifted from using rockwool cubes to now using oasis cubes for this purpose, although they both work similarly. Because of their open cell structure, Oasis cubes can absorb air and water but are not as susceptible to become waterlogged as rockwool cubes. Another benefit of Oasis cubes over Rockwool is that no pre-soaking is required. Negatives include not being organic and not environmentally sustainable. Overall, Oasis cubes are a good choice for hydroponic propagation

4. Lava rocks:

Lava rocks have a long history of being used as a hydroponics growing medium. Because they provide beneficial drainage,

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aeration, and water retention, and are pH neutral. Lava rocks are also lightweight, and porous, and provide trace elements (magnesium, zinc, copper, calcium, aluminum, cadmium, manganese) to plants grown in this hydroponic grow medium. A notable disadvantage is the fact that the inherent sharp edges of lava rocks have the potential to damage the root systems of hydroponically grown plants. However, lava rocks have many beneficial hydroponic growth medium properties and are worthy of consideration.

5. Lightweight Expanded Clay Aggregate (L.E.C.A)

Lightweight Expanded Clay Aggregate (L.E.C.A) is one of the most popular growing mediums used in hydroponics. These pellets are essentially balls of clay – processed at a super high temperature – to form a highly porous and effective growing medium. They are lightweight, yet heavy enough to provide good support to a plant. LECA are pH-neutral, non-degradable, and release almost no additional nutrients into the water. Being porous and shaped spherically helps to maintain a beneficial balance of oxygen to water.

These clay pebbles are also reusable, which makes them an economical hydroponic growing medium for years to come. Note that LECA tends to drain and dry out quickly and may not be the best choice when using "ebb-and-flow" systems, as this hydroponic growing medium is too heavy.

6. Coconut fiber or coconut coir:

Coconut fiber or coconut coir is a popular hydroponic growing media. Made from the discarded outer husks of coconuts, this recycled coconut coir is the most environmentally friendly grow used in hydroponics. Some advantages of coconut fiber include being anti-fungal, retaining moisture, slow to decompose, and it provides plenty of aeration for plants' rooting system to remain healthy. Drip and wick systems are a better fit for using coconut coir. Overall, coco coir also mixes well with a variety of other mediums to create a solid, soil-less hydroponics growing medium, or when used alone. Coir Pith Blocks are used in agriculture, horticulture, floriculture nurseries, and for landscaping as a soil conditioner and substitute for soil.

7. Sponge:

Hydroponic sponge is porous and can retain water while not being too heavy on plant roots. It is a great growing medium for hydroponics because it is affordable easy to find, lightweight, and easy to work with.

Technical growth parameters for hydroponics:

Hydroponics involves growing plants in a nutrient-filled water solution instead of soil. To achieve the best plant growth and yields, it's essential to track these key factors:

1. Nutrient Solution

- EC (Electrical Conductivity): This measures how much nutrients are dissolved in the water. Ideal EC levels depend on the plant species but generally range from 1.5 to 3.0 dS/m.
- pH Level: This indicates the water's acidity or alkalinity. Most plants thrive with a pH between 5.5 and 6.5. Maintaining the right pH is crucial for nutrient uptake.
- Nutrient Balance: Ensure that key nutrients (like nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, and trace elements) are present in the correct amounts for the plants' growth stages.

2. Water Quality

- Temperature: Keep water temperatures between 18°C and 22°C (64°F to 72°F). Extreme temperatures can affect nutrient absorption and plant health.
- Dissolved Oxygen (DO): Adequate levels of dissolved oxygen (above 6 mg/L) are necessary for healthy roots and effective nutrient uptake. Use air pumps or oxygenators to ensure this.
- TDS (Total Dissolved Solids): This measures all dissolved substances in the water. Maintain TDS levels within the recommended range for the plants being grown.

3. Light

- Intensity: Plants require specific light intensities, usually between 400-800 µmol/m²/s of photo-synthetically active radiation (PAR), depending on their growth stage.
- Duration: The amount of light needed varies by plant type. Leafy greens often need 14-16 hours of light per day, while flowering plants may require a 12-hour light and 12-hour dark cycle.

4. Temperature

- Air Temperature: Ideal temperatures are between 20°C and 25°C (68°F to 77°F) during the day, with cooler temperatures at night. Extreme temperatures can stress plants and impact their growth.
- Humidity: Keep relative humidity between 50% and 70% to prevent diseases and ensure healthy plant growth. Use humidifiers or dehumidifiers to adjust humidity levels as needed.

5. CO_2 Levels

Concentration: Increasing CO_2 levels can boost plant growth rates. While ambient CO_2 is around 400 ppm, raising it to 1000-1500 ppm can be advantageous for plant development.

6. Growing Medium

Typical hydroponic growing mediums include rock wool, perlite, vermiculite, and coconut coir. Choose a medium that is suitable for your plant species and hydroponicsetup.

7. System Maintenance

- Cleaning: Regularly clean and sanitize system components to avoid problems like algae and nutrient buildup. This includes cleaning reservoirs, pumps, and tubing.
- Monitoring: Regularly check and adjust all parameters to maintain optimal growing conditions for your plants.

Resources for hydroponics

1. Site Selection: Although hydroponics is a highly controlled growing method, choosing an optimal natural environment can provide additional benefits, primarily affecting setup costs rather than the efficiency of the hydroponic system itself. Essentially, any natural condition can support a functional hydroponic unit, as the efficiency of the system is largely independent of external environmental factors.
2. Energy and Water: Hydroponic greenhouses increasingly rely on sustainable energy sources, including water, wind, and solar power, to meet their energy needs. In these systems, water serves as the medium for delivering nutrients in a closed-loop system, with the only loss occurring through plant transpiration.
3. Structures and Environmental Control: To create a consistent growing environment, greenhouses are designed with specific spatial volumes. Temperature regulation materials, such as polyethylene sheets (reducing heat transfer by 20%) and porous polyester (with a 57% reduction), are used to manage heat within the greenhouse. Advanced computer systems oversee the operation of numerous climate and nutrient control devices, adjusting based on input parameters. This data acquisition system allows growers to analyze the interplay between various factors, enhancing their understanding of how these elements influence product timing and overall growth.
4. Production: Standardized protocols have been established over time to ensure the desired quality and quantity of hydroponic produce. Key factors that contribute to achieving these standards include
5. Nutrient Balance: Precisely measuring and adjusting the nutrients provided to plants at various growth stages helps to enhance produce quality and reduce the time required to achieve desired results. This careful management ensures optimal plant health and efficiency in nutrient use.
6. Pest management: To avoid viral infections and root diseases like Pythium root rot and bacterial wilt in hydroponic systems, the drainage solution is typically sterilized through methods such as heat treatment, ozone, and ultraviolet radiation before it is recirculated into the irrigation system. Additionally, integrated pest management (IPM) strategies are employed to control pests.
7. Quantity: Precision handling systems in hydroponics aim to achieve the highest possible yield with the least amount of resources.

Vertical farming, Plant Density, Number of crops per year, Carbon dioxide concentration in the air, The temperature of the plant and its surroundings, Light, Water, Relative humidity, pH of the nutrient solution, the amount of oxygen the plant roots receive, night time temperature, number of hours of illumination per day.

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Managing Pests and Diseases in Hydroponics

Aphids, White flies, Thrips

Management

1. Before you enter your growing area, you should be wearing sterile (or at least clean) clothes.
2. Before introducing vents, tanks, or any other equipment into your growing area, they must be thoroughly cleaned. It's also crucial to inspect the seals around your growing area. While good ventilation is important, it's essential to prevent pests from entering. Ensure that seals on windows and doors—particularly those close to external vegetation—are intact and in good condition.

Pythium is a prime example of a root-infecting pathogen, as it impacts all crops within hydroponic systems.

Management

1. Sanitation and sterilization of materials, equipment, and surfaces in the greenhouse should be thorough.
2. It's crucial to focus on producing pathogen-free transplants. Healthy-looking roots alone are not sufficient; plants can carry Pythium even if they show no symptoms like brown roots. One infected transplant can trigger a root rot outbreak in a hydroponic system.
3. Ensure effective insect control.
4. Consider filtering water from external sources, such as through sand, particularly if it is surface water.

Advantages: Some of the benefits of the hydroponic farming are:

1. Can be grown anywhere.
2. Higher plant intensity.
3. Low cost and time for land preparation
4. Conservation of water.
5. Herbicide/Weedicide free
6. Yields can be maximized
7. Less/No usage of Pesticides.
8. Less use of fertilizer.
9. Ease of control over agro-climatic factors.
10. Easier access to roots
11. Crop rotation/fallowing are not necessary.
12. Relieves stress/Hobby grower.

Disadvantages

Like any farming method, hydroponics has its own set of drawbacks. Some of the disadvantages of hydroponic farming include:

1. High initial cost.
2. High running cost.
3. Skill and knowledge are needed to operate properly.
4. Disease and pests can spread quickly through the system.
5. The availability of plant varieties is not always ideal.

Sales and marketing: The hydroponics market is flourishing and contributing in shaping the future of the agriculture industry. Hydroponic cultivation has great prospects for Indian agriculture. In the changing scenario of food habits and the growing fad of green vegetables, herbs, and fruits, hydroponics technology is going to play a major role for sustainable and round the year production in urban and pre-urban areas.

The global hydroponics market size was valued at USD 5.00 billion in 2023 and is expected to grow at a compound annual growth rate (CAGR) of 12.4% from 2024 to 2030. The rapid growth in this sector is linked to the expanding utilization of hydroponic systems in the indoor cultivation of vegetables.Indian Hydroponics market reached USD 1.4 billion in 2022 and is expected to reach USD 5.3 billion by 2031 and is expected to grow with a CAGR of 17.6% during the forecast period 2024-2032.The increased adoption of sustainable agricultural practices and rising demand for protective environmental farming increased the Indian hydroponics market growth.

Conclusion

Hydroponic farming in the North Eastern Region has greater potential to revolutionise the agricultural sector and enhancing food security. North Eastern Region, Hydroponic is an eco- friendly afterward in overcoming problem posed by abioticand biotic stress, eventually obtaining quality produce. It's gaining popularity in the North Eastern region because of efficient resource management and quality agriculture production.

ICDS- A BOON FOR WOMEN AND CHILDREN OF MANIPUR

Dolica Brahmacharimayum,
Dr. Puspita Das, Meghali Nath

Malnutrition is currently one of the biggest challenges facing the modern world. In India, the Integrated Child Development Services (ICDS) scheme was started with the objective of improving child health, nutrition and development. It was introduced in Manipur on 2nd October 1975 with a pilot project at Ukhrul T.D. Block. After that the Scheme has been successfully being implemented by the Department of Social Welfare as the nodal department.

It is one of the most ambitious and comprehensive survival and child development schemes for enhancing the health, nutrition and learning opportunities for pre-school children and their mothers by simultaneously providing all the requisite services at the village level. The significant factor is that the deprived and underprivileged children are fortunate enough being the part of this scheme.

There are 42 ICDS Projects operational in Manipur which includes 9(nine) Rural Projects, 1(one) Urban Project and 32 (thirty two) Tribal Projects under which 9958 Anganwadi Centres and 1552 Mini Anganwadi Centres as approved by Government of India, have been functioning through Anganwadi Workers/Helpers and Mini Anganwadi Workers in each centre. A total of 74,287 pregnant women and lactating mothers are being served by these Centres. Regular health check-ups and immunization are important components of the scheme. Four Anganwadi Workers Training Centres run by government and non-government agencies are regularly imparting trainings to the hundreds of Anganwadi workers. ICDS is a very important intervention to ensure the health, nutrition and development of children under six in the state. Besides caring for proper psychological, social and physical development of children, ICDS aims to reduce the mortality, morbidity, malnutrition and school drop-outs among children. ICDS services are delivered through Angawadi centres established in villages and run by a worker and a helper. All children, pregnant women and lactating mothers covered under an Angawadi Centre are provided supplementary nutrition for 21 days in a month. Those suffering from severe malnutrition are to be provided special supplementary nutrition and referral services. ICDS care for children below six years of age. It also takes care of essential needs of pregnant women and nursing mothers residing in socially backward villages and urban slums.

Manipur tops in the Integrated Child Development Services (ICDS) among the 90:10 division states, as per the sixth edition of Public Affairs Index (PAI) 2021 published by the Public Affairs Centre (PAC).

The aims and objectives of ICDS Scheme include improving the nutritional and health status of children in the age group 0-6 years, focussing on psychological, physical and social development of the child, reducing the incidence of mortality, morbidity, malnutrition and school dropouts, achieving effective coordination of policy and implementation among various departments to promote child development, enhancing the capability of the mother to look after the health and nutritional needs of the child, through proper health and nutrition education.

Apart from working on the objectives of ICDS, the ICDS Centers of Manipur are also engaged in performing some other activities as well. Those include:

1. **The Community based events (CBE):** Itis conceptualized under Poshan Abhiyan. It is being celebrated on 4th & 20th of every month in all Anganwadi centres. The themes includes Annaprasan Diwas, SuposhanDiwas, Celebrating coming of age – getting ready for preschool at AWC, Messages related to public health for improvement of nutrition and to reduce illness.

a) **Inviting women during the first/ second trimester of pregnancy:** To advise the pregnant women and key members of her family on nutrition and health care practices important for a safe pregnancy


Fig 1: Community based event program

b) **Annaprasan Diwas:** To ensure complementary feeding is initiated for all the infants who have completed 6 months of age.

Fig 2 :Inviting women during the first/ second trimester of pregnancy

c) **Suposhan Diwas (Specifically focused on orienting husbands):** To create awareness and educate husbands about the relevance of maternal and child nutrition.

d) **Celebrating coming of age – getting ready for preschool at AWC:** This event, it is proposed to organise a celebration for all children turning three years of age who will start attending preschool sessions at the AWC.

Fig 3: Annaprasan Diwas

2. **Village Health Nutrition Day (VHND):** Itis a conceptualized under National Health Mission (NHM) across the country since 2007. The VHND is to be organized once every month at the AWC in the village.It is an inter sectorial collaboration of following four components namely health, nutrition, early childhood development and Sanitation.

Fig 4: Celebrating coming of age – getting ready for preschool at AWC

3. **YOGA Programmes:** Yoga session is conducted once in every month in the Anganwadi centre. In order to convey the message of building strength, awareness and harmony in both mind and body.

Fig 5: YOGA program

Fig 6: Poshan Pakhwada Rally Organised by Anganwadi workers

4. **Poshan Pakhwada (2023):** Moreover, the fifth Poshan Pakhwada was celebrated from 20th March to 3rd April 2023 with various activities nationwide with an aim to raise awareness about the importance of nutrition and promote healthy eating. The theme of this year's Poshan Pakhwada 2023 is "Nutrition for All: Together Towards a Healthy India". With the declaration of 2023 as the International Year of Millets, this year the focus of Poshan Pakhwada was to popularise 'Shree Anna'- the mother of all grains, as a valuable asset to address malnutrition. Also, popularizing Saksham Anganwadis with upgraded infrastructure and facilities as centres of improved nutrition delivery and early childhood care and education.

As under ICDS parents and children are getting so many additional facilities and getting awareness on nutrition education, care of the children and special services like observation of special days, it helps to make Manipur in the top rank in the field and acts as a boon for the women and children in Manipur.

ORGANIC AQUACULTURE: A WAY FORWARD FOR HEALTHY AND SUSTAINABLE FOOD SUPPLY

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The global fishery industries is in a stage of fishery resources depletion due to unsustainable fishing practices, large scale aquatic pollution, commercial exploitation of aquatic environment and destruction of primary breeding environment such as mangrove forests & coral reefs. Due to intensification of aquaculture practice all over the world, has in turn resulted in accumulation of high levels of antibiotics, residues of pesticides and heavy metals causing a great damage to environment. Organic Aquaculture is the only solution to increase fish production in sustainable and environment friendly manner.

Organic aquaculture is production of high quality foods in a stable aquatic ecosystem by managing the natural resources and environment without any negative effects and to secure the genetic diversity and richness of species in a native system.

Current problem with the industrial aquaculture practice of fish harvested from wild as feed for the production of cultured fish, 3 tons of wild fish is used to produce feed for the production of 1 ton of farmed fish, so this depletes the natural stock available in wild. To increase production, fast growing exotic fish varieties are farmed this result in weakening of the native species and transfer of disease from farmed aquatic animals to wild fish is also major problem in the current aquaculture systems. Organic aquaculture is a method to reduce the above mentioned adverse effects of the industrial aquaculture practice. Organic aquaculture is most important in the sustainable and environmental friendly aquaculture production. This method of culture also farms the aquatic organisms in conditions similar to that of the natural environment.

