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Directorate of Extension Education
Central Agricultural University, Imphal, Manipur

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From the Editor's Desk

Prof. Ph. Ranjit Sharma
Director (Extension Education)

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

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

Our publications have played a pivotal role in strengthening the connection between scholars, researchers and faculty from different campuses of CAU Imphal, as well as in facilitating knowledge sharing with farmers across Northeast India. We have been committed to providing farmers with the latest advancements in agricultural practices, encouraging the adoption of innovative techniques that lead to sustainable and profitable farming. Our ongoing initiatives have covered several critical topics that aim to address the challenges faced by farmers today. These include Natural Farming: A Way to Sustainable Crop Production; Role of Botanicals in Pest Management; Composting: A Component of Natural Farming; Climate Smart Agriculture: Adapting to Climate Change; Indigenous Knowledge: The Key to Save for a Sustainable Future; African Swine Fever: A Major Challenge to Farmers' Socio-Economic Stability; Popularization of Vanaraja in South Garo Hills and others.

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

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

(Prof. Ph. Ranjit Sharma)
Chief Editor

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CONTENTS

ISSN : 2279-0454

MAXIMIZING VALUE: INNOVATIVE APPROACHES TO WASTE UTILIZATION IN THE FRUITS AND VEGETABLES PROCESSING INDUSTRY

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Introduction

The total global production of fresh fruit in 2021 was 909.64 million metric tons. Asia Pacific was the largest region in the global fruit farming market, accounting for 49% of the market in 2018. The top 20 highest fruit-producing countries in the world include China, India, Brazil, Turkey, Mexico, the United States, Indonesia, and Spain. Based on the Food and Agriculture Organization Corporate Statistical Database, the total world vegetable production for 2020 was 1,148,446,252 metric tonnes.

Among the fruits and vegetables, citrus, apples, pineapples, grapes, tomatoes,and potatoes are processed in substantial quantities. The waste generated in fruit and vegetable processing industries includes both solid and liquid waste, including peels, seeds, pulp, skins, and other byproducts. The fruit and vegetable processing industry generates 10- 60 % of the raw materials as solid waste. The composition of this waste suggests enormous potential for producing value-added products. Effective utilization of this waste can contribute to environmental sustainability and economic benefits. Proper management of the waste is both a regulatory requirement and an economic necessity.

The typical example is the citrus processing industry, which produces a number of value-added byproducts from waste, some of them being even more valuable than the main product, viz., citrus juice concentrate. In fact, the waste from one processing plant could become the raw material of another plant, and utilization of waste rather than disposal should be the goal of the industry. Bioremediation of fruits and vegetables processing waste to produce value-added products has also opened up enormous product opportunities. The future of the food processing industry, and in particular the fruit and vegetable processing industry, lies in achieving zero waste processing systems.

Various innovative techniques can be employed to utilize waste effectively. These include converting waste into biogas, creating natural fertilizers, and producing value-added products such as juices and snacks. Each method not only reduces waste but also contributes to a more sustainable production cycle.

The following are some key innovative methods for waste utilization:

1. Production of Value-Added Products

- *Bioactive Compounds Extraction:* Wastes from fruits and vegetables, such as peels and seeds, are rich in bioactive compounds like antioxidants, vitamins, flavonoids, and carotenoids. These compounds can be used in (a) nutraceuticals and dietary supplements, (b) cosmetics and personal care products, and (c) natural food preservatives and colorants.

- Pectin *Production:* Citrus peels and apple pomace are excellent sources of pectin, used as a gelling agent in jams, jellies, and other food products.

- Essential *Oils:* Citrus fruit peels can be processed to extract essential oils for use in aromatherapy, flavoring, and cosmetics.

2. Animal Feed

- *Direct Feed:* Fruit and vegetable byproducts such as pulp, peels, and seeds can be processed into animal feed.

- *Fermented Feed:* Enhancing the nutritional value through fermentation.

3. Bioenergy Production

- *Biogas*: Anaerobic digestion of waste can produce biogas, which is a renewable energy source.

- *Bioethanol:* Fermentation of sugar-rich wastes like fruit peels can yield bioethanol.

- *Biodiesel:* Oil-rich seeds from certain fruits can be used for biodiesel production.

4. Composting and Vermicomposting

- Organic waste can be composted to produce nutrient-rich compost or used in vermiculture to produce vermicompost, which serves as a natural fertilizer for agriculture.

5. Production of Fibers and Biomaterials

- **Edible Films and Coatings**: Biodegradable films can be made from cellulose extracted from fruit and vegetable waste.
- **Packaging Materials**: Conversion of agricultural waste into bioplastics or packaging materials.

6. Enzyme Production

- Waste such as pineapple skins and papaya peels can be used for the production of enzymes like bromelain and papain, which have industrial and pharmaceutical applications.

7. Alcoholic and Non-Alcoholic Beverages

- Fermentation of fruit pulp or peels can result in beverages like wine, vinegar, and cider.

8. Charcoal and Activated Carbon

- Wastes like coconut shells and other fibrous materials can be processed into activated carbon for water purification and other industrial uses.

9. Dye Production

- Extracting natural pigments such as anthocyanins, carotenoids, and betalains for use in textiles and food coloring.

10. Mushroom Cultivation

- Agro-industrial waste like vegetable leaves and stems can serve as a substrate for mushroom farming.

11. Environmental and Economic Benefits

- Reduces landfill waste and associated methane emissions.
- Lowers environmental pollution caused by improper disposal.
- Generates additional revenue streams for industries.
- Encourages sustainable practices and circular economy models.

By integrating these strategies, the fruits and vegetable processing industry can reduce waste, minimize environmental impact, and enhance profitability.

Fruits and vegetables wastes having potential for utilizations

1. APPLE

Apple (*Mallus domestica*, Borkh) is a deciduous fruit grown mostly in temperate regions in the world. Apple pomace or apple press cake is the major waste of apple processing industries although some quantity of industrially discarded apples and belt rejections also constitute the waste.

Composition of pomace

Proximate composition of apple pomace showed that, pomace is rich in carbohydrates (9.5- 22%), pectin (1.5-2.5 %) and also contains protein (1- 1.8 %).