Principles of organic aquaculture

The main principles of organic aquaculture are as follows:

- Monitoring of environmental impact
- Natural breeding procedures without use of hormones and antibiotics
- No use of inorganic fertilizers
- Integration of natural plant communities in farm management
- No synthetic pesticides and herbicides
- Feed and fertilizer from certified organic agriculture and fisheries
- Organic criteria of sustainability for fish meal sources
- Absence of GMOs(Genetically Modified Organisms) in stocks and feed
- Stocking density limits
- Restriction of energy consumption (e.g. regarding oxygenation)
- Preference for natural medicines
- Processing in approved organic facilities

History of Organic aquaculture

Organic aquaculture is based on the organic agriculture farming technology, and these root causes continue to shape the organic aquaculture sector in many ways. Organic farmers in Austria and Germany first started to develop extensive "organic" carp production system in the early nineties. At that time, although the organic food market was still a niche market in terms of volume, it already offered most types of food in organic quality – with the exception of fish. The successful launch of organic salmon, first in Germany and later in the United Kingdom and France, accelerated the development process of organic aquaculture initiatives throughout the world. A further milestone in the history of organic aquaculture was the development of standards for the production of organic shrimp. After the launch of the organic shrimp concept, which drew attention internationally, a number of European development agencies became interested in spreading the initiative to more southern countries. Organic farming of additional finfish species started in Europe, Asia, and Latin America. In continental Europe, organic trout production took off, a big organic Pangasius catfish project was started in Vietnam by the Germany-based seafood company, organic tilapia farming started in Israel and Ecuador and in the Mediterranean, seabass and seabream farms were converted to organic management.

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All over the world there are 240 number of certified organic aquaculture operations (including the production of micro algae) in 29 different countries in 2009, most of the operations are located in Europe. In China, 72 operations have received organic certification under the national Chinese regulation. Commonly in China organic production of carp in polyculture, in combination with crabs, shrimps or other local species. There are also certified operations producing turtles or sea cucumbers in China. In Bangladesh, India, Thailand, and Vietnam there is increase in the organic production of Black Tiger Shrimp, In Vietnam organic Pangasius catfish is produced and organic production of micro-algae in India. Total organic aquaculture production reached about 53,500 tons in 2009, accounting for about 0.1 percent of aquaculture production worldwide.

INDOCERT (Indian organic certification) is an Indian certification body accredited as per National Programme for Organic Production (NPOP), Govt. of India to carry out inspections and issue certificates for organic production systems. INDOCERT is offering certification for the domestic market based on the National Standards for Organic Production and certification for export markets based on USDA (United States Department of Agriculture).

Organic Agriculture in India

Since January 1994 'Sevagram Declaration' for promotion of organic agriculture in India, organic farming has grown many folds and number of initiatives at Government and Non-Government level has given it a firm direction. While National Programme on Organic Production (NPOP) defined its regulatory framework, the National Project on Organic Farming (NPOF) has defined the promotion strategy and provided necessary support for area expansion under certified organic farming.

Before the implementation of NPOP during 2001 and introduction of accreditation process for certification agencies, there was no institutional arrangement for assessment of organically certified area. Initial estimates during 2003-04 suggested that approximately 42,000 ha of cultivated land were certified organic. By 2009 India had brought more than 9.2 million ha of land under certification and it has been increased further.

General standards for Organic aquaculture production

Some of the general standards which are to be followed in an organic farming aquaculture system are listed unit wise:

Production unit setup

Standards: The production unit should manage the surrounding environment from any impacts like escapement of cultured organism, spreading of disease, avoiding the use of synthetic and chemical fertilizers and paints. Consideration for the surrounding environment is crucial for positioning and management of the organic unit.

Environment / Water Quality

Standards: The water system must be loaded to the minimum possible extent with feed wastage and faeces that can cause over-fertilization or other disturbances to natural environment. Aqua farmers should not deplete nor excessively exploit the available water resources, and must preserve the natural water quality.

Breeds and Breeding

Standards: Breeds that are adjusted to local conditions should be used. Breeding must be done on a large number of breeding pairs to prevent inbreeding, enetic damage and loss of genetic variation. Triploid, genetically modified and sex reversed organisms should not be used.

Feed and feeding

Standards: The feed should consist of organic raw materials originating from wild aquatic stocks. For management of fishery resource, aquatic raw materials from stocks that are not used for human consumption and from by-products must be used for feed preparation. Feeding must be performed in a way that allows natural feed available in pond system also gets consumed with minimal wastage of the supplemented feed.

Additives

Standards: Additives such as growth promoters, hormones and appetizers should never be used and the usable additives like vitamins, minerals, antioxidants and colouring agents should be of natural in origin or it should be close to natural form as possible. Synthetic and unnatural additives must not be used in organic farming system.

Treatments and animal health welfare

Standards: Considering the health management in aquatic organisms "Prevention is better than cure" concept should be followed so that there will not be any need for medication. If there is still sign of disease, suitable measures shall be adopted immediately. Drugs with the minimum environmentally harmful effect and

with the minimum risk to human and animal health should be used for treatment.

Record keeping

Standards: It is a very important protocol to be followed in feed management and in disease management of the aquatic organism. For disease management record must have all the details related to disease and its treatment procedures followed. The farm manager should maintain a monthly record of the feed type, feed producer, and quantity fed used till the end of the crop.

A universally accepted standard for organic aquaculture practices does not currently exist. To risk investment in this sector, producers require formally recognized standards in order to communicate the advant ages of the organic aquaculture products to consumers. The key to the continued growth and development of organic aquaculture lies in resolving a number of issues that currently stand in the way of instituting internationally accepted certification standards.

MANAGEMENT OF FRACTURE IN A DOG: A CASE REPORT

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A bone fracture is the medical definition for a broken bone. Fractures occur commonly in both dogs and cats. While typically fractures occur after a traumatic incident, such as being hit by a car or falling from a height, some fractures occur following a pathologic weakening of the bone, which is seen with certain neoplastic conditions, such as osteosarcoma. Limb fracture leads to lameness which is defined as an abnormal stance or gait caused by either a structural or a functional disorder in the locomotor system (Stephen, 2015). Typically, severe lameness is noted and the affected limb is obvious. Pets that have sustained major trauma, such as being struck by a motor vehicle or falling from a height, may have more than one broken limb, and may be unwilling or unable to walk (ACVS,2024). Other symptoms of fractured bone include:

- Swelling and bruising surrounding the affected joint
- Difficulty moving the joint, accompanied by pain and stiffness
- Asymmetrical appearance (one joint looks deformed, swollen, or otherwise abnormal or out of place)
- Bending, twisting, or shortening of the joint (AEC, 2024)

Relieving pain and restricting the movement of the lame animal are the most important components for treatment of bone fracture and may allow faster recovery. Nonsteroidal anti inflammatory drugs (NSAIDs) and other pain relieving drugs are used to control pain in lame animals.

Case History: In Dagalgopgre village, South Garo Hills District, Meghalaya a case of forelimbs fracture was reported in a 8 months old male dog (local breed) weighing 2 kg body weight. It was reported that the dog was brutally hit on both the forelimbs by a hard object (wooden stick) resulting in lameness and acute pain. Due to the small size nature of the dog, the limbs were easily affected by trauma. Other Clinical signs include welling around the affected limbs (forelimbs) and general body discomfort. It also developed anorexia for 2 days due to the apparent pain caused by the injury. On Palpation of the affected limbs (forelimbs), crepitation sound on

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the elbow joint of both the limbs was noticed. However X-ray examination for fracture confirmation was not done as there is no facility for X- ray examination in the village under mention (being a remote one). The case is tentatively diagnosed as fracture of the forelimbs based on the typical clinical sign (a crepitating sound on palpation of the limbs) and treatment was initiated accordingly.

Treatment: Initially the dog was properly restrained on a table and the mouth was muzzled to prevent from biting. By pulling forward, the affected limbs were straightened and were wrapped with cotton and gauge bandage. Finally splint was applied on both the forelimbs by using cut pieces of disposable plastic bottle. To relief pain, Melonex (NSAID) was injected 0.2ml IMly for 4 days. Osteocalcium syrup was given 5ml orally twice daily for 20 days to hasten the healing process of fractured bone. The dog was then confined to a cage for 4 weeks to restrict the movement. The splint was removed once the leg was able to bear weight. After 40 days both the limbs were able to bear weight. The dog recovered uneventfully.

Fig. 1: Splint application on the affected limbs

Fig. 2 : After recovery

Conclusion

Fracture in dog is very common due to their active nature. Bones which bear weight like the femur (thigh bone) and radius and ulna (bones in the limbs). Fracture case will require application of cast and splint and supportive treatment such as providing Calcium & Phosphorus supplement to hasten the healing process in addition to relieving pain and restricting movement. Canine fractures need a minimum of four weeks in young puppies and eight weeks in older animals to heal sufficiently and eventually return to normal (The Kennel Club Limited 2020). In our case, the exact cause of fracture was due to beating hard on the forelimbs by wooden stick and the case was treated successfully by applying splint on the affected limb, relieving pain by injecting meloxicam and restricting the movement for 4 weeks.

REDISCOVERING THE NUTRITIONAL AND GENETIC RESOURCES OF NORTH EAST RICE LANDRACES

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ABSTRACT

Northeast India is a centre of diversity for rice (*Oryza sativa* L.), this region serves as a major genetic resource for future crop improvement to fulfil the growing need for food production. High rainfall, humidity, varied topography and altitude have contributed to the region's vast floral and agricultural diversity. Despite the loss of many varieties during the Green Revolution, these landraces offer untapped genetic diversity and nutritional value. The article highlights the nutritional information of rice, focusing on brown rice's abundant nutrients and the presence of anti-nutritional components. Additionally, it discusses the phytochemical composition in rice, emphasizing the protective properties of these non-nutritive plant chemicals. The conclusion underscores the importance of extensive research and promotion of native rice varieties for a more vibrant, sustainable and nutritionally diverse food culture.

Introduction

Rice, a primary cereal crop consumed as a staple food by over half of the world's population, has its centre of diversity in the ecologically diverse region known as North East India (NE India).This region, plays a crucial role in maintaining and exploring the diversity of rice varieties available today.India is home to 6000 rice varieties but prior to 1970, India possessed over 110,000 different varieties of rice; however, with the focus on monoculture and hybrid crops during the Green Revolution, these variety were lost (Rathna *et al.*, 2019). There are unique landraces popular for their coloured aleurone and aroma as the colourful varieties

of rice possess health benefits. These landraces, often overlooked in favour of modern rice varieties, hold the key to untapped nutritional benefits and exhibit fascinating genetic diversity. In this article, we study the colourful world of North-eastern rice landraces, exploring their properties, nutritional profiles and the immense potential they offer.

The diversity of North Eastern Rice Landraces

Northeast India, with its unique agro-climatic conditions and cultural diversity, boasts a remarkable array of rice landraces. These include the aromatic Joha rice, the sticky Bora rice, and many more, each adapted to specific regions and purposes. These landraces are not just known for their flavours and textures but also for their nutritional content. In Manipur, rice is grown in variable environment ranging from deep water rice, jhum farming, and higher altitudes. In addition to other native short grain rice, the state is enriched with the unique black rice known as Chakhao Poireiton. In Meghalaya genetic diversity is widely spread across the Jaintia, Garo, and Khasi highlands. Farmers who cultivate jhum and upland areas tend to favour native genotypes with distinct regional tastes. The majority of these native rice landraces have durations ranging from 130 to 170 days. About 11.7% of the land of Sikkim (a high-altitude hill state), is used for agricultural purpose. It has been observed that most of the state's local landraces are cold tolerant. Tripura has a varied terrain, with *jhum*, marsh, and deepwater rice among its rice ecosystems. In Assam, rice is grown in a variety of ecosystems, including highland *jhum* and flood-prone regions of the Brahmaputra and Barak valleys.Joha (aromatic rice) is found in this region with two variants known as Kala Joha and Amru Joha (Kumar *et al*, 2017).

Nutritional information of Rice

Brown rice possess an abundant quantity of nutritional traits as it retains its bran layer (containing vitamins, minerals and fibre) as it does not undergo polishing. It is highly nutritious, has low calorie coupled with a high amount of fibre. Furthermore, it is a good source of magnesium, phosphorus, selenium, thiamine, niacin, vitamin B_6 and an excellent source of manganese. Rice grain is mainly composed of carbohydrates (80 g/100g approx.), protein (9.5 g/100g approx.), moisture (8–10 g/100g), fibre (4–5 g/100g), ash and fat (3–4 g/100g). Starch is the major carbohydrate in rice which is highest amongst cereals and consists of amylose and amylopectin. The amylose content (AC) in rice is commonly categorized as waxy/glutinous (0–5%), low AC (< 20% of amylose), intermediate AC (21% - 25%) and high AC (>25%) (Kongseree and Juliano 1972) while the total protein content (PC) is another nutritionally relevant component in rice which is also related to the texture of cooked rice since it inhibits water absorption and swelling of starch upon cooking and can be classified as High ≥12%, Medium11.9–9% and Low ≤8.9% (Silveira *et al.* (2010). Brown rice grains are also rich in oil content (5.5 g/100g).In addition to their nutritious qualities, rice grains have certain anti-nutritional components such as phytic acid and polyphenols. Different types of polyphenolic compounds have been identified based on the pericarp colour of rice grains, where rice grain with red and black pericarp has the highest concentration. Both brown and black rice are low in fat and are good source of healthy carbohydrates. Red rice is known to be rich in iron and zinc while black and purple rice are especially high in protein and crude fibre. Brown rice typically has an iron content of 6.3-24.4 mg/kg and a zinc content of 13.5–28.4 mg/kg. This range indicates a roughly four-fold variation in iron and a more than two-fold variation in zinc levels, indicating some genetic potential to raise these micronutrient concentrations in rice grains. (Gregorio, 2002).Iron and zinc are crucial micronutrients for human health, playing key roles in various physiological functions. Iron is essential for the formation of haemoglobin, while zinc is a cofactor for enzymes that are involved in processes such as DNA synthesis, cell division, and protein metabolism. Given the importance of these micronutrients and diversity existing in north east region, landraces of North East have the potential to be valuable sources of iron and zinc micronutrients and other desirable traits which can help in crop improvement programmes

Phytochemical composition in rice

Phytochemicals are the non-nutritive plant chemicals with protective or disease-preventing property. The phytochemical compounds are mainly accumulated in the pericarp and bran of the rice. They offer a variety of beneficial biological functions in addition to preventing oxidative damage in food.Phytochemicals can be divided into - carotenoids, phenolics, alkaloids, nitrogen and organo-sulphur containing compounds while Phenolic compounds are further sub-grouped as phenolicacids, flavonoids, coumarins and tannins. Anthocyanin falls under the class of flavonoid and are primarily responsible for the red and black colour of rice. "Chakhao Poireiton" which has been awarded GI tag of Manipur is one such landrace which possess high anthocyanin content. Anthocyanins found in coloured rice bran have anti-diabetic and reductase enzyme inhibitory properties. Reductase inhibitors are

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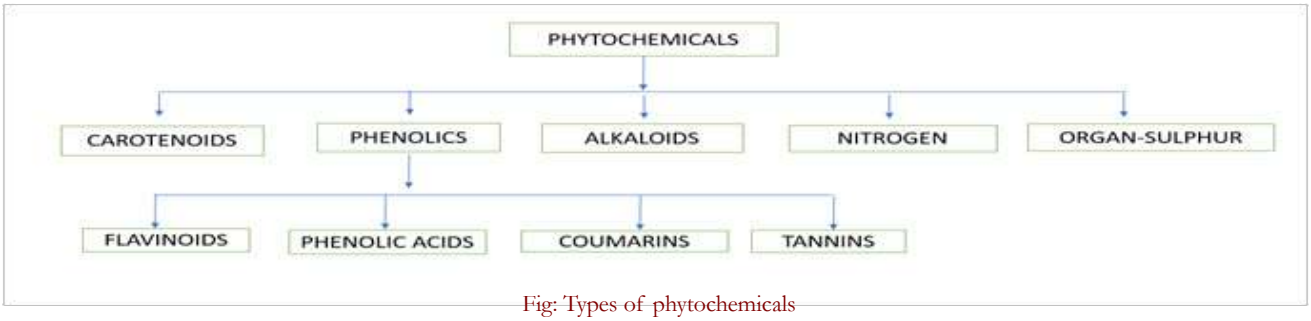

Fig: Types of phytochemicals

used to treat benign prostatic hyperplasia and to lessen symptoms related to the urinary system since they have antiandrogen properties.

Conclusion

Discovering and exploring the diverse rice landraces of North East India is not just a journey into agricultural heritage but also a path towards a healthier, more sustainable future. While the nutrient profiles of these local landraces remain largely unknown to many, incorporating them into our diets not only supports local farmers but also enriches our culinary traditions. The vibrant and nutritious qualities of these landraces, waiting to be rediscovered, offer a promising scope for a more flavourful and health-conscious lifestyle. To unlock their full potential, it is necessary for stakeholders to undergo extensive research, ensuring these native varieties become accessible to consumers, either as everyday staples or as specialty functional foods. In doing so, we take a significant step towards a more vibrant, sustainable, and nutritionally diverse food culture.

EMPOWERING LIVELIHOODS THROUGH MUSHROOM FARMING: SUCCESSFUL CASES FROM MEGHALAYA

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Mushroom cultivation in Meghalaya is a transformative force, driving economic empowerment and sustainability in the region. These remarkable fungi are not only a source of vital nutrients, boasting protein, fibre, and essential vitamins, but they also offer a path to economic growth with minimal upfront investments and significant profit potential. Mushroom farming, with its labour-intensive nature, generates employment opportunities that greatly benefit both rural and semi-urban areas. Meghalaya's climate is incredibly well-suited for mushroom cultivation, with plenty of rainfall and a mild, temperate environment, especially during the monsoon season. The moderate temperatures, typically ranging from 15°C to 25°C, create the perfect conditions for a variety of mushroom species. The lush forest cover offers a natural habitat for both wild and cultivated mushrooms. High humidity levels, a common feature in the state, create an environment highly conducive to mushroom cultivation. Additionally, the region's diverse altitudes allow for the cultivation of different mushroom species, each tailored to their specific temperature and moisture requirements.

Mushroom farming isn't just an extra source of income; it's an economic catalyst. It offers individuals and communities a dependable source of income with minimal upfront investment requirements, effectively reducing economic vulnerability. The short cultivation cycle ensures quick returns, making it an ideal choice for those seeking immediate income. Moreover, year-round cultivation minimizes the seasonality of earnings, a common challenge in traditional agriculture. Mushroom farming is sustainable and eco-friendly, often employing organic substrates made from agricultural and industrial waste, contributing to recycling efforts and waste reduction.

In Meghalaya, a variety of mushroom types are commonly cultivated, capitalizing on the region's favourable climate and conditions. Oyster mushrooms, such as *Pleurotusostreatus* and *Pleurotussajor-caju*, are highly favoured for their adaptability and high yields. Shiitake mushrooms, renowned for their rich flavour and health benefits, thrive in Meghalaya's moderate temperatures and humidity. Button mushrooms are also grown, often in controlled environments that maintain the necessary temperature and humidity levels for optimal growth. The combination of climate, variety, and sustainability in Meghalaya's mushroom farming industry not only empowers individuals and communities with a reliable source of income but also has a positive impact on the environment, turning it into a symbol of economic resilience and ecological harmony.

Training programs are crucial for equipping individuals with essential skills in mushroom cultivation. They enhance productivity, quality control, economic diversification, sustainability, entrepreneurship, and community development, ultimately contributing to food security and local empowerment. For instance, the three-month vocational training programme on mushroom cultivation held in 2018 at CPGS-AS, Umiam, Meghalaya, under the leadership of Dr. R. K. Tombisana Devi and coordination by the Directorate of Extension Education, CAU, Imphal, successfully trained 18 individuals with financial support from the Power Finance Corporation (PFC), New Delhi. This initiative played a pivotal role in empowering individuals with the knowledge, skills and attitude needed for effective mushroom cultivation, driving economic empowerment and sustainable agriculture in the region, with two notable successful cases as follows.

Successful cases:

Case-I: "Transforming Challenges into Success: The Inspiring Journey of a Mushroom Entrepreneur"

Name	:	Mr. Junmanik Lyngdoh
Age	:	29 years
Gender	:	Male
Education	:	Class XII
Family type	:	Nuclear Family
Main Crops/ Enterprise	:	Mushroom
Village	:	Mawsyntai
Sub-Division/Block	:	Umling Block
Agricultural Landholding (ha)	:	Nil

Mr. Junmanik Lyngdoh

Challenge: Mr. Junmanik Lygdoh, a 29-year-old educated unemployed resident of Mawsyntai village in Ri-Bhoi Meghalaya, could not find a steady earning opportunity in his local area. Health issues of family members prevented him from seeking work in other areas. While he was interested in mushroom farming, a lack of technical knowledge, skills, access to credit, confidence, and market information hold him back.

Initiative: In 2018,Junmanik came to know about the three-month mushroom cultivation training at CPGS-AS, Umiamin a local newspaper and applied. He was selected and participated in the training with utmost diligence. The programme provided essential skills and information. Study tour to successful farms in other parts of the country provided the needed exposure and confidence to start mushroom farming. Encouraged by family, relatives, and friends, he began a small oyster mushroom unit and gained positive feedback from local customers.

Outcome: In 2021, he secured a loan of fifty thousand rupees from Union Bank of India. He wisely invested this amount in purchasing bamboo frames, hanging ropes, and constructing a mud-growing room. With the new growing room in place, he initiated his oyster mushroom cultivation journey, starting with 120 bags and 24 kg of spawn in his first cycle, resulting in a yield of 140 kg of mushrooms. To maintain a loyal customer base in his locality, he decided to sell his high-quality produce at a price lower than the market rate, offering it for Rs. 200/- per kilogram instead of the standard Rs. 300/-.One notable advantage he had was managing all the tasks himself, eliminating the need to hire labour, which reduced labour costs. Moreover, direct marketing within the local area spared him from additional expenses related to transportation, market margins, promotions, and advertisements during the first cycle. However, for subsequent cycles, he occasionally sold a portion of his production to local mushroom sellers at a rate of Rs. 150 per kilogram when he faced storage constraints. By the end of the year, his annual production had reached approximately 605 kg across all four cycles, achieved within the 660 square feet area.

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This impressive yield translated into a substantial return of one lakh fifteen thousand rupees annually, marking a significant milestone in his success story.

Impact: Junmanik gained recognition as a reputed and successful mushroom grower in his locality. His mushroom cultivation not only provided additional income but also allowed him more time to care for his family while earning respect from the community. He plans to expand his unit and increase production. He transformed from struggling to find daily work to becoming an entrepreneur, creating his own business. His success inspired others in the community to start their own ventures with his guidance.

Lesson Learned: Junmanik emphasizes that determination and hard work are key to success. He faced initial challenges with pests and diseases but overcame them by seeking advice from experienced mushroom growers and maintaining cleanliness in his unit. He advises budding entrepreneurs to start with a small-scale operation, gain experience and expertise before expanding, and tailor production to local consumer preferences, harvest seasons, and marketing capabilities.

Case – II: "A Journey from Cab Driver to Successful Mushroom Entrepreneur"

Name	:	Mr. Kyntiewlang Kharbuli
Age	:	32 Years
Gender	:	Male
Education	:	Class XII
Family type	:	Nuclear family
Main Crops/ Enterprise	:	Mushroom
Village	:	Mawtawar
Sub-Division/Block	:	Mawlai
Agricultural Landholding (ha)	:	Nil

Challenge:

Mr. Kynthiewlang Kharbuli, a resident of Mawtawar village, East Khasi Hills district, Meghalaya. He is a determined individual on a quest to enhance his income. He worked as a cab driver but found it unsatisfying, and his attempt at poultry farming fell short of expectations. Searching for a better opportunity, he stumbled upon the potential of mushroom cultivation through friends and the media. Intrigued, yet burdened by a lack of knowledge, skills, credit, confidence, and market insights, he hesitated to take the plunge into the world of mushrooms. Little did he know that this challenge would lead to a transformative journey.

Mr. Kyntiewlang Kharbuli

Initiative: He learned about the three-month vocational training programme on mushroom cultivation through his sister who is an employee of CPGS-AS and decided to grasp the oppourtunity. He was fortunate to be selected and attended the programme. The training provided him with the knowledge and skills needed for mushroom cultivation, and a study tour and hands-on practice boosted his confidence. After completing the programme, he developed a favourable attitude toward mushroom cultivation and decided to start on a small scale, driven by curiosity, self-interest, and encouragement from extension personnel and family support.The lockdown due to the COVID-19 pandemic proved to be a blessing for him. His family members had free time to assist him. With family help, he expanded his farm by constructing another shed on top of the terrace. It was a blessing, since the shed proved more suitable for cultivation than the room.

Outcome: His dedication was unwavering, and by 2022, he expanded his operation, adding another two growing rooms, resulting in a total cultivation area of 960 square feet by 2022. This strategic move yielded an impressive 1200 kg of mushrooms across all four cycles, with a gross income of Rs. 3,60,000. The financial transformation he experienced allowed him to better support his family and take an active role in his community, serving as a source of inspiration for others seeking to improve their livelihoods through mushroom cultivation. Furthermore, he secured financial assistance of Rs. 5,00,000 through the PRIME(Promotion and Incubation of Market Driven Enterprises) of Government of Meghalaya to establish his mushroom spawn production unit, facilitating further growth and prosperity.

Impact

Within his community, Kyntiewlang has not only secured a means of livelihood but has also garnered the respect of his peers. His journey reflects a transformation from job seeker to job provider, creating employment opportunities and inspiring aspiring mushroom

entrepreneurs to follow suit. With ambitious plans for expanding his mushroom cultivation unit and venturing into commercial-scale spawn production, he has also ventured into value-added mushroom products, signaling that his success is not just personal but a source of hope and empowerment for his entire community. He operates his business "Kharbuli Mushroom" as a registered food vendor under FSSAI in Mawtawar, Mawalai, Meghalaya, offering value-added products like dried oyster mushrooms and mushroom pickles. He is also exploring opportunities to create mushroom biscuits and powder for use in home recipes, restaurants, and fast food establishments. To reach customers and fulfill orders, Kyntiewlang employs social media platforms such as WhatsApp, Facebook, and Instagram. Furthermore, he has attended various training programs organized by the Department of Horticulture in Karnataka, the Rural Self-Employment Training Institute in East Khasi Hills District, Meghalaya, and the Rain Forest Research Institute in Jorhat, Assam. His engagement in the North East Food Show in 2022 further underscores his commitment to growth and innovation.

Lesson learned: Kyntiewlang Kharbuli reflected on his journey and shared, "I learned that determination and hard work are the key to success. In the initial stages of mushroom cultivation, I faced the challenges of pests and diseases in my unit. However, I overcame these obstacles by seeking advice from experienced mushroom growers and learning to maintain hygiene in the unit. I believe that budding entrepreneurs should begin their mushroom cultivation on a small scale, gaining valuable experience and expertise before expanding. It's essential to plan production based on consumer behavior in the target area, considering factors like the harvest period and marketing strategies for a successful venture." His insights serve as valuable guidance for aspiring mushroom cultivators, emphasizing the importance of perseverance, knowledge sharing, and a well-thought-out approach.

Table 1 Common key interventions and strategies followed in both successful cases

S. No.	Key Interventions	Advantages
1.	Selection of oyster mushroom farming	The favourable climate and forested environment provide ideal conditions for oyster mushroom growth and high-quality yields.
2.	Establishment of simple and low-cost farm design and growing mushrooms	By using simple, low-cost bamboo and thatched roof sheds, they reduce initial capital investment, minimize operating costs, and take advantage of favourable local weather, enabling successful oyster mushroom cultivation with the potential for higher profitability.
3.	Maintaining separate dark and light rooms	This provides an optimum environment for controlling various aspects of mushroom growth and development
4.	Purchase of spawn from CPGS-AS, Umiam	Assurance of high-quality, reliable spawn that can contribute to successful and productive mushroom cultivation.
5.	Gradual expansion of enterprise	This allows for controlled growth, minimizes financial risk, and provides an opportunity to gain experience and optimize operations before committing to larger investments, increasing the likelihood of long-term success.
6.	Marketing and promotion using digital gadgets and social media	This helps in reaching a wider and more targeted audience, facilitate direct communication, and efficiently promote products or services within the mushroom industry

Fig. 1 Mushroom unit of Mr. Junmanik Lyngdoh

Fig. 2 Low-cost mushroom growing room of Mr. Kyntiewlang Kharbuli

Fig. 3 Mushroomunit of Mr. Kyntiewlang Kharbuli

Fig. 4 Value added products of Mr. Kharbuli Mushroom

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WHY, WHAT AND HOW TO WRITE FARMERS?

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Like the others, farmers are units of our communities. They contribute the nation in strengthening the economy and overall development. They like to read agricultural literatureswhich are recent, relevant, reliable, readable and related to their interests and needs. Most of the farmers are adults by their age, literate to graduate by education, having joint families, whose members help them in the agricultural work. Hence, the principle of how to write primers for adult is to be adopted while writing for farmers.

The local farmers while learning the subject may have special problems, particular needs and different environment. Writings that too of technical nature should be effective for the farmer readers and learners to prepare them to face these challenges. The use of local idioms, colloquial words and phrases, feature stories of popular nature and events make it more interesting to farmer readers.

First visualize, analyze and then organize before writing. Farmer is our audience. Visualize your readers and think of them as individuals along with their desires. Common sense and knowledge of farmers are the two important components need to know by every writer. He should develop sensitivity towards humanity in general and individuals in particular. Here a farmer's personality with his socioeconomic background and his rural settings need to be visualized by a writer, when he is writing for farmers. Then, what should we do while writing for farmers? In this context, some guiding principles as given below are required to follow:

1. Analyze: Define the job to be done and decide how you are going to approach the farming community. There are always problems and limitations pertaining to the space, time and money.

2. Organize thinking and material: Analyze your thoughts related to your subject. These are to be written in sequence of thoughts. Turn the subject matter around in your mind until it crystalizes into sharp outline of one to four or more points required to be covered for a complete or full-fledged narration, it the story is to be clear and complete. Shift these ideas around until they fall into a sensible sequence. As a writer of reporter you would ordinarily use the third person approach. You must follow whichever basis you decide on. Remember that the basic point of view is one of the principle key to good report writing.

3. Dramatize your presentation: The true meaning of dramatization is to bring life and reality. This is what you must do with everything you want the farmer to read. How do you bring a piece of copy to life? First by being yourself alive, full of enthusiasm and interest in what you write about, and the farmer for whom you write.

4. Peep to your previous writings: Look back at some of your own articles. Do they show that you visualized your audience (farmers), analyze their problems, organized your thoughts and dramatize your presentation? This will give you an idea as to how you may have to work on.After you have written your article and if, you have doubt as how far it will reach the farmers, try it out on a farmer friend to get their honest opinion. Remember that your story must inform, give useful knowledge and change farmers' thinking about subject under their situations.

5. Incorporating the suggestions: Maintain dignity as writer. Be selective in subject material. Maintain good farmer's reactions. Develop understanding of newspaper personnel and their problems, accept their criticism and suggestions. This will improve your merit of writing.

6. Writing for Newspapers: Although a newspaper primarily provides news, views and advertisement, yet extension articles meant for farmers and success stories do find place. The characteristics of such write up should be simple, easily understandable, short sentences with photographs andwell-illustrated.

7.Writing for Periodicals and Magazines: Such publications are of immense importance in dissemination of know-how. Many such periodicals provide information supplemented with data. There are exclusive farm periodicals like *Indian Farming, Kheti, Intensive Agriculture, Agricultural Extension Review, Kisan Shakti, Baliraja and Phal Phool.*

8. Books and Booklets: For unique and single topic, booklets are prepared by agricultural scientists. This publication caters the need of farmers.

9. Leaflets, Folders, Handouts, Pamphlets and Bulletins: These are most convenient means of providing scientific know how. These should be prepared time-to-time and made available to the farmers.

10. Newsletters: These are aimed at reminding people in time to intimate immediate action. News letters should have: (i) Appropriate caption (ii) Interesting, attractive and provoking introductory paragraph (iii) It should state the importance of problem (iv) It should be well timed and written in simple and effective language.

11. Handbills: It is a one sheet material used for popularizing a new product, practice or idea.

12. Wall-Newspapers: They are big sheets of papers with current news, experiences, recommendations printed on them for being pasted on wall which invite attention of viewers for reading. Farmers like to read writing that is recent, relevant, reliable and readable.

Steps in Writing:

(i) **Planning:** Plan for easy reading. Think through why you are putting up your publication? Whom it is meant for? What to tell and how? Therefore be clear on the following

- (a) Why you are writing – purpose.
- (b) Whom you are writing for – audience.
- (c) What you want to tell – message.
- (d) How you will outline facts – plan.

(ii) **Writing:** Guideline to clear writing:

- (a) Short sentences
- (b) Simple words
- (c) Short and specific words
- (d) Cite examples
- (e) Write in a positive way
- (f) Use technical words carefully
- (g) Eliminate unnecessary words and ideas
- (h) Use illustrations

(iii) **Timing:** prune and polish your writing, but not the meaning. Weed out the unnecessary ideas, words, sentences, phrases and clause. No shortcuts at the cost of clarity.

(iv) **Checking:**use simple words, short sentences, and remember you are writing for farmers. Use 15 – 19 words per sentence, 7% personal words and 15% personal sentences. This checking in written material makes it easier to read. The principle of readability should be achieved too.

Readable Writing

In all your writings strive for clarity, simplicity and accuracy. In the process of writings, your writing is meant for layman or farmer. Hence you must write in layman's or farmer's language. In the technical writing, you must convert the terminology of scientist into that of layman or farmer. Technical writing at its best is lay-writing. There are many factors in achieving simplicity in writing. In the process of writing whenever feasible try to personalize or humanize your article. Put the reader into your writing. Let the reader see, what you have to say is of real interest or concern to him. Help him by picturing himself in it.

There are three purposes in writing: to inform (or educate), to influence for persuade and to entertain. It is desirable for you to realize that people are interested in people, secondly in things and thirdly in ideas. Frequently in writing and especially in technical writing, you have to make a compromise between your desire to communicate and what you actually communicate to your reader and what your reader is willing to absorb. For instance, you may wish to report in great detail the findings of a research project, you have conducted on grape mealy bugs. If only a few people are interested in the project, to read such a detailed report, you present only the highlights or a summary of it. Your detailed treatment, of course, depends upon the reader and the mass media you are using.