Possible by- products from apple waste

Apple waste	By- products
Discarded apples and belt rejections	Pulp, RTS, Squashes
Pomace	Alcohol, flavour components, pectin, Nutrition fiber, Biogas, beer, soft drink, vinegar, cider, citric acid
Peel, Core, Off cuts, stem and seeds	Pectin methyl esterase

2. BANANA

Banana (*Musa paradisiaca*), though is marketed mainly as a table fruit, is also processed primarily into puree which goes into the manufacture of baby foods. The main waste material from banana processing is the peel which constitutes about 20-40% of the fruit weight. Depending upon the marketing conditions 10-30% of the banana harvest is also discarded because of over and under ripeness, blemishes and other reasons which make the fruit unacceptable for the export market.

ISSN : 2279-0454

Bioconversion of waste

Bioconversion of banana is done by *Aspergillus foetidus* for production of protein and gluco- amylase. Alpha amylase production from banana waste using solid state fermentation has been standardized. Maximum enzyme activity of 5345000 U mg min $^{-1}$ was achieved. Maximum Biomass (Bioprotein) yield with *Pichia spartinae* under optimal conditions were 53% on ripe banana pulp liquid and 58% on ripe banana skin liquid. Amino acid analysis of the protein revealed a high lysine content and an essential amino acid pattern comparing favorably with FAO reference protein. Fermentation of whole banana waste liquor for lactic acid production has been investigated.

Other products

A number of products have been developed from banana waste at CFTRI. About 1000 banana plants are estimated to yield 20-25 tonnes Pseudostem. The inner core which is tender is used as a vegetable. The Pseudostem contains starch which is used for edible purposes and sizing in textile industry. Banana bunch after removing fruits, yields 8-10 % of stem portion which has a very little commercial value. After steam processing under pressure, it can be used as deworming feed for cattle's. The stem as well as the pseudostem fiber can be used for making paper. Hygienically collected peels of ripe banana can be processed into Murraba type of sweet product, where cooked banana skins are dipped in 40° Brix syrup and the concentration of which is gradually increased to 70° Brix or more. The product is cooled and packed into bottles.

3. CITRUS

Oranges, mandarins, limes, lemons, pomelos and grapefruit belongs to citrus family. Citrus processing is one of the most important food industries of the world. The main processed product of citrus processing industry is juice and juice concentrate. During the production of citrus juice, large amount of processing residue consisting of peel and rag, pulp wash and seed are generated which amounts to about 50-60%.

Dried citrus pulp and molasses

The majority of citrus processing waste is converted into dried citrus pulp and used as a cattle feed. It is low in crude protein, fiber and fat but rich in carbohydrates. The low bulk density of dried citrus pulp results in high storage and handling costs which has led to the development of palletizing industry.

Citrus peel oil

The flavedo portion of the peel contains numerous oil cells which on crushing ejects out oil. Fresh orange peel yields about 0.54% oil by cold press method. The citrus peel oil has attained a great commercial importance in the flavoring of several kinds of beverages, confectionery and bakery products. They are also used in cosmetics and perfumery.

Citrus seed oil and meal

Citrus seeds have long been recognized as a source of edible oil with characteristics suitable for human consumption. The dried seeds with or without flaking is pressed at high pressure in an oil expeller to recover the turbid oil which can be clarified in plate and frame filter press. Citrus oil contains a considerable quantity of poly unsaturated fatty acid, Linoleic acid and linolenic acid. Citrus seed meal can be used for animal feed purposes. The dry oil extracted meal obtained during oil manufacturing operation makes a valuable poultry feed.

Pectin

The citrus fruit components such as flavedo, albedo, membrane, juice vesicles and core contain varying quantities of pectin which is mainly in the form of proto pectin. Pectin is widely used in the manufacture of foods such as jellying agents, thickeners and stabilizers of dispersed system. Normally lemon, lime, grapefruit and orange waste is used for pectin production.

Specialty products

Gelled citrus peel, frozen citrus juice sacs, dries juice sacs, puree, brined and sulphured peels, candied peels, marmalades, blended syrup have been produced.

4. PINEAPPLE

Depending on the variety and the shape of the fruit, the total waste generated is 30-60 % of the fruit.

Waste component	**Byproducts**
Mill Juice	Sugar syrup, Bromelin, Wine
Centrifuged Juice under flow	Oleoresin, Hemicellulose-β, α-Cellulose
Core	Syrup, Vinegar
Crown, peels and leaves	Fiber

Mill Juice

Most of the pineapple waste components can be milled and pressed to extract mill juice, and the compact residue can either be easily disposed of or further dried to produce pineapple bran. A number of value-added products can be prepared from milled juice.

Bromelin

Among all the pineapple by products, extractions and characterization of bromelin, a proteolytic enzyme has been the most extensively studied. A process for the production of bromelin from pineapple has been patented in India.

Wine

Attempts have been made by several workers to produce wine from pineapple waste juice. General acceptability, flavour, appearance and aroma was recorded to be good.

Vinegar

Pineapple canary waste juice being good source of sugar (7-10%) could be a good substrate for vinegar. The process consists of fermenting the extracted juice with S*accharomyces cerevisiae* after adjusting the final Brix to 10°. The alcoholic fermented juice is fed to a generator for acetic fermentation with *Acetobacter* culture. Vinegar containing up to 7 % acetic acid could be produced in less than 24 hrs.

5. MANGO

Mango (*Mangifera indica*) is one of the most important tropical fruits. Ripe mangoes are processed into Frozen mango products, canned products, dehydrated products and RTS. During manufacture of mango products large quantities of waste are generated which accounts for 35-55% of the fruit depending on the variety. A rough estimate of the waste available annually in India alone based on the quantities of the mango processed (0.2 Million tones) is of the order of 90,000 tonnes .The fiber portion along with some quantity of adhering pulp is rejected as pulper waste. The approximate proportion of different components is given below :

Mango pulp - 45-65% , Pulper waste - 10-15%,

Peels - 15-20%, Stones (seeds) - 10-20 %

Mango Peel Pectin

The quality of pectin was comparable to orange peel pectin. In general the quality is suitable for food and pharmaceutical purposes. On dry basis, the pectin content ranges from 13-19 % and the jelly grade ranges form 155-200.

Other Products

There is possibility for the preparation of products such as juice, wine, vinegar from peel and pulper waste from Totapuri mangoes. The juice yield of 55 % from peels and 75-78 % from pulper waste on enzyme liquefaction and pressing. The average yield of 2.5 l absolute alcohol could be obtained from 100 kg mango peel waste. Mango aroma concentrate could be prepared from mango peel waste.

Mango Kernel Fat

Extensive work has been carried out on mango kernel fat. The reported values on kernel fat content vary from 8.85-16.13 %. It is reported that mango kernel fat contains 94.8- 97 % of neutral lipids, 1.1-2 % phospholipids, and 1.3-2.2 % un-saponifiable matter. It can be used as a substitute for tallow in the preparation of quality soaps and as an extended to cocoa butter. The fat extracted meal can be used in animal feed rations and as a direct sizing agent in textiles.

Mango Seed (Stone)

Mango seed or kernel consists of tenacious coat enclosing the kernel. The seed content of different varieties of mangoes ranges from 9-23 % of the fruit weight and the kernel content of the seed ranges from 45- 72 %. The reports indicate that mango kernel is comparable to most of the cereals in respect of carbohydrates, proteins, fat and minerals. [Carbohydrates = 69-78%, Fat = 8.5- 16%, Protein= 6-10%, Fiber = 0.15- 3%]. In traditional food items, 20-30 % of kernel flour could be used without adversely affecting their acceptability.

Peel Waste

Mango peel along with pulper waste sometimes referred to as peel waste constitutes about 20-30%. The peel waste is a good source of sugars and pectin and also contain substantial quantities of protein, tannins and crude fiber.

ISSN : 2279-0454

TOMATO

Tomato pomace leftover as a waste after extracting tomato juice constitutes about 20-30% of raw material. The pomace usually consists of seeds and skin.

Seed Oil

Tomato seed oil is characterized by its high content of Mono unsaturated fatty acids namely oleic acid (C 18:1). Although this edible fatty acid is of low nutritional value compared to polyunsaturated fatty acids, especially linoleic acid (C 18:2), which is predominant in crops like safflower, sunflower, corn etc. Oleic acid can be used as a soap base in the manufacture of oleate ointments, cosmetics, polishing compounds, lubricants and food grade additives.

7. POTATO

Major waste material in the potato processing plant is the form of peel and waste containing solids. Potatoes are processed for different products and for starch. The waste effluent from the potato starch manufacturing are similar to that of the effluents from cutting and chopping operation of other processes. The other source of potato waste are damaged produced from harvest, sprouted, green and damaged potato from storage and rejected ones. A number of products can be prepared from potato waste which is given below :

Waste component	By- products
Damaged produced from harvest, sprouted, green and damaged potato from storage and rejected ones	'Chips', 'flour', 'tikki', 'burfee', 'halva', 'gulab jamun'
Potato pulp and liquor	Starch, Ethanol, Proteins, Enzymes
Peel	Dietary fiber

IMPLEMENTATION OF MODEL INTEGRATED FARMING SYSTEM PROJECT IN RI-BHOI DISTRICT OF MEGHALAYA

Rajkumari Padamini[1] and U.K. Behera[2]

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The NEH Region has hills and mountain ecology and soils are mostly acidic. The Agroecosystem is fragile with problems of soil erosion and high rainfall. Overall, the Agroecosystem is not very conducive to agricultural development. Agriculture is the main occupation of the people of Meghalaya. About 83% of the total population of the state depends on agriculture for their livelihood. The state offers scope for the cultivation of a wide variety of crops because of highly diversified topography, altitude, and climatic conditions.

Meghalaya is one of the most promising states within the NEH Region as far as the organic farming potential is concerned. The farmers have been practicing traditional agriculture for thousands of years and grow their crops without applying any inorganic inputs, fertilizers, and pesticides. Despite having immense potential in terms of agricultural development, the state is lagging in agriculture mainly due to under-exploitation of its natural resources coupled with non-adoptions of modern technologies and inadequate extension, availability of credit, and poor infrastructure. The farmers are mostly resource-poor and their socio-economic condition is not so good for taking agriculture for making farming with modern practices. Under that situation, there is a need to provide these farmers with input and technical support for enhancing productivity and profitability from farming. Considering the above, a project entitled "Development of Model IFS villages for tribal and resource-poor farmers of NEH region" was developed and implemented in Meghalaya. The project was implemented in two districts of Meghalaya, Ri-Bhoi district and West Jaintia Hills district, in eight adopted villages. Lad Umpih village in Ri-Bhoi district is among the eight adopted villages. For the development

of IFS village in Meghalaya, it was important to select villages with most of the households engaged in farming and allied activities. As per the data from the Umsning Block office, Umsning Block produces most of the seasonal vegetables and it is the main growing area of fruits like pineapple, banana, papaya, and strawberry. A survey was conducted by the faculties of CoA (CAU) Kyrdemkulai for the selection of villages. Based on the survey conducted, it was decided that Lad Umpih would be suitable for the proposed project. The development of this village through the implementation of the Development of model Integrated Framing System project by conducting training programmes for the promotion of Integrated Farming System, including promotion of vegetable production, the introduction of Kharif onion in Meghalaya, kitchen garden, backyard poultry rearing and farming, dairy farming, mushroom cultivation, apiculture, etc. Conducting on farm research in farmers' fields, training programs, input distribution, etc according to their demands and needs with the help of the village headman and secretary of the village. In this village, agriculture inputs in the form of fruits plants/ saplings (guava, mango, pineapple, litchi, peach, Assam lemon, Khasi mandarin, dragon fruit, etc.), vegetable seeds (cabbage, cauliflower, broccoli, capsicum, French bean, kharif onion, tomato, potato, gourds, cucumber, brinjal, chili, radish, capsicum etc.) seeds of field crops (rice, lentils etc.), poultry chicks, piglets, etc. were given to farmers for strengthening their farming system with the support from ICAR-IIVR, Varanasi; ICAR-CIRC, Meerut and ICAR-CRIJAF, Barrackpore. The objective of the implantation of the project was to develop efficient, economically viable, and environmentally sustainable IFS Models for small holdings. Systematic random sampling was done through a questionnaire, households were selected randomly; efforts were made to collect different information regarding the farming system, resources available, market opportunities, existing farming practices, farm enterprises, recycling/ utilization of farm products in the farming system and the farm constraints of the farmers.