The same is true for your word choice as suggested earlier in the matter of simplicity. The publications such as newsletters are of value for their news or other features cannot serve as repositories of scientific knowledge. A scientific paper exactly demands the same qualities of thoughts as are needed for rest of the scientific articles: logic, clarity and precision.

In addition to organization, use of appropriate language is equally important. Use of correct Language, is necessary to transmit scientific knowledge effectively, clearly and meaningfully.

A conference report is a paper published in a book or journal as a part of the proceeding of a symposium, national or internal congress, workshops, roundtable etc. Therefore the vast conference literature that normally in print is not primary. Writing, after all just a way of getting your ideas over to people you

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might not reach in any other way. In writing we have to achieve our ends by choosing forceful, accurate, image provoking words and by the way, we hang our words and sentences together. Writing is specialized field of communication, but its relation to grammar is not different form that of other forms of writing. So grammar is necessary. You will have to well learn to use it to your advantages. Hence grammar is the most essential part for effective writing.

Finally, 10points must be followed while writing for farmers to make it readable:

i) Each problem should agree with its antecedent.

ii) Just between you and one, case is important.

iii) A problem is a poor word to end a sentence.

iv) Verb should agree with their subject.

v) Do not use a double negative.

vi) A writer should not misprision your point of view.

vii) When dangling, don't use principles.

viii) Joint clauses correctly by means of a conjunction.

ix) Don't write run on sentences. It is difficult when you got to punctuate it, so it makes sense when the reader reads what you write.

x) Take care of sentence fragments.

THE PATH TO WELLNESS: ENGAGING YOUTH FOR A HEALTHIER LIFE

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Introduction

In today's rapidly changing world, the health and well-being of rural youth have become increasingly critical. Limited access to healthcare and educational resources often leaves young people in rural areas lacking the knowledge and skills necessary to maintain a healthy lifestyle. The importance of regular physical activity for children and adolescents cannot be overstated, as it has both short- and long-term health benefits. Despite this, a notable number of young individuals do not meet the recommended guideline of engaging in 60 minutes or more of moderate-to-vigorous physical activity daily, as highlighted by monitoring and surveillance studies.(Trost & Loprinzi, 2008). Similarly, Marques *et al.* (2020) emphasized that adolescents generally lack healthy lifestyle habits, highlighting the urgent need for increased efforts in promoting health awareness and encouraging healthier behavior among young people.

Promoting healthy lifestyles among rural youth is crucial for their individual well-being and the development and sustainability of their communities. Initiatives that integrate agricultural training with health education can significantly enhance young people's understanding of nutrition and encourage healthier eating habits, addressing both food security and health challenges simultaneously (Qurani *et al.*, 2020). Research has shown that combining agricultural skills with nutrition education empowers youth and fosters a sense of community responsibility, contributing to the creation of sustainable food systems and improved health outcomes (Addo, 2018). Furthermore, equipping rural youth with knowledge about traditional food crops and sustainable farming practices can enhance nutritional security, promote biodiversity, and lead to healthier lifestyle choices within their families and communities (Bisht *et al.*, 2020). This holistic approach not only enhances the economic viability of agricultural practices but also ensures that they are socially equitable and environmentally sustainable, aligning with contemporary goals for rural development.

Recognizing the need for such interventions, the Department of Human Development and Family Studies at the College of Community Science, Tura,

under the Central Agricultural University (CAU), Imphal, organized a twodays training program focused on promoting healthy lifestyles among rural youth. This initiative aimed to empower participants, particularly young women, by equipping them with the tools necessary to make informed health decisions.

The training addressed physical, mental, and emotional well-being, recognizing the holistic nature of true wellness. By targeting young women, often the backbone of their families and communities, the program aimed to create a ripple effect, where the knowledge gained would benefit not only the participants but also their families and communities.

Through interactive sessions, practical demonstrations, and expert guidance, the training covered a wide range of topics, including basic nutrition, stress management, yoga, and drug abuse awareness. This article highlights the key components of the training, the participants involved, and the anticipated outcomes expected to contribute to healthier communities in the long term.

Participants

A group of 15 young women from rural areas participated in the training. The training included individuals from diverse backgrounds, with participants from various social categories, ensuring a holistic approach to community health.

Objective and Need Assessment

The main objective of the training program was to empower rural youth with the knowledge, skills, and motivation needed to foster and sustain healthy lifestyle practices within their communities. The need for such training was identified based on a gap in understanding basic health concepts like nutrition, stress management, and the importance of regular health check-ups, particularly among women in rural areas.

Evaluation: Pre and Post-Training

Pre-Training Evaluation: Before the training, participants showed limited knowledge in essential areas such as basic nutrition, health check-ups, stress management, yoga, and awareness of drug abuse. This indicated a strong need for the training program to equip them with crucial information and skills.

Post-Training Evaluation: Upon completion of the training, significant improvements were noted. Participants displayed a stronger understanding of nutrition, recognized the importance of regular health check-ups, adopted effective stress management techniques, and developed a positive attitude towards practicing yoga. Additionally, they became more aware of the dangers of drug abuse and how to avoid them.

Training Activities: Day-by-Day Breakdown

The twodays training, organized by the Department of Human Development and Family Studies, College of Community Science, Tura, under the Central Agricultural University (CAU), Imphal, covered a range of topics crucial to promoting a healthy lifestyle.

Day 1:

- **Session 1:** The training started with a discussion on the *Importance of a Healthy Lifestyle*. This session covered the concept of a healthy lifestyle, emphasizing its benefits and the significance of maintaining a balanced diet.
- **Session 2:** Health check-ups were conducted for all participants. This session aimed to help them understand their current health status and the importance of regular check-ups.
- **Session 3:** Participants received education on *Basic Nutrition*, learning about healthy food choices and their impact on overall well-being.
- **Session 4:** The day ended with a session on *Stress Management*, where participants learned practical techniques to handle stress effectively.

Day 2:

- **Session 1:** The second day began with a *Yoga Session* led by Miss Shraddha KarkyChetry, a certified Yoga Instructor. This session provided participants with the opportunity to experience the physical and mental benefits of yoga.
- **Session 2:***Awareness of Drug Abuse* was raised by Miss L. Kingbawl. Participants were informed about the risks and consequences of drug abuse, making them more aware of the importance of avoiding harmful substances.

Results and Discussion

The analysis of the pre-test and post-test scores of the participants reveals significant insights into the effectiveness of the training program in promoting healthy lifestyles among rural youth. The pre-test scores ranged from 8 to 20, while the post-test scores improved markedly, ranging from 13 to 24. This improvement is quantitatively supported by the paired t-test, which resulted in a t-statistic of -6.14 and a p-value of 0.000025.

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Table 1: Mean score of Pre & Post Test of Knowledge on Healthy Lifestyle

Measures	Mean	SD	t-test	p-value
Pre Test	15.2	3.32	-6.14	0.000025
Post Test	20.4	3.04		

Significance of Results

The p-value being far below the conventional threshold of 0.05 indicates a statistically significant difference between the pre-test and post-test scores. This suggests that the training program had a substantial positive impact on the participants' knowledge and understanding of the topics covered, such as basic nutrition, stress management, yoga, and drug abuse awareness.

Key Observations

1. **Overall Improvement:** All participants, except one, demonstrated an increase in their scores, indicating enhanced knowledge and understanding of healthy lifestyle practices. For example, Biswas showed the most notable improvement, with her score increasing from 8 to 20.
2. **Consistency Across Categories:** The improvement was observed across all social categories (Gen, OBC, ST), highlighting that the training program was effective regardless of the participants' backgrounds.
3. **Individual Variations:** While most participants showed significant improvement, there were individual variations. For instance, Hajong's score slightly decreased from 18 to 17. This could be due to various factors such as test anxiety or misunderstanding specific content. This outlier suggests the need for further investigation into how different participants absorb and retain information.

Discussion

The significant improvement in post-test scores underscores the effectiveness of the training program in enhancing the participants' knowledge of healthy lifestyle practices. The structured approach, which combined theoretical knowledge with practical sessions, appears to have successfully engaged the participants, leading to better retention of the information presented.

However, the slight decrease in one participant's score raises important questions about the varying ways in which individuals learn. This suggests that future training programs might benefit from incorporating more personalized or adaptive learning strategies, ensuring that all participants can fully benefit from the content.

The success of this program also highlights the potential for similar initiatives to be expanded to other rural areas. By empowering rural youth with the knowledge and skills needed to lead healthy lives, such programs can have a far-reaching impact, improving not only the health of individuals but also the well-being of entire communities.

In conclusion, the training program has proven to be a valuable intervention in promoting healthy lifestyles among rural youth, particularly women. The statistically significant improvement in knowledge as evidenced by the post-test scores indicates that participants are now better equipped to make informed health decisions, which can lead to lasting positive changes in their communities.

Some tips for promoting healthy lifestyles:

1. *Healthy diet- a diet rich in fruits, vegetables, whole grains& lean meat for better weight management*
2. *Getting adequate sleep is important for mind & Body*
3. *Reducing screen time by substituting it with physical play, creativity, socializing, and reading*
4. *Proper stress management by doing yoga, meditation, journal writing, etc.*
5. *Doing regular exercise at least walking briskly or jogging.*

AGRICULTURAL TECHNOLOGY INFORMATION CENTRE (ATIC): A WAY TO TRANSFORM AGRICULTURE

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In an era marked by technological advancement, agriculture stands at the forefront of innovation, ensuring the sustenance of growing global populations. With the escalating demand for food production, the Agricultural Technology Information Centre (ATIC) emerges as a trailblazer, empowering farmers and enthusiasts alike with state-of-the-art technologies and indispensable information. Acting as a pivotal link between research institutions, intermediary users, and end farmers, ATIC heralds a new age in agriculture, fostering knowledge dissemination, problem-solving, and sustainable practices.

The Birth of Agricultural Transformation

The establishment of ATIC marks a significant leap in agricultural progress. Rooted in the belief that knowledge, technology, and expertise are catalysts for change, ATIC serves as a single-window delivery system. By connecting farmers with cutting-edge research, seeds, planting materials, and publications, ATIC ensures that valuable innovations reach the fields where they are needed the most. Through its inception under the National Agricultural Technology Project (NATP) sponsored by the World Bank, ATIC has become a beacon of hope for agricultural communities across the nation.

Mandate of ATIC

- **Single Window Delivery System**: ATIC acts as a centralized hub, delivering agricultural information, products, and technologies developed by research institutions directly to the farmers, ensuring the dissemination of high-quality services.
- **Enhancing Advisory Services**: By adopting a multidisciplinary approach to problem-solving, ATIC strengthens farm advisory services. Expert consultations and collaborations facilitate the seamless flow of knowledge from the research system to the end users.
- **Knowledge Repository**: ATIC serves as a repository of agricultural information encompassing farming skills, practices, inputs, and education. This vast reservoir of knowledge becomes a valuable asset for farmers seeking guidance.
- **Consultancy and Training**: Beyond dissemination, ATIC offers consultancy services to stakeholders, fostering partnerships and enhancing agricultural expertise. Additionally, the center provides training to unemployed youth, transforming them into job providers, aligning with initiatives like NABARD's projects.

Empowering Farmers through Technology

ATIC acts as a bridge between traditional farming methods and cutting-edge technologies. By granting farmers access to innovative tools, precision farming techniques, and sustainable practices, ATIC revolutionizes productivity. Through advancements like drone-assisted crop monitoring and automated irrigation systems, farmers optimize resource usage, resulting in higher yields and increased efficiency.

Knowledge Dissemination and Training

A core function of ATIC lies in knowledge dissemination. Workshops, seminars, and training programs serve as platforms where farmers learn about best practices, crop management, pest control, and post-harvest handling. Expert-led sessions ensure that farmers are not only informed but also adaptable, staying abreast of the latest agricultural trends.

Incorporating Information Technology

ATIC harnesses the power of information technology to provide real-time data and insights to farmers. Mobile applications and web platforms offer farmers weather forecasts, market prices, crop-specific information, and pest management strategies. This instant access to information enables farmers to make timely decisions, minimizing risks and maximizing profits. Additionally, ATIC champions the adoption of block chain technology, enhancing transparency in the agricultural supply chain and ensuring fair compensation for farmers' efforts.

Research and Development

ATIC serves as a hub for agricultural research and development. Collaborating with universities and research institutions, the center conducts studies to enhance crop resilience, develop drought-resistant varieties, and promote sustainable farming practices. Research outcomes are shared with farmers, enabling them to adopt innovative techniques that improve soil health, conserve water, and reduce environmental impact.

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Entrepreneurship and Agribusiness Development

ATIC nurtures aspiring entrepreneurs in the agricultural sector. Through guidance, mentorship, and access to funding opportunities, startups focused on agricultural technology, agribusiness, and value addition receive support. Networking events connect entrepreneurs with investors and industry experts, fostering a thriving ecosystem of agricultural innovation and entrepreneurship.

Environmental Sustainability

Championing eco-friendly practices, ATIC advocates for organic farming, water conservation, and agroforestry. By promoting bio-pesticides, organic fertilizers, and sustainable irrigation methods, the center ensures that agriculture not only meets current demands but also preserves the environment for future generations. ATIC's initiatives significantly contribute to biodiversity conservation and environmental sustainability.

The Agricultural Technology Information Centre stands as a testament to the transformative power of technology in agriculture. By empowering farmers with knowledge, innovative solutions, and sustainable practices, ATIC plays a pivotal role in enhancing food security, supporting rural livelihoods, and promoting environmental conservation. As agriculture continues to evolve, ATIC remains at the forefront, steering progress and ensuring a prosperous future for farmers and communities worldwide. In cultivating tomorrow, ATIC lights the path towards a sustainable, tech-driven agricultural revolution.

CHALLENGE MALNUTRITION THROUGH BIO-FORTIFICATION

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Rice (*Oryza sativa* L.) is the most important staple food crop for more than 1/2 of the world's population and is playing an essential role in providing human nutrients security especially for Asian countries. 90% of the rice produced and ate up in Asia is linked to poverty. Rice is regularly related to poverty in many parts of the world, while it constitutes the primary source of calories. Nutritional problems like hidden hunger, malnutrition arise when critical vitamins along with zinc and iron are lacking from a staple food grain. The rice germ is the coronary heart of the grain, which sprouts when the seed is planted. It's far rich in vitamin B, vitamin E, protein, unsaturated fat, minerals, carbohydrates and dietary fiber. The endosperm constitutes the most important part of the grain. It's composed mainly of carbohydrates within the form of starch, with a few incomplete protein and strains of vitamins and minerals. Bran is the masking and consists basically of carbohydrate cellulose with strains of diet B (consisting of thiamine, niacin and B-6), minerals (which include iron, phosphorus, magnesium and potassium) and incomplete proteins. The outer husk or hull is inedible but is often used as fuel or fertilizer. Rice grain carries 80% starch, 7.5% protein, 0.5% ash and 12% water. The proportion of amylose and amylopectin in starch determine the cooking and eating characteristics of rice. No matter the fact that rice is a number one supply of carbohydrate, it's also a great supply of protein, however it isn't always a complete protein, which means that it does not comprise all the critical amino acids in sufficient quantities for proper health and must be combined with other sources of protein, which include nuts, seeds, beans, fish or meat so that it will provide a balanced nutrient intake. Consequently, rice alone can't meet the recommended day by day allowance. Healthy and effective population requires adequate quantities of vital vitamins and minerals. Malnutrition poses critical socio-financial implications worldwide, mostly within the underdeveloped and developing countries. In underdeveloped and developing countries triggered because of insufficient consumption of balanced weight loss program, malnutrition results in terrible fitness, increased susceptibility to various illnesses and big lack of annual Gross domestic Product (GDP), which is as high as 11% in Asia and Africa. Globally, around two billion people are afflicted by malnutrition, even as 815 million humans are undernourished. Youngsters are mostly affected because of malnutrition; as an end result 151 million kids below the age of 5 are stunted, while 51 million do not weigh enough in line with top. Nearly 45% of deaths amongst kids below the age of

five are related to malnutrition. The problem is so huge that 88% of the countries have two or three forms of malnutrition. In India, 21.9% of the population live in extreme poverty and it is anticipated that 15.2% of them are undernourished. Fitness problems resulting from zinc deficiency consist of anorexia, dwarfism, weak immune system, pores and skin lesions, hypogonadism and diarrhea. Adult males aged 15 to 74 years want about 12 to 15 mg of zinc daily whilst females aged 12 to 74 years want approximately 68 mg of zinc every day. Iron dependent anemia in turn results in maternal mortality, preterm births, decreases immunity and will increase placental weight for the duration of being pregnant. Further, the iron requirement is highest in the course of 7–9 months of pregnancy. Bio-fortification is an important technique by means of whichwe can improve dietary composition of food. This refers to the genetic enhancement of principal meals crops for grain nutrients consisting of micronutrients (Fe, Zn, etc.), protein, crucial amino acids, vitamins and many other essential nutrients. Rice is the most important caloric complement for two thirds of Indian populace with an intake of around 220g per day. But it's far poor in protein (7-8%) and micronutrients which include Zn (10-15 ppm) and Fe (2-3 ppm) in polished rice. Even, rice grain lacks vital amino acids which include lysine that our body can't synthesize and because of this, large efforts had been made to improve the nutritional composition of numerous food plants, including rice. Lysine, a basic vital amino acid with two amino organizations, is adequately found in cheese, eggs, fish, milk, potato and meat, and serves as an essential factor for the growth of children, nitrogen balance in adults, curing reproductive disorder, growth retardation and weight management etc. These major roles have drawn the attention of food and nutrients associated studies.