Farm constraints of the farmers

Components	Constraints
Crop	1. Variation in the price of the produce 2. Unavailability of manures 3. Infestation with diseases and pests 4. Use of local cultivars instead of improved varieties 5. Limited knowledge regarding the package of practice of different crops, usage of fertilizers and pesticides
Livestock	1. Uncertain death of pigs and poultry birds 2. Not able to supply feed to farm poultry birds (layer or broiler)
Farm Constraints	1. Acidic soil 2. Poor soil fertility

IMPLEMENTATION OF THE PROJECT - DEVELOPMENT OF MODEL IFS VILLAGES FOR TRIBAL AND RESOURCE-POOR FARMERS OF THE NEH REGION

New interventions

For improvement of farming system of small and marginal farmers, different adopted villages were selected. The farming practice they adopted are mostly traditional and organic in nature. The farmers would not wish to go for inorganic agricultural practice. There is prevalent of rice based, vegetable-based farming systems. These farming systems were selected for improvement by providing various technology and input supports.

Scientific interventions

The farmers were trained and made aware of the resource conservation technologies and adaptation to climate change by recycling of the waste and by-products of farms in IFS. As a result, scientific agri-practices were promoted which could contribute to mitigation and adaptation to climate change and water saving.

Technological interventions

The farmers of these adopted village and other parts of the state were given skill development training in area of vegetable farming, kitchen gardening, fruit cultivation,

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etc. which could enhance their capacity for adopting the improved production technology as a result rural bio-entrepreneurship was promoted.

Inputs distribution

In these villages, fruits plants/ saplings, vegetable seeds (cabbage, cauliflower, broccoli, capsicum, French bean, kharif onion, tomato, potato, etc.) seeds of field crops (rice, mustard, lentil, etc), etc. were given to farmers for strengthening their farming system.

Impact of implementation of the project

Results in higher productivity from the unit area. Higher profitability from farms for enriches the farmers of the area. The economic conditions of the farmers were developed.

1. The farmers have shown very good response to our technical interventions, training program, and on-farm demonstrations.
2. The study has great impact by transferring scientific farming practices, quality seed materials, planting materials, and making awareness overall resulting in an improvement of the economic condition of farmers.

Outcome of implementation of the project

Development of four IFS models in Lad Umpih village.

1. Development of four Farm Development Card (FDC) in Lad Umpih village

Farm Development Card (FDC)

FDC is a tool or farm plan that is based on a holistic approach to farm development by considering the overall situations of the farmers including the knowledge and skill they possess. FDC takes into account the following components: Ecological development, economic development, water productivity, soil health management, energy production, agro-biodiversity, and system productivity. It is an important business plan for the overall development of the farm to make the farmer an entrepreneur.

Advantage of FDC

1. Additional income
2. Additional employment
3. Allows inclusive growth
4. Climate change mitigation and adaptation
5. Sustainability of pesticide uses
6. Better livelihood security.

The IFS model developed at Mrs. Mirda Lyngdoh Nonglait at Lad Umpih village, Ri-Bhoi district Meghalaya

Details of Farm Development Card

FARM DEVELOPMENT CARD:
Business plan for rural bio -entrepreneurship

Farm development card (FDC) is a tool or farm plan which is based on a holistic approach for farm development by considering the overall situations of the farmers including the knowledge and skill they possess. FDC takes into account the following components: Ecological development, economic development, water productivity, soil health management, energy production, agro-biodiversity and system productivity. It is an important business plan for the overall development of the farm to make the farmer an entrepreneur.

Advantage of FDC : Additional income, additional employment, allows inclusive growth, climate change mitigation and adaptation, sustainability-less pesticide use and better livelihood security.

Description of the farmer
- Name: Mr. B.S. Khongwir
- Village: Lad Umpih
- G. P: Kyrdemkulai
- Block: Umsning
- District: RiBhoi
- Pin code: 793 105
- Aadhaar card /EPIC No:
- Mobile No: 8731064747
- Farm area : 8.0 ha + 0.1 ha homestead land
- Operational area : 0.62 ha (0.2 ha irrigated)

Present existing farming System
Chilli (X1) = 150 m^2
Brinjal (X2) = 150 m^2
French bean (X3)= 350 m^2
Tomato (X4) = 500 m^2
Potato (X5) = 100 m^2
Litchi (X6) = 050 m^2
Resource available
Land: 0. 82 ha
Labor:1000 mandays
Capital: Rs. 2.40-3.00 Lakhs
Net Returns: Rs10,910
Expected income: Rs 3.00 Lakhs

Present farm problems
- Soil Acidity
- Burning of crop residues/weed biomass
- Manure availability for crop production is not adequate
- Soil erosion
- Poor technical knowledgebase

•Recommendations
- Organic input production: Compost making with the available crop residues to produce 10.0 t Compost/year
- High value crops to enhance income
- Inclusion of Livestock: 3 -4 No. (dairy CB cows) will result in the production of 20.0 t FYM/year (based on farmers interest).
- Water harvesting in low lying areas and utilization of harvested water for multiple purposes (fishery, dairy and life saving irrigation).
- Backward poultry for family requirement
- Apiary-3 boxes

BUSINESS PLAN FOR THE FARMER

Enterprise	Crop	Area (m^2)
Maize	X2	200
Baby Corn	X3	300
Sweet Corn	X4	300
French bean	X7	300
Tomato	X8	300
Potato	X9	150
Brinjal	X10	150
Palak	X11	50
Papaya	X12	50
Pineapple	X13	1790
Banana	X14	850
Litchi	X15	50
Ginger/ Turmeric	X16	1000
Chilly	X18	300
Dairy	X20	4 Cross Bred cows
Fishery	X21	350

Soil Fertility status
Available K, kg /ha :150.1
Available P, kg /ha :15.1
Available N, kg /ha :160.8
Organic carbon ,% : 0.40
Soil pH : 5.30
Ec : < 4.0

Recommended varieties
Maize : RCM 1–76
Baby corn: G 5414
Sweet Corn: Sugar 75
Potato: Kurfi Megha/KurfiJyoti
Turmeric: Megha turmeric /Lakadong
Ginger : Nadia
Cow: Cross -bred (Jersey)
Fishery: composite pisciculture
Banana : Jahaji (intercropping with radish and greens)
Fishery : Napier grass in fish pond dykes for dyke/bund stabilization

Income Generation:
Rs. 2,36,089/-
Resource use/required:
Land: 0.62 ha
Labor: 478 man-days
Capital: Rs. 298,000

FARM DEVELOPMENT CARD:
Business plan for rural bio -entrepreneurship

Farm development card (FDC) is a tool or farm plan which is based on a holistic approach for farm development by considering the overall situations of the farmers including the knowledge and skill they possess. FDC takes into account the following components: Ecological development, economic development, water productivity, soil health management, energy production, agro-biodiversity and system productivity. It is an important business plan for the overall development of the farm to make the farmer an entrepreneur.

Advantage of FDC : Additional income, additional employment, allows inclusive growth, climate change mitigation and adaptation, sustainability-less pesticide use and better livelihood security.

Description of the farmer

* Name: Mrs. Mirda Lyngdoh Nonglait
* Village: Lad Umpih
* G. P: Kyrdemkulai
* Block: Umsning
* District: RiBhoi
* Pin code: 793105
* Aadhaar card /EPIC no: ZBV0001339
* Mobile no: 6009306865
* Farm area : 3.2 ha + 0.05 ha homestead land
* Operational area : 0.8 ha (rainfed)

Present existing farming System

Mint (X1) = 2000 m^2
Pea (X2) = 25 m^2
Cabbage (X3) = 25 m^2
Broccoli (X4) = 25 m^2
Pig (3 number)(X5) = 50 m^2
Cow (X6) = 050 m^2

Resource available
Land: 0. 80 ha
Labor: 400 mandays
Capital: Rs. 1.94 Lakhs
Net Returns: Rs 54 ,000
Expected income: Rs 1.10 Lakhs

Present farm problems

- Soil Acidity
- Burning of crop residues/weed biomass
- Manure availability for crop production is not adequate
- Soil erosion
- Poor technical knowledge-base
- Availability of improved crop variety
- Poor farm mechanization: manual land preparation

Recommendations

- Organic input production: Compost making with the available crop residues to produce 5.0 t Compost/year
- Crop diversification: High value crops to enhance income
- Inclusion of Livestock: 2 no (dairy CB cows) will result in the production of 10.0 t FYM/year (based on farmers interest).
- Water harvesting in low lying areas and utilization of harvested water for multiple purposes (dairy and irrigation for vegetables).
- Backward poultry for family requirement and income
- Apiary-3 boxes

Goal of Farmers:

- Doubling farmers income
- Family requirement of food
- Improve ecology of the farm

BUSINESS PLAN FOR THE FARMER

Enterprise	Crop	Area (ha)
Rice	X1	0.1
Mint	X2	0.1
Potato	X3	0.05
French beans	X4	0.005
Radish	X5	0.01
Ginger	X6	0.025
Turmeric	X7	0.005
Broom-grass	X8	0.20
Tapioca	X9	0.0025
Pig (unit/no.)	X10	3
Poultry (1unit: 25 birds)	X11	1
Dairy (1 unit: 2 cows)	X12	1

Soil Fertility statu

Available K, kg /ha :150.1
Available P, kg /ha :15.1
Available N, kg /ha :160.8
Organic carbon ,% : 0.40
Soil pH : 5.30
Ec : < 4.0

Recommended varieties/Technological requirements

Rice: Sahabhagidhan/DRR 44
Potato: Kufri Megha/Kufri Jyoti
Turmeric: Lakadong/ Megha turmeric
Ginger : Nadia
Radish: Kashi Hans/Pusa Chetki
Bean: Kashi Sampann
Cow: Cross -bred (Jersey)
\

Other Priorities:

- Making availability of manure through adopting composting technology
- Farm mechanization: light machinery/power tillers

Income Generation:
Rs. 113,231
Resource use/required:
Land: 0.512 ha
Labor: 461 man-days
Capital: Rs. 200,000

FARM DEVELOPMENT CARD:
Business plan for rural bio-entrepreneurship

Farm development card (FDC) is a tool or farm plan which is based on a holistic approach for farm development by considering the overall situations of the farmers including the knowledge and skill they possess. FDC takes into account the following components: Ecological development, economic development, water productivity, soil health management, energy production, agro-biodiversity and system productivity. It is an important business plan for the overall development of the farm to make the farmer an entrepreneur.

Advantage of FDC : Additional income, additional employment, allows inclusive growth, climate change mitigation and adaptation, sustainability-less pesticide use and better livelihood security.

Description of the farmer

* Name: Mr. Alfred Umdor
* Village: Lad Umpih
* G. P: Kyrdemkulai
* Block: Umsning
* District: Ri-Bhoi
* Pin code: 793105
* Aadhaar card /EPIC no: DHJ0588707
* Mobile no: 8731015999
* Farm area: 2.83 ha + 0.05 ha homestead land
* Operational area : 2.43 ha (rainfed)

Present existing farming System

Rice (X1) = 4046 m^2
Turmeric (X2) = 100 m^2
Mint (X3) = 2000 m^2
Jackfruit (X4) = 1.0 m^2
Banana (X5) = 25 m^2
Broom grass (X6) = 16184 m^2
Banana (X7) = 4046 m^2
Jackfruit (X8) = 25 m^2

Resource available
Land: 2. 43 ha
Labor: 330 mandays
Capital: Rs. 1.23 Lakhs
Net Returns: Rs 36,200
Expected income: Rs 1.0 Lakhs

Present farm problems

- Soil Acidity
- Burning of crop residues/weed biomass
- Manure availability for crop production is not adequate
- Soil erosion
- Poor technical knowledge-base
- Availability of improved crop variety
- Poor farm mechanization: manual land preparation