Plants bred for accelerated uptake and utilization of trace minerals (eg, zinc and iron) may be harnessed to concurrently enhance crop productivity and human nutrition. Bio-fortification is one of the techniques for enhancement of micronutrient ranges of staple crops through biological techniques, which includes plant breeding and genetic engineering. It is able to be powerful in lowering the problem of malnutrition as part of an approach that includes dietary diversification, supplementation, business fortification and different factors. Getting consumers to just accept bio-fortified crops may be a project, however with the arrival of accurate seed systems, the improvement of markets and merchandise, and call for advent, this could become a fact. Rice is a major supply of dietary carbohydrate for greater than half of the sector's population. Now,agriculture has to have consciousness on a new paradigm with the intention to no longer best produce extra meals however also higher satisfactory food. Bio-fortification of staple meals plants for better micronutrient content through genetic manipulation is the first-rate option available to alleviate hidden starvation with little ordinary fees.

Fig: Promotion of Bio-fortified Paddy Variety CR Dhan 310 and CR Dhan 311 undwe KVK Sepahijala

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ESTABLISHMENT OF FISHPOND: A MEDIUM FOR SUSTAINABLE AGRICULTURE

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The agricultural landscape of Garo Hills, a region within the northeastern Indian state of Meghalaya, has been shaped by generations of farmers who have harnessed the area's bountiful natural resources to sustain their livelihoods. One innovative practice that has gained prominence in recent years is the use of fishponds, which have not only provided a reliable source of protein-rich food but also contributed to the overall sustainability of the region's agricultural systems. The establishment of a model fishpond at the College of Community Science in Tura, Meghalaya, marks a significant step towards enhancing the livelihood opportunities for the local communities of the Garo Hills. This initiative aligns with broader efforts to promote sustainable agricultural practices and improve food security in the region. The Garo Hills, with their rich biodiversity and natural resources, offer a unique environment for integrating traditional knowledge with modern aquaculture techniques. This model fishpond is not just an educational tool but a potential driver of economic development and environmental conservation.

The Garo Hills are ideal for fish farming since the region is naturally rich in rivers, streams, and ponds. Many types of freshwater fish thrive in the area, known for its rain and pleasant weather. With a tradition of eating fish deeply rooted in the culture both economically and culturally fish farming is successful, in this region.Farmers can increase their overall resilience to challenges from the environment and the economy and diversify their sources of revenue by combining fish rearing with other farming activities. Several fish species like Rohu (*Labeo rohita*), Grass Carp (*Ctenopharyngodon idella*)and Mrigal (*Cirrhinus mrigala*) are well-suited to the region's conditions.Out of all the species, Grass Carp can be excellent option because of easily available local resources like duckweeds and varieties of grasses.This approach not only cuts down on costs of farming but also aligns with the principles of natural farming, ensuring the fish are raised in an environment friendly way.

The establishment of the fish rearing unit involved several key steps, starting with choosing the right fish species and designing the ponds.The pondwas built to make the best use of water and create a healthy environment for the fish to thrive.These are the procedure for pond preparation in the College of Community Science, Tura, Meghalaya.

- While preparing the pond with polylining, an inlet should be provided to allow rainwater/surface run-off to enter the pond.
- Similarly provide a suitable outlet, preferably at the bottom with a stand pipe to maintain the required depth of water and avoid over flow.
- Once the plastic lining is over,apply atleast 10-15 cm layer of soil over the pond bottom.
- Allow the water to fill with rainwater. Once it is filled upto the desired level, apply lime as per the recommended dose after checking the pH of the water. A pH range of 7-9 is considered favourable for fish growth.
- Seven days after liming apply cow dung @ 200 kg/ bigha or poultry manure @80 kg/bigha or pig dung @ 100 kg/bigha initially.
- Then apply urea @ 1.5kg/bigha and SSP @ 2kg/ bigha. Application of fertilizer and manure shall ensure better growth of planktons-the natural food of fish. Slowly the watercolour turns green. Appearance of greenish colour indicates that there is sufficient growth of fish food organisms, and the pond is ready for stocking fish.

The size of the pond is 28m x 15m *i.e.*, a gross area of 420 m^2, with a depth of 1.5-2 metres. In many areas the soil type is such that it cannot hold water. In such areas, it is essential to seal the pond to reduce seepage and percolation losses. This polythene (HDPE 500 μ) lined ponds can store water which can be readily used to culture fish. To keep the pond water clean and safe, natural farming methods were used, like adding organic materials such as farmyard manure and compost to improve the growth of planktons which acts as feeds for the fishes. Prior to releasing the fishes, water testing was done with the expert from Krishi Vigyan Kendra, South Garo Hills for better survivability of the fishes.

According to the result, nitrite content was found nil while nitrate content was 20-30 ppm.pH was found near neutral *i.*e., 6.8. Alkalinity was found to be 40-60 ppm. These result indicated that there is no need for liming and was found fit for rearing of the fishes. The study also incorporated traditional knowledge from local communities, who have long been skilled in managing water and fish. By blending these traditional practices with modern techniques, the model unit is designed to be both scientifically and culturally effective.

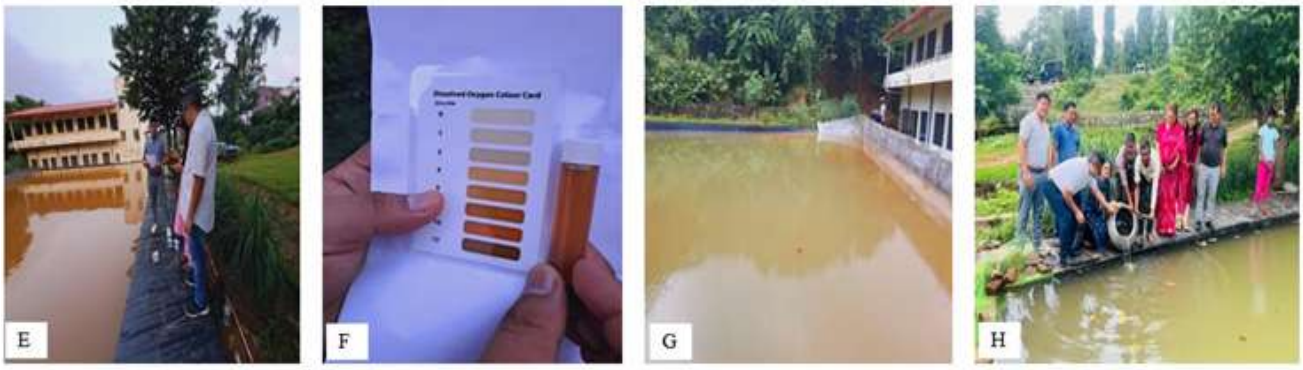
One of the most immediate and noticeable benefits of the model fishpond is its ability to positively impact the local economy. Sustainable fish farming can offer a consistent income for local farmers, who traditionally rely on agriculture that doesn't always provide the best financial returns. In the Garo Hills, where traditional farming is deeply rooted but sometimes limited by seasonal and environmental challenges, aquaculture introduces a new, reliable source of income. By cultivating fish species that thrive in the local environment, the model pond not only boosts fish production but also enhances food security and economic stability for the community, making it more resilient to climate change and other disruptions.

Conclusion

The model fish pond at the College of Community Science in Tura is a groundbreaking demonstration project with significant impact on the local communities of the Garo Hills. It provides a steady livelihood, boosts food security, supports environmental conservation, and honours the region's cultural traditions. As this project grows, it has the potential to inspire similar efforts throughout the region, helping to advance the broader goal of sustainable development in Meghalaya.

A-C: Laying of pond liner

D. Rain water accumulation



E-G. Water testing for fish rearing

H. Release of fishes

(Pic. A model fish rearing plant at the College of Community Science, Tura, Meghalaya)

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MORINGA THE MIRACLE PLANT FOR MANKIND

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Moringa or Drumstick (*Moringa oleifera*) is an important vegetable and almost in all the backyards in rural area have a moringa tree, unlike in urban area. It is also known as Ben oil tree as ben oil extracted from the seeds of moringa. It is a native to Asia and Africa which belongs to Moringaceae family. It is one of the most popular tree vegetables in the south Indian households. In India the cultivation of moringa is mainly confined in Tamil Nadu, Karnataka, Kerala and Andhra Pradesh. In North east region, it is grown in the backyard for family consumption. In Manipur, the important of moringa is becoming aware so initiated planting and consumed by few people (Fig.1). The fruits, leaves and flowers are used in culinary preparation. Immature fruits are cut into pieces and used in several culinary dishes specially called "Sambar" in South India (Fig.2).

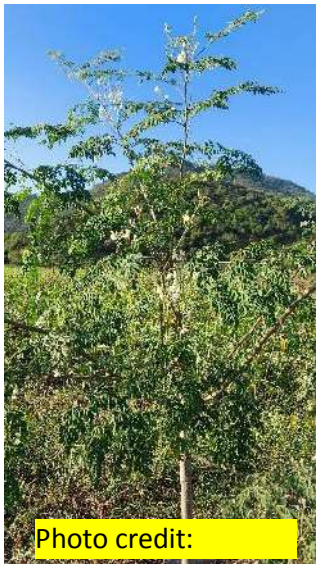

Fig.1: Moringa plant

It is used to protect and nourish skin; hair and it is used to cure all the ailments. Even though moringa tree is available in rural areas in plenty, its presence in urban area is limited. Moringa is a multipurpose vegetable grown widely in India. It is the only vegetable crop in which flower and foliage are more nutritious than the fruits, and has a wide medicinal significance.

Fig.2: Moringa Pods

This vitamin-rich vegetable offers a multitude of benefits, with its leaves, flowers, pods, bark, seeds, and roots all serving as remedies for a variety of human ailments and playing a crucial role in primary healthcare in rural regions (Fig.3). The plant is used for treatment of rheumatism and as cardiac and circulating stimulants. The leaves are commonly consumed as part of salads or in curry dishes, while the seeds contain a non-drying oil known as Ben Oil with up to 40% oil content, used for lubricating, watches, computer, delicate machinery and in artistic applications. Additionally, the wood from the moringa tree can be utilized to produce a blue dye. The oilcake is a water coagulant and used for purifying effluent water.

Fig.3: Moringa flowering

Nutritional Security of Rural Population

The prevalence of food scarcity and malnutrition among the rural population, often attributed to poverty, challenging desert climates, or economic hardships, can be mitigated through the cultivation of moringa. Its leaves are a rich source of five essential vitamins and minerals, including calcium, iron, and vitamins A, E, and K, in addition to being packed with plant protein and dietary fiber. Consequently, the growth of moringa serves as a valuable nutritional resource, significantly improving food security within rural communities. Moringa 100g pods contain 2.5g protein, 8.5g carbohydrates, 4.8g fibre and some calcium, iron, niacin, and vitamin C. It also contains some estrogen hormone like substances including pectinesterase and beta-sitosterol, which is a cancer fighter. The seed has 38.4g crude protein. The root-bark has moringine, and moringinine, both alkaloids. Moringinine is a heart stimulant, raises blood- pressure and affects the sympathetic nervous system and smooth muscles. This versatile crop is also called as Miracle Tree (never die).

Varieties

There are two types of moringa cultivated in India which are perennial and annual.

1. Perennial type:

- Jaffna: The pod is 60-90cm length, soft flesh of good taste, 400 -600 pods bears per tree in a year.
- Chavakacheri murungai: Its pod is 90-120 cm length, 500-600 pods/tree per year.

- Chem Murungai: This variety bears fruit round the years, 400-500 pods/tree, tip of pod is red in colour.
- Palmurungai: It has thicker pulp, better taste, 400-500 pods/tree.
- Puna murungai: It bear 300-400 pods/tree in a year.

2. Annual moringa type:

- Kodikal murungai: The pod is 20-25cm, thick flesh, pod and leaves tastier, grown with betelvine as standard, leaves smaller, propagated by seed.
- KM 1, PKM-1 and PKM-2 are from Tamil Nadu.
- GKVK-1, GKVK-2, GKVK-3 and Dhanaraj are from Bangalore.

Fig.4: Moringa Seeds (Var. PKM1)

Climate and soil

Drumstick is primarily cultivated in dry and arid regions. However, through intensive cultivation with proper irrigation and systematic agricultural practices, it can yield well, particularly for the annual variety. The plant thrives and grows vigorously when the temperature ranges between 25-30°C. High temperatures can lead to excessive flower shedding, while frost can severely damage the crop. Although drumstick can be grown in various soil types, it performs best in sandy loam to clay loam soil that is rich in organic matter. The most ideal pH range for cultivation is between 6.0 - 6.5. it cannot withstand prolonged water logging.

Production Technology

Moringa is a fast growing and drought tolerant crop which can be grown under varied agro-climatic conditions, however, for good production it needs good agricultural practices.

Propagation

Perennial types of the drumstick plant are typically reproduced through the use of limb cuttings, which should measure around 90-100 cm in length and have a diameter of 5-8 cm. however, annual drumstick varieties are propagated by seeds.

The seeds, on average, weigh approximately 0.288 gram and 10 grams of these seeds contain approximately 35 individual seeds. For drumstick cultivation, it is recommended to sow 625 grams of seeds per hectare, a process that can be carried out by either directly placing them in pits or transplanting seedlings that have been nurtured in polythene bags (Fig.5). Seeds are sown during September in South India.


Fig.5: Moringa Seedlings in polybag

Transplanting the seedlings is typically done about one month following the initial sowing. It is prudent to also nurture additional plants in polythene bags to serve as replacements for any gaps in the plantation. The timing for sowing the seeds of annual drumstick varieties or planting limb cuttings varies from one region to another, contingent upon the onset of the monsoon. Normally limb cuttings are planted in situ during the rainy season from June to October.

Land preparation and spacing

Field is ploughed 3-4 times. Apply FYM @ 20 t ha/ha at last ploughing. Dig pits of size 45 x 45 x 45 cm at a spacing of 6.0 x 6.0 m for perennial types and 2.5 x 2.5 m for annual types, apply 10 kg FYM per pit. Three months after sowing, 100:100:50g Urea, SSP and MOP is required to apply per plant.

The Cultivation of Moringa oleifera is a Blessing for the World's Underdeveloped Rural Communities

Moringa, often referred to as "The Miracle Tree," stands out for the remarkable social, environmental, and economic benefits it offers to rural communities. These advantages are just one facet of its recognition.

Local residents can establish a sustainable source of income by cultivating and selling moringa, as opposed to relying on aid. They can market various parts of the tree, including the immature pods, roots, and leaves, either as fresh vegetables or as dried herbs with medicinal uses. The bark, pods, leaves, nuts, seeds, tubers, roots, and flowers of the moringa tree are all edible, and each of these components is renowned for its exceptional nutritional and therapeutic properties (Fig.6).

Fig.6: Nutritional Benefits of Moringa Leaves

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Intensive Moringa Leaf Production

Moringa, whether intended for use as green manure, livestock fodder, or human consumption, offers remarkable potential when cultivated intensively, boasting impressive yields of up to 650 metric tonnes of green matter per hectare. This level of productivity stands out as particularly notable when compared to other green manure crops, such as Indian beans, which typically yield around 110 tonnes of green matter per hectare when grown as a sole crop.

To achieve these high yields, a strategic approach is essential. It entails thorough sub- soiling of the soil to a depth of 60 cm, a process facilitated through the use of a rotavator, which aids in optimizing drainage and fostering robust root development. In this method, planting is carried out at a density of 10 x 10 cm, equivalent to one million plants per hectare, and is supplemented with the addition of appropriate fertilizers, with cow dung often being the preferred choice due to its effectiveness.

Harvesting of the green matter is typically timed when the plants have attained a height of 50 cm or more. This practice is recurrent, occurring every 35 to 40 days, and when harvesting, cutting is executed at a height of 15 to 20 cm above the ground, ensuring that the plant remains to regenerate effectively. It's worth mentioning that while some initial losses of seedlings may range between 20 to 30 percent during the first year of cultivation, the vigorous regrowth of the surviving seedlings is remarkably productive, resulting in the generation of 3 to 5 new shoots after each cutting. Up to nine harvests can be obtained annually. A yield of 650 metric tonnes of leaf yield was obtained in sandy and well-drained soil.