Recommendations

- Organic input production: Compost making with the available crop residues to produce 5.0 t Compost/year
- Crop diversification: High value crops to enhance income
- Inclusion of Livestock: 2 no (dairy CB cows) will result in the production of 10.0 t FYM/year (based on farmers interest).
- Water harvesting in low lying areas and utilization of harvested water for multiple purposes (dairy and irrigation for vegetables).
- Backward poultry for family requirement and income
- Apiary-3 boxes

Goal of Farmers:

- Doubling farmers income
- Family requirement of food
- Improve ecology of the farm

BUSINESS PLAN FOR THE FARMER

Enterprise	Crop	Area (ha)
Rice	X1	0.1
Potato	X2	0.05
French beans	X3	0.057
Ginger	X4	0.025
Turmeric	X5	0.005
Broom-grass	X6	0.20
Tapioca	X7	0.0025
Pineapple	X8	0.1
Assam lemon	X9	0.005
Black pepper	X10	0.005
Pig (unit/no.)	X11	3
Poultry (1unit: 25 birds)	X12	1

Soil Fertility status

Available K, kg /ha :150.1
Available P, kg /ha :15.1
Available N, kg /ha :160.8
Organic carbon ,% : 0.40
Soil pH : 5.30
Ec : < 4.0

Recommended varieties/Technological requirements

Rice: Sahabhagidhan/DRR 44
Potato: Kufri Megha/Kufri Jyoti
Turmeric: Lakadong/ Megha turmeric
Ginger : Nadia
Radish: Kashi Hans/Pusa Chetki
Bean: Kashi Sampann

Other Priorities:

- Making availability of manure through adopting composting technology
- Farm mechanization: light machinery/power tillers

Income Generation:
Rs. 114,795
Resource use/required:
Land: 0.78 ha
Labor: 471 man-days
Capital: Rs. 207,100

FARM DEVELOPMENT CARD:
Business plan for rural bio-entrepreneurship

Farm development card (FDC) is a tool or farm plan which is based on a holistic approach for farm development by considering the overall situations of the farmers including the knowledge and skill they possess. FDC takes into account the following components: Ecological development, economic development, water productivity, soil health management, energy production, agro-biodiversity and system productivity. It is an important business plan for the overall development of the farm to make the farmer an entrepreneur.

Advantage of FDC : Additional income, additional employment, allows inclusive growth, climate change mitigation and adaptation, sustainability-less pesticide use and better livelihood security.

Description of the farmer

* Name: Mr. Lasterfield Rani
* Village: Lad Umpih
* G. P: Kyrdemkulai
* Block: Umsning
* District: Ri-Bhoi
* Pin code: 793105
* Aadhaar card /EPIC no: ML0519810005142
* Mobile no: 8837456800
* Farm area: 3.23 ha + 0.05 ha homestead land
* Operational area : 1.62 ha (rainfed)

Present existing farming System

French bean (X1) = 20 m^2
Pumpkin (X2) = 25 m^2
Chilli (X3) = 25 m^2
Litchi (X4) = 4046 m^2
Pineapple (X5) = 8092 m^2
Betelnut (X6) = 2000 m^2
Banana (X7) = 4046 m^2
Jackfruit (X8) = 25 m^2
Guava (X9) = 30 m^2
Cow (2 No.) (X10) = 54 m^2

Resource available
Land: 1. 62 ha
Labor: 387 mandays
Capital: Rs. 172.160 Lakhs
Net Returns: Rs 36,200
Expected income: Rs 1.0 Lakh

Present farm problems

- Soil Acidity
- Burning of crop residues/weed biomass
- Manure availability for crop production is not adequate
- Soil erosion
- Poor technical knowledge-base
- Availability of improved crop variety
- Poor farm mechanization: manual land preparation

Recommendations

- Organic input production: Compost making with the available crop residues to produce 5.0 t Compost/year
- Crop diversification: High value crops to enhance income
- Growing of fruits plants for family nutrition and enhance income
- Backward poultry for family requirement and income
- Apiary-3 boxes

Goal of Farmers:

- Doubling farmers income
- Family requirement of food
- Improve ecology of the farm

BUSINESS PLAN FOR THE FARMER

Enterprise	Crop	Area (ha)
Rice	X1	0.1
Mint	X2	0.3
Potato	X3	0.05
French beans	X4	0.057
Radish	X5	0.05
Ginger	X6	0.025
Turmeric	X7	0.005
Broom-grass	X8	0.20
Tapioca	X9	0.0025
Pig (unit/no.)	X10	3
Poultry (1unit: 25 birds)	X10	1
Dairy (1 unit: 2 cows)	X11	1

Soil Fertility status

Available K, kg /ha :150.1
Available P, kg /ha :15.1
Available N, kg /ha :160.8
Organic carbon ,% : 0.40
Soil pH : 5.30
Ec : < 4.0

Recommended varieties/Technological requirements

Rice: Sahabhagidhan/DRR 44
Potato: Kufri Megha/Kufri Jyoti
Turmeric: Lakadong/ Megha turmeric
Ginger : Nadia
Radish: Kashi Hans/Pusa Chetki
Bean: Kashi Sampann
Cow: Cross-bred (Jersey)

Other Priorities:

- Making availability of manure through adopting composting technology
- Farm mechanization: light machinery/power tillers

Income Generation:
Rs. 136,752
Resource use/required:
Land: 0.80 ha
Labor: 454 man-days
Capital: Rs. 207,400

Recommendations

IFS involving land-based enterprises such as vegetable, vertical farming, fruit cultivation, apiary, agro-forestry, fisheries, backyard poultry, etc. could help in increasing the farm income by 100 %. Employment by 80% and providing balance nutrition to the farm family and overall improvement in livelihood of farmer. Promotion of IFS in region is very much needed for sustainable of small and marginal farmers of this region.

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CLIMATE-SMART AGRICULTURE: ADAPTING TO CLIMATE CHANGE WITH AI

Pavan Kumar S.T and Geeta Gadekar
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Introduction

Climate-Smart Agriculture (CSA) is an innovative approach to tackle the challenges posed by climate change in the agricultural sector, with AI emerging as a transformative tool. CSA focuses on three main intentions to increasing agricultural productivity, enhancing resilience to climate impacts and reducing greenhouse gas emissions. AI-driven systems play a crucial role in achieving these goals by offering predictive analytics for weather patterns, soil moisture and crop growth under changing climatic conditions. CSA commit to transform and reposition agricultural development to meet the climate change challenges (Lipper *et al.,* 2014). The CSA framework provides a platform for assessing how livelihood assets operate and how they are affected by policy processes and structures, as well as the technologies needed for restorative agricultural transformation (FAO.2013). CSA seeks to intensify linkages among global, national and local agricultural stakeholders by accelerating cross-scale adaptation and mitigation synergies (Adger *et al*.,2005). Therefore, CSA helps continuously improve agricultural production capacity, income and adaptability to climate change, reduce and even eliminate GHG emissions, and thus promote the realization of national food security and sustainable development goals, providing a solution concept for the problems faced by global agricultural development (Lipper *et al.,* 2014 and Thornton *et al.,* 2018).

AI-based climate models enable farmers to adapt by suggesting suitable crop varieties, planting schedules and irrigation practices tailored to specific environments. Additionally, AI-powered early warning systems for extreme weather events, such as droughts or floods, allow proactive measures to mitigate risks. By integrating AI with sustainable agricultural practices, CSA promotes resilience and supports global efforts toward food security and environmental sustainability. Sustainable, climate-resilient and equitable development must consider climate variability and change. Therefore, requires usable climate information to guide development, along with mechanisms and capabilities to integrate information into planning, investments, and decisions (Taylor *et al.*, 2021; Vincent *et al.*, 2018).

Effective crop management relies on accurate and timely data. Various sources such as satellite imagery, weather data, soil sensors, and historical records contribute to a comprehensive dataset. However, pre-processing is essential to handle data quality issues, standardize formats, and extract relevant features for model training. Predicting crop yields is crucial for planning planting schedules, optimizing resource allocation and estimating future revenues. Supervised learning techniques, including regression and ensemble methods, are applied to historical yield data along with factors such as weather patterns, soil conditions and crop variety to build predictive models. The agrodealer programs in Kenya, Malawi, Mozambique and some other African nations have increased farmers' access to inputs. Agro-dealers are educated to provide seasonal agroadvisory information to lead farmers on the optimum inputs for various agro-ecological locations (Nyasimi *et al.,* 2014 & Simelton *et al.,*2021)

Nutrient Management

Machine learning techniques can be leveraged to develop nutrient management strategies that maximize yield while minimizing fertilizer waste.

Fertilizer Recommendations: ML models analyse soil samples, historical yield data, and nutrient levels to generate personalized fertilizer recommendations. Algorithms such as decision trees and support vector machines help determine optimal nutrient application rates tailored to specific crops.

Remote Sensing for Nutrient Monitoring: Satellite and drone imagery, coupled with ML algorithms, enable remote sensing of crop health and nutrient deficiencies.

Dynamic Nutrient Management: ML algorithms continuously monitor soil nutrient levels and environmental variables, adjusting fertilizer application rates in real-time.

Climate Resilient Agriculture

Climate change poses significant challenges to agricultural productivity and sustainability. This chapter explores how machine learning can help farmers adapt to changing climate conditions, mitigate risks and build resilience in agricultural systems.

Climate Modelling and Prediction: ML models trained on historical climate data and climate simulations provide forecasts of future climate conditions, including temperature, precipitation and extreme weather events. These predictions inform decision-making related to crop selection, planting dates and irrigation scheduling.

Crop Modelling and Resilience: Physiological crop models simulate plant growth and development under different climate scenarios, allowing farmers to assess the resilience of various crop varieties to climate stressors. ML techniques enhance the accuracy and predictive power of these models by incorporating additional factors such as genetic traits and management practices.

Climate-smart Decision Support Systems: ML-powered decision support systems integrate climate forecasts, crop models and economic analysis to recommend adaptive strategies for mitigating climate risks. These systems enable proactive management practices, such as diversifying crop portfolios, implementing conservation practices and investing in resilient infrastructure. Artificial intelligence (AI) uses a digital computer or other controlled machines to simulate, extend, and expand human intelligence, perceive the surrounding environment, and acquire relevant knowledge (Subeesh *et al*,.2021).

Market Analysis and Agricultural Economics

Market dynamics play a crucial role in shaping agricultural production and resource allocation decisions. Machine learning can analyse market data, identify trends, and optimize farm-level decision-making to maximize profitability and competitiveness.

Price Forecasting and Risk Management: ML models analyse historical price data, market trends, and external factors (e.g., weather, policy changes) to forecast commodity prices and assess market risks. Predictive analytics help farmers hedge against price volatility and make informed decisions about crop selection, marketing timing and storage strategies.

Supply Chain Optimization: ML algorithms optimize supply chain operations, including logistics, transportation, and inventory management, to minimize costs and maximize efficiency. Techniques such as clustering, regression analysis, and demand forecasting improve resource allocation and distribution, reducing waste and improving market access for farmers.

Consumer Preferences and Market Segmentation: ML techniques analyse consumer data, social media sentiment, and market surveys to understand consumer preferences and segment markets. Predictive modelling and recommendation systems help farmers tailor production and marketing strategies to meet evolving consumer demands, driving product differentiation and brand loyalty.

Weather Forecasting and Crop Planning

Weather conditions have a profound impact on crop growth, development, and yield.

Weather Data Acquisition and Integration: ML models utilize diverse sources of weather data, including meteorological stations, satellites, and weather APIs, to generate accurate and timely forecasts. Data integration techniques consolidate information from multiple sources and formats, providing a comprehensive view of weather patterns and trends.

Crop Response Modelling: ML algorithms analyse historical weather data and crop performance to develop predictive models of crop response to weather variables. Regression analysis, neural networks, and ensemble methods quantify the relationships between temperature, precipitation, solar radiation, and crop growth stages, facilitating scenario analysis and risk assessment.