INDIA – Major Supplier of Moringa

India plays a pivotal role in the global supply of moringa, accounting for a substantial 80% share of the worldwide demand. The production of moringa in India primarily occurs on extensive plantations and adheres to conventional farming practices. This approach allows for the mass production of moringa products at cost-effective price points, contributing to India's competitive advantage in the market. This substantial cost-efficiency poses a considerable challenge for smaller-scale moringa suppliers when it comes to price competition with Indian companies. The standardization of moringa leaf powder, particularly with regard to factors like protein content, omega-9, and vitamin E levels, is a focus even for Indian companies, who aim to deliver consistent and high-quality products. Some Indian companies have taken this a step further, registering their moringa-related ingredients as intellectual property, adding a layer of protection to their offerings. Furthermore, Indian companies extend their operations to produce finished products that are based on moringa, showcasing a diverse range of products incorporating the valuable properties of this versatile plant.

Top Moringa Products in Demand

Moringa Leaf Powder

The urgent need for immediate drying of freshly harvested moringa leaves is a critical requirement, and the substantial expenses tied to the transportation of loose dried leaves pose a formidable challenge. Consequently, European Union (EU) buyers frequently find themselves reliant on countries that have the capability to provide moringa in powdered form to efficiently fulfil their growing demands (Fig.7).

Photo credit: Internet

Fig.7: Moringa Powder and capsule

Indian wholesalers distinguish themselves by presenting moringa leaf powder at notably competitive prices, rendering it a particularly appealing option for international buyers seeking cost-effective solutions. The pricing of Moringa Leaf Powder within the global market is intricately linked to several pivotal factors, including the volume of the product, its quality attributes, and the specific application it's intended for.

The wholesale pricing spectrum for Indian moringa leaf powder, which represents the most widely distributed product in this category, displays a notable span ranging from US$2.26 to US$7.90 per pound, with the average price point resting at US$2.97 per pound. Notably, India currently maintains a position of pre-eminence in the worldwide market, successfully catering to over 80% of the global demand for various moringa products.

Moringa Oil

Moringa oil exhibits a wide array of advantageous properties. It contributes to skin nourishment, possesses anti-aging attributes, and enhances hair health. This is primarily attributed to its rich antioxidant content and anti-inflammatory characteristics, which

collectively augment skin complexion and mitigate conditions such as acne. Furthermore, its utility extends to wound healing and the provision of protective measures against environmental stressors. When ingested, Moringa oil demonstrates the potential to reduce low-density lipoprotein (LDL) cholesterol levels and consequently support cardiovascular health. Prior to application, it is prudent to conduct a dermal patch test, and for internal use, consultation with a healthcare professional is advised (Fig.8).

Fig. 8: Moringa Oil

Exotic plant-based oils like moringa often have specific active and functional properties, making them particularly valuable for use in cosmetic products. Following health and wellness trends. Western consumers increasingly prefer cosmetics with ingredients derived from plants, rather than mineral oil. Wholesale prices for moringa oil exported from India ranged near average price of US $32.13/L (minimum US$18.5/L, maximum US $79.64/L).

VETERINARIAN AS AN EXTENSION EDUCATOR

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Extension Education is an applied behavioural science consisting of the contents derived from experiences, researches and principles of other branches of social sciences like psychology, sociology, anthropology, synthesized into a useful body of knowledge aimed at bringing desirable changes in the behaviour (knowledge, attitude and skill) of an individual through out of school non-formal education to improve his family, his community and thereby his nation.

For this, an extension educator has to be a teacher, guide, friend and philosopher to the clients—the villagers, the farmers, the livestock keepers. But, it is easier said than done. Nonetheless, possessing the right attitude and aptitude is essential for a good extension


Illustration: Author

educator. A bachelor of veterinary sciences and animal husbandry (BVSc&AH) is eligible to become a veterinary officer competent to carry out the job of extension educator at village level.

Veterinary Extension Educator

Initially, a veterinary officer may be perceived as an outsider by the local people. But, over time (s)he may become the teacher, guide, friend and philosopher

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to the villagers making him aware of the situation, problem, need and aspiration of the clients.

Besides teaching clients how to rear animals in a better way and organize themselves in cooperatives and other farmers' organizations, a veterinary officer can play the role of an extension educator bringing desirable changes in behaviour—knowledge, attitude and skill—of clients following the philosophy and principles of extension education.

Change in Knowledge

Whenever a client visits the veterinary officer at her dispensary or vice-versa there will always be an exchange of ideas, views, information, intelligence, and news. Knowledge can be imparted through dissemination of information. Low-cost technology can be transferred without much effort.

Example: Feeding of paddy straw to cattle is common in rural India. If a farmer does not chop straw and use salt in water, (s)he may be advised to chop straw, soak in water, add common salt, if possible molasses, and feed the cattle. The farmer will be benefited with information and little extra effort.

Change in Attitude

Attitude is the perception of an individual towards an object, event, idea, or person. Attitude is conditioned by socio-cultural context and is relatively permanent. Different methods are required to be employed for change in attitude.

Example: Adoption of artificial insemination (AI) in cattle requires a change in attitude. Relatives, neighbours and friends have a greater role in attitude change. Attitude can be changed based on the principle of "seeing is believing". If one sees the benefit of rearing cross-bred animals in the neighbourhood, (s)he may be convinced.

Change in Skill

Skill change is not as difficult as attitude. To bring a change in the skill, the principle of "learning by doing" is the best policy. Training is the best method for change in skill. Clients may be trained in basic skills of veterinary and animal husbandry.

Example: In rural India, basic veterinary service is still unavailable and inaccessible to a large extent. On the first day, the client can get his animal injected at the dispensary. But if (s)he does not know how to administer, at least an intra-muscular injection (IMI), (s) he has to depend on somebody for the purpose.

Conclusion

Among the various extension teaching and communication methods—individual, group and mass methods—veterinary officer has to select a few, and use them in combination suitable for the purpose and need of his clients—the livestock keepers.

Proper selection and combination of methods is essential, for every method has its advantages and disadvantages. As a rule of thumb, if the purpose is to change "knowledge", mass method; if the purpose is to change "attitude", group method; and if the purpose is to change "skill", individual method; are useful.

KITCHEN GARDEN/ NUTRITION GARDEN

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Home gardening or homestead gardening is a rewarding, healthful and enjoyable hobby for children and other family members. It can provide fresh, nutritious and choice vegetables continuously round the year. Unfortunately vegetable growing in home garden is almost vanishing due to shrinking of open space around dwellings in large cities as a result of increased urban population and high rise residential buildings and commercial complexes. However, growing of vegetables in backyard of houses needs to be encouraged in rural areas so that the daily vegetable consumption of the village population can be increased which is presently lower than the recommended dietary allowance per capita. In China, homestead gardening on 8 per cent of arable land produces 21 per cent of the total vegetable production in the country. The value of vegetables produced in the home gardens in the USA is more than US $ one billion annually. About 40 per cent of the agricultural production in Russia is from homestead gardening.

Location

The home garden is usually located at the backyard of the house or on one side of the house. However, its location depends on the site of the house. The home garden should be preferably on the southern side receiving full sunlight without any shade of nearby trees or buildings. A well-drained level location having medium loam or sandy loam soil is ideal for the home garden.

Size and Layout

The size of home garden will depend upon the number of family members and the space available. A kitchen garden of 250-300 sq. metres is suitable for a small family of 3-4 persons. Perhaps it may not be possible to meet the entire daily requirement of vegetables for the family from the home garden. Nevertheless, it can provide many kinds of fresh vegetables superior in quality than those available in the market.

If the space for home garden is limited, one can grow some vegetables also in containers, such as, tomato, eggplant, chillies, and sweet pepper in pots and leafy vegetables, like palak, amaranth, coriander, mint, methi, fennel (sounf), dill (sowa), lettuce and parsley in wooden boxes or pots.

People living in apartments can grow vegetables in pots or boxes in limited numbers and keep them on terrace or balcony which gets full sunlight.

Climbing types of vegetables, like hyacinth bean (sem), bitter gourd, bottle gourd, ridge gourd, smooth gourd, french bean (climbing), cowpea (climbing) may be planted near the fence or boundary of the garden and trained on trellis. Cucurbits, like bottle gourd, pumpkin, luffa gourds, muskmelon and watermelon which have long vines should not be grown on the ground as they will occupy large spaces. Root crops (radish, carrot, turnip, beet) can be grown on ridges along the borders of the plots.

Selection of vegetables

The vegetables to be grown in a home garden depends upon the choice of the family members and the size of the garden. Preference may be given to freshness of leafy and seasoning vegetables (palak, amaranth, lettuce, methi, onion, garlic, turmeric, ginger, coriander, sowa), and peas and beans, and those vegetables that have multiple harvesting (tomato, chillies, brinjal, okra, peas, beans etc.) unlike cabbage or cauliflower. Vegetables having good nutritive value and early maturity may also be selected for kitchen garden. Some people may like to grow speciality vegetables, like broccoli, celery, parsley, endive, chive, pakchoi, basil, asparagus, artichoke, red cabbage, coloured (red and yellow) sweet pepper and small pickling cucumber. Those vegetables taking large space for growing (melons, watermelon, pumpkin etc.) are not suitable for growing in a home garden.

Cultural practices

Vegetables can be grown by seeds (okra, root crops, peas, beans. amaranth, palak. methi, coriander, etc.) or by transplanting seedlings (tomato, eggplant, chillies, sweet pepper, onion, cabbage, cauliflower, broccoli, knolkhol, etc.). Parval (pointed groud) is raised by planting rooted cuttings, potatoes by tubers, multiplier onions by small bulbs and garlic by cloves. In a limited garden space it may be useful to follow multiple cropping systems like intercropping, mixed cropping, relay cropping and succession cropping.

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In a home garden use of chemical fertilizers and pesticides should be avoided or used judiciously. Use of manures, like farmyard manure, compost, cowdung manure, oil cake, vermicompost and green manuring are safe to human health and environment-friendly. Vermiculture may be adopted for producing vermicompost utilizing kitchen wastes. Nowadays organic farming practices and integrated pest management are being advocated for home gardening.

Generally furrow irrigation is practised to supply water to plants. Water from tubewell or borewell is used for irrigation. Drinking water from house taps should not be used for irrigation.

Nowadays harvesting of rain water is being encouraged in urban areas. Rain water collected in large plastic tanks can be used for irrigation.

A combination of practices is necessary since no single practice is effective for all disease that threaten production of a given crop. Some of the plant protection measures that can be followed are use of resistant vegetable varieties wherever is available. Seed treatment with Pseudomonas fluorescens or Trichoderma harzianum or Trichoderma viride @ 1-2 g/100 g seed. Follow crop rotation atleast one legume in a cycle of one year. Remove and dispose of the diseased plants.

Conclusion

Therefore it is need of the hour in meeting the requirements of nutritive food at farm level only. It not only helps to meet the nutritional benefits of the families but also contribute towards the income of the farming family through reduction in food expenditure as well on medical expenses. To ensure a healthy diet women and youth in villages must be educated and trained about role of macro and micronutrients, importance of cultivating variety of vegetables and fruits in nutri- garden to have diet diversity. Vegetable based nutri-garden is the richest source of nutrition and can play an active role in eradicating under nutrition. Nutri-garden is advanced form of kitchen garden in which vegetables are grown as a source of food and income. For small and marginal farmers, nutri- garden can generate a critical contribution to the family diet and provide several other benefits, particularly for women.

MICROBIAL ANTAGONIST AND PHAGE THERAPY: EMERGING BIOLOGICAL APPROACHES AGAINST RALSTONIA SOLANACEARUM

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Introduction

Bacterial wilt of solanaceous crops, caused by *Ralstonia solanacearum* is a highly destructive disease affecting economically significant solanaceous crops globally causing yield loss 15-95%. This soil-borne vascular disease affects over 450 plant species and found in tropical, subtropical, and warm temperate regions worldwide.

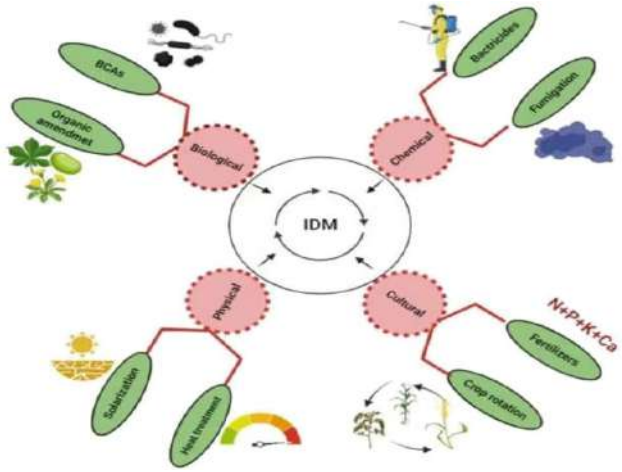

Fig. 1. Different management strategies used for the management of *R. solanacearum*.

Symptoms of bacterial wilt include initial yellowing of the upper leaves, followed by complete wilting of the infected plant within a few days in congenial environment conditions. Infected stems show brown discoloration in the vascular tissues, and a white or yellowish bacterial ooze may be seen when the stem is cut crosswise.

R. solanacearum typically infects the root xylem tissues of plants, including both susceptible and resistant varieties, by entering through natural opending like stomoata, lenticels, hydathoodes and small wounds and quickly spread to entire plants.

Managing bacterial wilt is challenging due to the wide host range of *the pathogen* and its ability to survive in soil and non-host plant roots, including various weeds. Managing the pathogen in infested soils is very difficult. Crop rotation with non-host crops is generally ineffective because of the pathogen's wide host range. Currently, there are no conventional bactericides known for its effectively management of the soil-borne pathogen. Traditional soil treatments with fumigants like methyl bromide have also proven unsatisfactory.

Various management practices have been developed for the management of bacterial wilt (BW) disease caused by *R.solanacearum*, like biological, chemical, physical and cultural but achieving efficient management strategies with both eco-friendly approachupto the desired level remains a challenge. Effective management methods are needed to eradicate this detrimental disease in numerous crops under field conditions. In this article, we discussed and analyzed the information reported on the biological management strategies for the management of *R.* solanacearum.

Biological Approaches

Biological approaches utilize natural agents, enemies, or bio-based products derived from animals, plants, or microbes to manage pests. The primary goal of biological approaches is to reduce or eliminate the reliance on chemical pesticides while effectively managing the pests. Selection of biological approaches depends on factors such as the type of host plant, environmental conditions, target pest species, and its life cycle patterns.

Biocontrol Agents

The adoption of biological control agents has increased compared to chemical control methods due to several advantageous characteristics they possess. These include long-term disease suppression, reduced reliance on nonrenewable resources, and self-sustaining capabilities etc. Despite the scarcity of effective biocontrol agents for managing bacterial wilt, there is growing interest in using biocontrol microbes. Various studies have explored the antibacterial potential of microbes such as bacteria, fungi, and bacteriophages against *R. solanacearum.*

Bacteria

The utilization of bacteria as biological control agents (BCAs) has been extensively explored for managing *R. solanacearum*, with promising results reported in various studies. Here are some key findings:

1. *Enterobacter cloacae*: Isolates from potato plants showed 26.5% suppression of bacterial wilt disease.
2. *Paenibacilluspolymyxa*: Found in potato soil, it caused an 80% reduction in bacterial wilt.
3. Endophytic and rhizobacteria: Species such as Bacillus, *Paenibacillus*, *Pseudomonas*, and *Serratia* have demonstrated potent biocontrol activity against bacterial wilt in various crops.
4. *Bacillus subtilis*: Seed endospheric bacteria of chili variety "Firingi" achieved an 86% reduction in chili bacterial wilt.
5. *Pseudomonas* species: *P. aeruginosa* and *P. syringae* effectively managed bacterial wilt in tomato through host resistance and antibiosis.
6. *Bacillus velezensis*and *Staphylococcus warneri*: Isolated from Gnetumgnemon plants, these strains exhibited antibiosis against *R. solanacearum* and promoted plant growth in tomatoes under bacterial wilt stress.
7. *Bacillus cereus* AR156: Isolated from forest rhizospheric soil, it demonstrated a 62.2% biocontrol effect against tomato bacterial wilt.
8. *Bacillus amyloliquefaciens*: Strain ZM9 from the tobacco plant rhizosphere managed tobacco bacterial wilt.
9. *Pseudomonas sp.* Y8 and *B. amyloliquefaciens* Y4: Field applications of these strains resulted in a 3-4-fold reduction in tobacco bacterial wilt disease.
10. *B. amyloliquefaciens* FZB42 and *Bacillus artrophaeus* LSSC22: Produced volatile compounds effective against *R. solanacearum.*

Furthermore, studies have highlighted the increasing utilization of *Bacillus amyloliquefaciens* as a biocontrol agent against *R. solanacearum*, indicating its effectiveness in managing bacterial wilt. Additionally, actinobacteria have demonstrated antibacterial potential against *R. solanacearum* through various mechanisms, including the induction of host resistance, production of extracellular degrading enzymes, and siderophore production.

In a recent development, effective apoplastic microbes from ginger plants have been utilized for biocontrol management. Isolation and screening of 87 isolates from ginger apoplastic fluid revealed active strains belonging to families such as *Enterobacteriaceae, Bacillaceae, Staphylococcaceae,* and *Pseudomonadaceae.*

Among these, *Bacillus licheniformis* showed promising results in reducing disease incidence when

applied via soil drenching and seed priming methods. In field tests involving soil solarization and application of *B. licheniformis*, a significant reduction in the population of *R. pseudosolanacearum* was observed, leading to complete suppression of ginger bacterial wilt. This integrated approach represents a successful method for controlling the disease, with *B. licheniformis* being promoted as a potential treatment under the product name "Bacillich."

Fungi

In addition to bacteria, certain fungal strains have demonstrated biocontrol efficacy against R. solanacearum:

1. *Trichoderma viride*: Studies have reported its antibacterial potential against *R. pseudosolanacearum,* based on findings from *in vitro* and greenhouse testing.
2. *Glomus versiforme*: Inoculation of this fungus resulted in a significant reduction in *R. solanacearum* population on the root surface, rhizosphere, and xylem of tomato plants. Colonization of plants by both *R. solanacearum* and *G. versiforme* led to higher concentrations of root phenols, potentially inducing host resistance.
3. *Pythium oligandrum*: This fungus has shown biocontrol potential in suppressing bacterial wilt disease. It induces host resistance to *R. solanacearum* through the action of cell wall proteins and regulation of the ethylene signaling pathway.
4. Secondary metabolites from *Trichoderma* spp.: In vitro growth of *R. solanacearum* was inhibited by these metabolites.
5. *Parmotrema tinctorum*: A lichen fungus, along with three other fungi including *Scutellospora sp.,G.* margarita, and G. mosseae, has been identified as potent biocontrol agents against bacterial wilt disease.

These findings highlight the diverse range of fungal species with biocontrol potential against R. *solanacearum*, offering promising avenues for biological management of bacterial wilt in crops.

Bacteriophages

Bacteriophages have shown promising biocontrol effects against bacterial wilt (BW), particularly in managing *R. solanacearum*:

1. Tobacco Bacterial Wilt: Evaluation of bacteriophages for managing tobacco bacterial wilt revealed a limited host range.
2. Banana Bacterial Wilt: Ramírez *et al.* (2020) demonstrated the control of *R. solanacearum* in banana plants using lytic bacteriophages isolated from banana-cultivated soil.
3. Waterborne Phages: Álvarez *et al.* (2019) successfully utilized a waterborne phage to control *R. solanacearum* in irrigation water.
4. Molecular Mechanisms: Ongoing research is focused on understanding the molecular mechanisms employed by phages for the biocontrol of R. solanacearum. Biosca *et al.* (2021) conducted genomic analysis of phages with depolymerase activity, aiming to enhance the biological control of the pathogen.
5. Host Specificity: Studies by Yamada *et al.* (2007) isolated and characterized various phages based on their infection of specific *R. solanacearum* biovars or strains. Rhizosphere bacteriophages collected from ginger soil showed host specificity, with isolated phages effectively targeting pathogens from the same geographical area.

These findings underscore the potential of bacteriophages as effective biocontrol agents against *R. solanacearum*, offering targeted and environmentally friendly solutions for managing bacterial wilt in various crops.

Conclusion

The biological management of *R. solanacearum* presents a promising, eco-friendly alternative to chemical and traditional methods, offering sustainable solutions to the persistent problem of bacterial wilt in economically significant crops. The utilization of biocontrol agents such as bacteria, fungi, and bacteriophages, demonstrates significant potential in suppressing this destructive pathogen.

Biocontrol agents like *Bacillus, Pseudomonas*, and *Trichoderma* species have shown effective suppression of *R. solanacearum* through various mechanisms including antibiosis, induction of host resistance, and production of extracellular degrading enzymes. The application of bacteriophages provides a targeted approach to manage bacterial wilt, particularly in crops like tobacco and banana, while also offering insights into the pathogen-specific interactions within the rhizosphere.

Overall, the advancements in biological control strategies underscore the importance of continued research and innovation in this field. By refining these methods and integrating them into comprehensive disease management programs, we can achieve more effective and sustainable control of bacterial wilt, ensuring better crop yields and agricultural resilience against this pervasive pathogen.

ROLE OF CAU, IMPHAL IN FORMATION AND PROMOTION OF FPOS IN NORTH EAST INDIA

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Ministry of Agriculture and Farmers Welfare, Government of India launched a pilot programme for promoting member-based Farmer Producer Organisations (FPOs) during 2011-12, in partnership with state governments, which was implemented through the Small Farmers' Agribusiness Consortium (SFAC). The pilot involved the mobilisation of approximately 2.50 lakh farmers into 250 FPOs (each with an average membership of 1000 farmers) across the country, under two sub-schemes of the Rashtriya Krishi Vikas Yojana (RKVY), namely National Vegetable Initiative for Urban Clusters and Programme for Pulses Development for 60,000 Rainfed Villages. The purpose of the project is to collectivise farmers, especially small producers, at various levels across several states, so as to foster technology penetration, improve productivity, enable improved access to inputs and services and increase farmer incomes, thereby strengthening their sustainable agriculture based livelihoods. SFAC is supporting these FPOs through empanelled Resource Institutions (RIs), which provide various inputs of training and capacity-building, and linking these bodies to input suppliers, technology providers and market players. SFAC is also monitoring the project on behalf of the Dept. and the states and reporting on its progress. The pilot has already shown encouraging results and more than 3.00 lakh farmers are presently mobilised into village-level Farmer Interest Groups (FIGs), which are being federated into registered FPOs. Besides empowering farmers through collective action, these grassroots bodies are emerging as nodal points for the transmission of cultivation technology, inputs and credit and pooling their production to leverage the market for better prices. To mainstream the process of institutional development of Farmer Producer Organisations, Govt. is issuing these guidelines to encourage states to directly support FPO promotion as a regular activity under RKVY during the XII Plan. These guidelines are meant to help he states follow a standard methodology for FPO promotion, as well as to provide indicative costs and a monitoring framework. States may directly engage RIs (such as NGOs, private companies, research bodies, cooperatives, farmers' groups) to mobilise farmers (in which case they are advised to follow open bidding norms suggested in these guidelines). Alternatively, they can invite SFAC to empanel suitable RIs on their behalf. A third option would be to award the work directly to SFAC, to undertake FPO promotion on behalf of the State, by providing the necessary budget to SFAC from the RKVY head. States are free to choose their preferred option. The primary objective of mobilising farmers into member-owned producer organisations, or FPOs, is to enhance production, productivity and profitability of agriculturists, especially small farmers in the country. The participant farmers will be given the necessary support to identify appropriate crops relevant to their context, provided access to modern technology through community-based processes including Farmer Field Schools; their capacities will be strengthened and they will be facilitated to access forward linkages with regard to technology for enhanced productivity, value addition of feasible products and market tie-ups. Farmers will be organised into small neighbourhood informal groups which would be supported under the programme to form associations/organisations relevant to their context including confederating them into FPOs for improved input and output market access as well as negotiating power.

The objectives of FPO are

1. Mobilising farmers into groups of between 15-20 members at the village level (called Farmer Interest Groups or FIGs) and building up their associations to an appropriate federating point i.e. Farmer Producer Organisations (FPOs) so as to plan and implement product-specific cluster/commercial crop cycles.
2. Strengthening farmer capacity through agricultural best practices for enhanced productivity.
3. Ensuring access to and usage of quality inputs and services for intensive agriculture production and enhancing cluster competitiveness.
4. Facilitating access to fair and remunerative markets including linking of producer groups to marketing opportunities through market aggregators.

FPOs are based on the values of self-help, self-responsibility, democracy, equality, equity and solidarity. FPO members must believe in the ethical values of honesty, openness, social responsibility and caring for others.

The Principles of FPO are

1st Principle: Voluntary and Open Membership FPOs are voluntary organisations, open to all persons

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able to use their services and willing to accept the responsibilities of membership, without gender, social, racial, political or religious discrimination.

2ND PRINCIPLE: Democratic Farmer Member Control- FPOs are democratic organisations controlled by their farmer-members who actively participate in setting their policies and making decisions. Men and women serving as elected representatives are accountable to the collective body of members. In primary FPOs farmer-members have equal voting rights (one member, one vote) and FPOs at other levels are also organised in a democratic manner.

3RD PRINCIPLE: Farmer member Economic Participation- Farmer members contribute equitably to, and democratically control, the capital of their FPO. At least part of that capital is usually the common property of the FPO. Farmer-members usually receive limited compensation, if any, on capital subscribed as a condition of membership. Farmer-members allocate surpluses for any or all of the following purposes: developing their FPO, possibly by setting up reserves, part of which at least would be indivisible; benefiting members in proportion to their transactions with the FPO; and supporting other activities approved by the members.

4TH PRINCIPLE: Autonomy and Independence- FPOs are autonomous, self-help organisations controlled by their farmer-members. If they enter into agreements with other organisations, including governments, or raise capital from external sources, they do so on terms that ensure democratic control by their farmer-members and maintain their FPO's autonomy.

5th Principle: Education, Training and Information- FPOs operatives provide education and training for their farmer-members, elected representatives, managers, and employees so that they can contribute effectively to the development of their FPOs. They inform the general public – particularly young people and opinion leaders – about the nature and benefits of FPOs.

6TH PRINCIPLE: Co-operation among FPOs- FPO serve their members most effectively and strengthen the FPO movement by working together through local, national, regional and international structures.

7TH PRINCIPLE: Concern for the Community- FPOs work for the sustainable development of their communities through policies approved by their members.

Central Sector Scheme on Formation and promotion of 10,000 FPOs

The agricultural industry is crucial to both national and economic development. India is leading the world in agricultural development. Over 86 percent of farmers in the nation are tiny and marginal, nevertheless. To encourage our farmers to produce higher-quality produce, it is necessary to give them access to better technology, loans, better input, and more markets. With a clear strategy, committed resources, the Indian government has started a new Central Sector Scheme called "Formation and Promotion of 10,000 Farmer Produce Organizations (FPOs)". For the purpose of utilising economies of scale and enhancing market access for members, FPOs are to be formed in produce clusters where agricultural and horticultural produces are grown/ farmed. Under this Central Sector Scheme with funding from Government of India, formation and promotion of FPOs are to be done through the Implementing Agencies (IAs), viz., Small Farmers Agri-Business Consortium (SFAC), National Cooperative Development Corporation (NCDC), National Bank for Agriculture and Rural Development (NABARD), National Agricultural Cooperative Marketing Federation of India (NAFED), North Eastern Regional Agricultural Marketing Corporation Limited (NERAMAC), Tamil Nadu-Small Farmers Agri-Business Consortium (TN-SFAC), Small Farmers Agri-Business Consortium Haryana (SFACH), Watershed Development Department (WDD), Karnataka and Foundation for Development of Rural Value Chains (FDRVC), Ministry of Rural Development (MoRD) and Central Agricultural University (CAU) Imphal. NGO, registered society, trust, cooperative, pvt. company etc. as Cluster Based Business Organizations (CBBOs) will be appointed by Implementing Agencies (IAs) to collect, register and offer each FPO expert handholding support for a period of five years. CBBOs will serve as the forum for comprehensive knowledge of all problems relating to FPO promotion.

Aims and Objectives of the Scheme

1. To create 10,000 new FPOs with a comprehensive and wide-ranging supportive environment in order to promote the growth of thriving, sustainable income-oriented farming and the socioeconomic development and general well-being of rural communities.
2. To increase productivity through resource utilisation that is economical, efficient, and sustainable; to achieve higher profits on their produce through better market connections and liquidity; and to become sustainable through group effort.
3. To assist new FPOs in all facets of management, including inputs, production, processing, and value addition, market links, credit links, technology use, etc., for up to five years following the year of inception.

4. To effectively improve FPOs' capacity for entrepreneurial development in agriculture so they can become self-sufficient and economically sustainable after their government support has ended.

Broad Services and Activities to be undertaken by FPOs

The FPOs may provide and undertake following relevant major services and activities for their development as may be necessary supply high-quality production inputs at competitive wholesale prices, including seeds, fertiliser, insecticides, and other inputs; make equipment for production and post-production available as needed, andequipment such as a combine harvester, tiller, sprinkler set, and moreequipment and machines on a custom-hire basis for participants to lower the per2cost per unit produced; make value-adding services like cleaning, assaying, sorting, grading, packing, as well as farm level processing facilities, available on a user fee basis at a reasonable price. The provision of storage and transportation facilities is also possible; start higher-paying businesses like seed production, beekeeping, mushroom farming, etc.; aggregate smaller lots of the produce produced by farmer-members; add value to increase their marketability; promote market information about the produce to enable wise production and marketing decisions; encourage the sharing of costs for logistical services such loading and unloading, transportation, and storage; offer better and more lucrative prices for the combined produce in the marketing channels and advertise it to buyers with stronger negotiating skills.

In order to qualify for the programme, an FPO must have a minimum of 300 farmer members in plains and 100 in north-eastern and hilly areas (including those in other UTs).A group of 15-20 farmers who are cooperatively located and share a similar interest are to be organised under the names Farmer Interest Group (FIG), Self Help Group (SHG), Farmers Club (FC), Joint Liability Group (JLG). To be eligible under this scheme in the plains, these 20 or more groups from a produce cluster area or a village or cluster of nearby villages based on certain commonalities must be combined to form an FPO with a minimum farmer-members size of 300, while in the hilly and north-eastern regions, 7-8 groups must be combined to form an FPO with a minimum farmer-members size of 100. In order to increase the effectiveness and inclusivity of FPOs, it may be especially important to include SC/ ST farmers, women's SHGs, small-scale, marginal, and female farmers as members.

Through intensive awareness campaigns and concerted efforts, FPO establishment in aspirational areas would be given priority. FPOs will also be made economically sustainable through proper support, handholding, training, and skill development. The development and promotion of FPOs in the country's notified tribal areas would receive top priority from the implementing authorities in order to support the forest and minor forest products produced by tribal populations. The Tribal Community and North-East Region should benefit from the Scheme in collaboration with the Tribal Affairs Ministry, DONER, and North Eastern Council in terms of increased market access, value addition, technology, credit, and processing (NEC). Existing FPOs will also be able to take advantage of pertinent benefits, if they haven't already done so under any Government of India programmes, such as the Credit Guarantee Fund and National Project Management Agency's (NPMA's) advising services under the 5 Scheme. The Scheme will also cover FPOs that are already registered but have not received funding under any other programmes and have not yet begun operations.

Duties and Responsibilities of Implementing Agency (IA)

1. Implementing Agencies will collaborate closely with CBBOs to make sure they carry out their duties in a way that makes FPOs economically viable.
2. Implementing Agencies will also keep an eye on CBBOs to guarantee consistent data submission on an integrated portal with regard to specific FPO details.
3. Implementing Agencies may conduct business through their MIS portal until an integrated portal is established to guarantee database homogeneity on FPO. In order to ensure smooth data transfer and to work in coordination with Integrated Portal design and requirements, Implementing Agencies will need to ensure interoperability with Integrated Portal once national level Integrated Portal managed by National Project Management Agency (NPMA) is in place.
4. According to the established protocol, NABARD and NCDC will maintain and manage the Credit Guarantee Fund (CGF).
5. Implementing Agencies will develop grading methods for FPOs in conjunction with DAC&FW to evaluate them in terms of activity level, economic viability, sustainability, etc. The evaluation of the FPOs may be a tool for promoting the FPOs.
6. The Project Management Advisory and Fund Sanctioning Committee (N-PMAFSC) will review the Annual Action Plan that the Implementing

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Agencies have prepared and submitted to DAC&FW in advance, together with the required Utilization Certificate.

7. As directed by Govt. the Implementing Agency will work with the relevant Value-Chain Organization(s) to coordinate the formation and promotion of FPOs by those organisations, as well as the costs associated with managing FPOs and using prior funds, as well as any requirements for equity grants, in order to channel their claim to N-PMAFSC for payment. 8. In order to manage the increasing number of FPOs and their activities, other implementing agencies may, with the prior approval of DAC&FW, establish their own monitoring and data management units for FPOs. However, they will collaborate with NPMA to provide all necessary input as the national level data repository.

Duties and Responsibilities of Cluster Business Based Organization (CBBO)

1. Assist in the implementation of the programme as per scheme guideline.
2. Assist IA in cluster identification.
3. Assist in community mobilization- baseline survey, cluster finalization, value chain study, formation of groups and FPO.
4. Registration of FPOs.
5. Training and capacity building of FPOs.
6. Encourage and promote social cohesiveness amongst members of FPOs.
7. Preparation and execution of Business Plan for long term sustainability of FPOs.
8. Assist in regular interface with stakeholders.
9. Assist in availing equity grant and credit guarantee facility.
10. Incubation and hand holding.

The creation and promotion of FPOs will increase cost-effective production, productivity, and member net incomes. The main aim of the FPO is to ensure a better income for the producers through an organization of their own. Small producers do not have the volume individually to get the benefit of economies of scale. In agricultural marketing, there is a chain of intermediaries, who often work non-transparently leading to the situation, where producer receives only a small part of the value, which the ultimate consumer pays. This will be eliminated. Through accumulation, the primary producers can avail the benefit of the economies of scale. Farmers Producers have better bargaining power in the form of bulk buyers of produce and bulk suppliers of inputs.

The Ministry of Agriculture & Farmers Welfare, Government of India has designated the Central Agricultural University (CAU), Manipur as Implementing Agency (IA) for Formation and Promotion of 60 FPOs in NER except Assam under the Central Sector Scheme (CSS) for Formation and Promotion of 10,000 FPOs vide order No. 28011/1/2020-M-II (Pt-I)/86049 dated 21/09/2022. Under the scheme mentioned above, CAU, Imphal has empanelled 15 nos. of CBBOs and 60 nos. of FPOs have been formed. The details of the FPOs formed are given in state wise below.

(A) Table 1. FPOs registration in the state of Manipur

SN	Name of CBBO	Block	District	Name of the FPO Promoted
1.	Indian Development Foundation	Island	Kangpokpi	Koubru Agro Farmer Producer Company Limited
2.	Women Income Generation Center	Bishnupur	Bishnupur	Imaloktak Farmers Producer Company Limited
3.	Women Income Generation Center	Khangbarol	Chandel	Thumleima Organic Farmers Producer Company Limited
4.	Women Income Generation Center	Nungba	Noney	Yotleima Organic Farmer Producer Company Limited
5.	Women Income Generation Center	Moreh (Kwatha)	Tengnoupal	Kounuleima Kwatha Farmers Producer Company Limited
6.	Humanism Foundation	Khetrigao CD block	Imphal East	Loushang Farmers Producer Company Limited
7.	Manipur Institute for Health and Social Development	Wangoi	Imphal West	Mayai Lambi Farmers Producer Company Limited

8.	Manipur Institute for Health and Social Development	Bungte Chiru	Kangpokpi	Tingkai Khunou Farmers Producer Company Limited
9.	Manipur Institute for Health and Social Development	Champhai	Kangpokpi	Chumphai Farmer Producer Company Limited
10.	Manipur Institute for Health and Social Development	Henglep	Ccpur	Khoushabung Farmers Producer Company Limited
11.	Social Action for Tribal and Background Classes (TRIBAC)	Paomata	Senapati	Paomata Agro Farmer Producer Company limited
12.	Social Action for Tribal and Background Classes (TRIBAC)	Saitu Gamphazol	Kangpokpi	Saitu Gangphazol Agro Farmer Producer Company Limited
13.	KVK, Thoubal	Lilong Cd Block	Thoubal	Apunba Loumee Farmer Producer Company Limited
14.	Aromatic Medicinal Plants and Socio Economic Development Society	Longmai	Noney	Sangdai Fuam Farmers Producer Company Limited
15.	Aromatic Medicinal Plants and Socio Economic Development Society	Sahamphung TD Block	Kamjong	Huirangya Farmers Producer Company Limited
16.	Yaiphabi Handloom Weavers Co-Operative Society Ltd.	Tengnoupal	Tengnoupal	Yaiphabi Farmer Producer Company Limited
17.	Royal Natural Stones Pvt. Ltd.	Phungyar	Kamjong	Imaram Farmer Producer Company Limited
18.	Royal Natural Stones Pvt. Ltd.	Haochong	Noney	Sangdai Fuam Farmers Producer Company Limited
19.	Royal Natural Stones Pvt. Ltd.	Tamenglong	Tamenglong	Makam Tammenlong Crop Producer Comapny Limited
20.	Village India Kalyan Sansthan	Chingai	Ukhrul	Eaho Tribal Women Farmer Producer Company Limited
21.	Permaculture & Jaivik Khetiki Foundation	Kasom Khullen	Kamjong	Kasom Khullen Block Mayo Farmer Producer Company Limited
22.	Permaculture & Jaivik Khetiki Foundation	Patsoi	Imphal West	Patsoi Block Integrated Farmer Producer Company Limited

(B) Table 2. FPOs registration in the state of Arunachal Pradesh

SL.	Name of CBBO	Block	District	Name of the FPO Promoted
1.	Women's Income Generation Centre (WIGC)	Kaying	Siang	Kaying Farmers Producer Company Limited
2.	Women's Income Generation Centre (W)	Dirang	West Kameng	Anouba Asha Farmers Producer Company Limited
3.	Women's Income Generation Centre (WIGC)	Daring	Lepa Rada	Daring Organic Farmers Producer Company Limited

4.	Women's Income Generation Centre (WIGC)	Kalaktang	West Kameng	Kalaktang Women Farmers Producer Company Limited
5.	Women's Income Generation Centre (WIGC)	Nafra	West kameng	Yaikubi Farmers Producer Company Limited
6.	Women's Income Generation Centre (WIGC)	Monigong	Shi Yomi	Shiyomi Royal Farmers Producer Company Limited
7.	Tirap Community Resource Management Society (TCRMS)	Palin	Kra Daadi	Palin Spices Farmers Producer Company Limited
8.	Tirap Community Resource Management Society (TCRMS)	Pip Sorang	Kra Daadi	PIP Sorang Spices Farmers Producer Company Limited
9.	Tirap Community Resource Management Society (TCRMS)	Tawang	Tawang	Tawang Green Farmer Producer Company Limited
10.	Tirap Community Resource Management Society (TCRMS)	Thingbu	Tawang	Thingbu Green Spring Farmer Producer Company Limited
11.	Tirap Community Resource Management Society (TCRMS	Yangte	Kra Daadi	Yangte Spice hub Farmer Producer Company Limited
12.	Tirap Community Resource Management Society (TCRMS	Baririjo	Upper Subansiri	Baririjo Agro Culture Farmer Producer Company Limited
13.	Tirap Community Resource Management Society (TCRMS	Zemithang	Tawang	Zemithang Healthy Harvest Farmer Producer Company Limited
14.	Tirap Community Resource Management Society (TCRMS	Lumla	Tawang	Jetsun Milarepa Agro Farmer Producer Company Limited
15.	Previlege Advisory Services Private Limited (PASPL)	Gangte	Kra Daadi	Kurung Kumey Todum Agro Producer Company limited
16.	Previlege Advisory Services Private Limited (PASPL)	Chambang	Kra Daadi	Hepu Farm Agro Producer Company Limited
17.	Previlege Advisory Services Private Limited (PASPL)	Tali	Kra Daadi	Tesun Tereh Agro Producer Company Limited
18.	Previlege Advisory Services Private Limited (PASPL)	Mukto	Tawang	Bomja Green Agro Producer Company Limited
19.	Previlege Advisory Services Private Limited (PASPL)	Kitpi	Tawang	Kitpi Block Agro Producer Company Limited
20.	Previlege Advisory Services Private Limited (PASPL)	Hunli Desali	Lower Diabang Valley	Kera-Ah Ethun Valley Agro Producer Company Limited
21.	Manipur Institute for Health and Social Development	Jegging	Upper Siang	Rotgo Banggo Farmer Producer Company Limited
22.	Manipur Institute for Health and Social Development	Singchung	West Kameng	Singchung Farmer Producer Company Limited
23.	Manipur Institute for Health and Social Development	Singa Gelling	Upper Siang	Gelling Singa Block Farmer Producer Company Limited

24.	Manipur Institute for Health and Social Development	Wakro	Lohit	Wakro Farmer Producer Company Limited
25.	Manipur Institute for Health and Social Development	Hawai-Walong	Anjaw	Walong Farmer Producer Company Limited
26.	Manipur Institute for Health and Social Development	Khenewa	East Kameng	Khenewa Farmer Producer Company Limited
27.	Manipur Institute for Health and Social Development	Tuting	Upper Siang	Bogum Bokang Farmer Producer Company Limited
28.	Youth Step Forward Centre	Hayuliang	Anjaw	Hayuliang Farmer Producer Company Limited
29.	Youth Step Forward Centre	Manchal	Anjaw	Manchal Farmer Producer Company Limited
30.	Youth Step Forward Centre	Changlagam	Anjaw	Chaglagam Farmer Producer Company Limited

(C) Table 3. FPOs registration in the state of Tripura

Sl.	Name of CBBO	Block	District	Name of the FPO Promoted
1.	Women's Income Generation Centre (WIGC)	Teliamura	Khowai	Teliamura Farmers Producer Company Limited
2.	Women's Income Generation Centre (WIGC)	Tulashikhar	Khowai	Tulashikhar Organic Farmers Producer Company Limited
3.	Sonartari Multi-State Agro Cooperative Society Limited (SONACO)	Mungiakami	Khowai	Mungiakami Farmer Producer Company Limited
4.	Sonartari Multi-State Agro Cooperative Society Limited (SONACO)	Khowai	Khowai	Khowai Agricultural Farmer Producer Company Limited

(D) Table 4. FPOs registration in the state of Nagaland

Sl.	Name of CBBO	Block	District	Name of the FPO Promoted
1.	NH Consulting Pvt. Limited	Ongpangkong (South)	Makokchung	Ongpangkong-S Horticultural Farmer Producer Company Limited
2.	NH Consulting Pvt. Limited	Akuluto	Zunhebeto	Akuluto Horticultural Farmers Producer Company Limited
3.	NH Consulting Pvt. Limited	Kubolong	Mokokchung	Kubolong Horticultural Farmers Producer Company Limited
4.	NH Consulting Pvt. Limited	Changpang	Wokha	Changpang Horticultural Farmers Producer Company Limited

Table 5. Summary: Details of FPO Registered statewise:

Sl. No.	State	No. of FPO Registered
1.	Manipur	22
2.	Arunachal Pradesh	30
3.	Tripura	4
4.	Nagaland	4
	Total	6 0

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Table 6. Contact details of 15 nos. of CBBOs under CAU, Imphal

SN	CBBO's Name	Address	Contact Person	Phone Number
1	NH Consulting Pvt. Ltd.	5E, 1st Floor, Dada Jungi House, Shahpur Jat, New Delhi-110049	Mr. Shivrama Reddy	8800478780
2	Sonartari Multi-State Agro Cooperative Society Limited (SONACO)	C-26, Sub-basement, Greater Kailash-1, New Delhi-110048	Mr. Jay Sinha	7640914886
3	Royale Natural Stones Pvt. Limited	Plot No. C-11 to C-16, Industrial Area Stone Park Purani Chhawani, Gwalior, Madhya Pradesh-474012	Mr. Nepoleean	9612427591
4	Indian Development Foundation	A89, Second Floor, Sector 65, Noida	Mr. Solomon	6002565213
5	Humanism Foundation			
	Keinapal, Utlou Mamang Leikai, PO-Nambol, District-Bishnupur, Manipur-795134	Mr. Rorrkychand	8787721405	
6	Krishi Vigyan Kendra, Thoubal	KVK Thoubal, near Rice Research Station, Wangbal, Manipur	Mr. Prabin Kumar	7005367546
7	Previlege Advisory Services Private Limited (PASPL)	2nd Floor,6,Sadabor Avenue, 7th Bye Lane, Mother Teresa Road, Geetnagar, Guwahati-781021	Mrs. Panchapata	8076860173
8	Women's Income Generation Centre (WIGC)	WIGC Complex, Thoubal Wangmataba, Thoubal District, Manipur-795138	Mrs. Indira Oinam	8837479417
9	Manipur Institute for Health and Social Development	Irengbam, Nambol, Manipur	Mr. Jibon Singh	7005571654
10	Tirap Community Resource Management Society	Tirap-CRMS, Khonsa, Tirap District, Arunachal Pradesh	Mrs. Pinky	8729944414
11	Aromatic Medicinal Plants & Socio Economic Development Society	Sagolband Meino Leirak, Imphal	Mr. Devajit	7005233363
12	Permaculture & Jaivik Khetiki Foundation	Sagolband Tera Tongbram Leikai, Imphal	Mr. Hijam Kulajit	7628075444
13	Yaiphabi Handloom Weavers Co-Operative Society Ltd	Lamding, P. O. Wangjing Bazar, Manipur-795148	Mrs. RK Nungthilchaibi	9862635306
14	Youth Step Forward Centre	Lamding, P. O. Wangjing Bazar, Manipur-795148	Mr. Y. Ibungochouba	8920654897
15	Social Action for Tribal and Backward Classes	Mao Gate (Near 1 B), Senapati, District , Manipur- 795150	Mr. Solomon	6002565213

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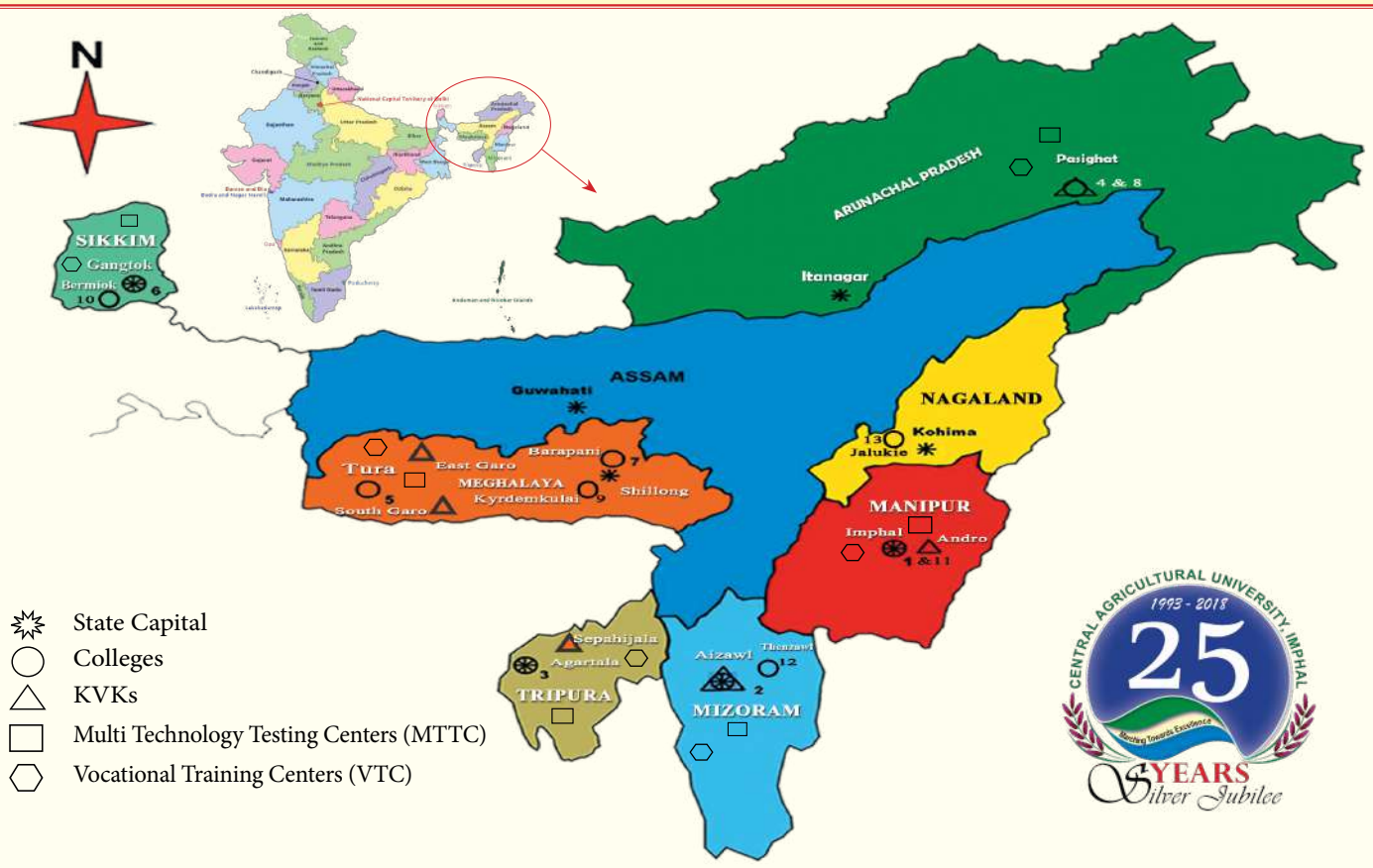

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1. College of Agriculture, Imphal, Manipur
2. College of Vety. Sc. & AH., Selesih, Aizawl, Mizoram
3. College of Fisheries, Lembucherra, Agartala, Tripura
4. College of Horticulture & Forestry, Pasighat, Arunachal Pradesh
5. College of Community Science, Tura, Meghalaya
6. College of Agri. Engg. & PHT, Gangtok, Sikkim
7. College of P G Studies in Agricultural Sc., Umiam, Meghalaya
8. College of Agriculture, Pasighat, Arunachal Pradesh
9. College of Agriculture, Kyrdemkulai, Meghalaya
10. College of Horticulture, Bermiok, Sikkim
11. College of Food Technology, Imphal, Manipur
12. College of Horticulture, Thenzawl, Mizoram
13. College of Vety. Sc. & AH., Jalukie, Nagaland
14. Krishi Vigyan Kendra, Impahl East, Andro, Manipur
15. Krishi Vigyan Kendra, Aizawl, Mizoram
16. Krishi Vigyan Kendra, East Siang, Arunachal Pradesh
17. Krishi Vigyan Kendra, East Garo Hills, Meghalaya
18. Krishi Vigyan Kendra, South Garo Hills, Meghalaya
19. Krishi Vigyan Kendra, Sepahijala, Tripura

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△ KVKs (Total 6)

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The Chief Editor
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