Dynamic Crop Planning: Weather-based decision support systems leverage ML-driven weather forecasts and crop response models to optimize planting schedules and input management strategies. Genetic algorithms, simulated annealing, and other optimization techniques generate planting recommendations that maximize yield potential while minimizing exposure to weather-related risks. Weather index-based insurance offers a novel approach to managing agricultural risks associated with natural disasters. By leveraging financial instruments, it attracts social investment to mitigate these risks, providing farmers with a new tool for risk transfer. This innovative solution simplifies claim settlement processes and promotes wider adoption, addressing the challenges of adverse selection and moral hazard inherent in traditional insurance. As weather index-based insurance products have evolved to cover a range of weather conditions, many developing countries have embraced this approach. Since the 21st century, these products have gained traction in various regions, including India, Ethiopia, Mongolia, Africa, and Central Asia (Shirsath *et al.*,2019 and Eltazarov *et al* .,2021).

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"POPULARISATION OF PADDY VAR. CAU R1" IN ADOPTED VILLAGES OF KVK-SOUTH GARO HILLS

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Krishi Vigyan Kendra, South Garo Hills, CAU, Imphal, Meghalaya-794005

Before Intervention

The South Garo Hills district is a subtropical hilly region with an average annual rainfall of 2011.8 mm (Department of Agriculture, Government of Meghalaya, 2020) and making it conducive for lowland paddy cultivation. The crop varieties prevalent in the region are mirosi, minil do·bima, minil nasket, etc. which are long duration and low yielding but preferred by the farmers for its glutinous properties and sweet taste. The improved varieties introduced by ICAR institutes and department of Agriculture, Government of Meghalaya are high yielding and has substantially increased the productivity in preceding years.

Intervention of KVK

KVK in its intervention targeted farmers with preference of glutinous varieties of rice which has longer crop duration with low yield to improve the yield, cropping system and economics keeping in mind the preference of the farmers by conducting OFT, FLD and training for 4 years (2020-23).

Success point after Intervention

- The knowledge on organic cultivation of Paddy var. CAU R1 is increased.
- The area under improved organic cultivation of semi-glutinous paddy var. CAU R1 increased by 58 ha
- The average yield of glutinous/ semi glutinous paddy varieties increased by 10 q/ha.

Initiative of KVK

- Created awareness amongst the farmers.
- Assisted in timely supply of quality seeds and bio inputs for soil and plant health management.
- Provided training and method demonstration of the technology
- Diagnostic field visit.
- Conducted field day.

Impact of Technology

Organic cultivation of paddy var. CAUR1 was done in 60 ha till 2023 and total village covered is 10. The duration of crop variety reduced by 30 days compared to existing varieties. The technology helped the farmer to improve their net income by Rs.19,600/ha on average.

Year	Average Yield (q/ha)	Area (ha)	Nos. of farmers Involve
2020	38.12	12	12
2021	37.89	14	13
2022	39.55	16	18
2023	38.44	18	25

Conclusion

It can be concluded that beneficiary farmers increased their knowledge on the technology after the OFT, FLDs and trainings were conducted. It can also be mentioned that the area under the technology has increased in beneficiary farmers which implies the impact of FLD and trainings to be on the higher side. Paddy CAU R1 gave higher yields where farmers were given training and FLDs were conducted during the last 4 years.

COMPOSTING: A COMPONENT OF NATURAL FARMING

Saroj Kumar Pattanaaik; P. Debnath; B.N.Hazarika and Jayashree Mohanty

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Composting has been a traditional process of decomposing organic matter practiced by the farmers of NE region of India since time immemorial. They prepare compost near to their farm and apply the well decomposed compost in their land to grow crops. They are reluctant to use chemical fertilizers for their crops. Unknowingly they get a good harvest as the application of compost builds long term soil fertility, good soil structure and tilth. Such a soil structure makes better use of water and soil nutrients. This makes the ploughing easier achieving optimum yields on a long-term basis. This important concept of using local organic wastes was lost with an objective to increase yield of crop by following conventional farming. There is a lot of scope to aware the farmers of the region about various methods of composting practiced in the other parts of the country.

Conventional farming use external inputs, chemicals, fertilizers and over use of irrigation water giving more emphasis on yield maximization rather than yield optimization leading to soil fatigue, high cost of production, declining factor productivity and causing imbalance in the ecosystem and lead to high dependency of the farmers on the market forces. Lands are degraded with waterlogging and salinity causing lands are not suitable for cultivation. Environment was badly affected with pollution of groundwater resource. This compels the scientific forum and policy makers to think for re-practicing of organic farming by looking to the agro-ecological conditions and resources with the small and marginal farmers in India. Natural farming is emerging as an alternative farming focusing on optimum utilization of native local resources according to principles of agro-ecology which are based on the cause and effect theory prevalent in the given niche landscape but in the same time follows the universal laws of nature to maintain balance among the components of ecosystem and wellbeing of human beings. Here composting and its methods are discussed as a component of organic farming.

Composting is the natural process of 'rotting' or decomposition of organic matter by microorganisms under controlled conditions. Raw organic materials such as crop residues, animal wastes, food garbage, some municipal wastes and suitable industrial wastes, enhance their suitability for application to the soil as a fertilizing resource, after having undergone composting.

Advantages of Composting

- Volume reduction of waste.
- Final weight of compost is very less.
- Composting temperature kill pathogen, weed seeds and seeds.
- Matured compost comes into equilibrium with the soil.
- During composting number of wastes from several sources are blended together.
- Excellent soil conditioner
- Saleable product
- Improves manure handling
- Reduces the risk of pollution
- Pathogen reduction
- Additional revenue.
- Suppress plant diseases and pests.
- Reduce or eliminate the need for chemical fertilizers.
- Promote higher yields of agricultural crops.
- Facilitate reforestation, wetlands restoration and habitat revitalization efforts by amending contaminated, compacted and marginal soils.
- Cost-effectively remediate soils contaminated by hazardous waste.
- Remove solids, oil, grease and heavy metals from storm water runoff.
- Capture and destroy 99.6 percent of industrial volatile organic chemicals (VOCs) in contaminated air.
- Provide cost savings of at least 50 percent over conventional soil, water and air pollution remediation technologies, where applicable.

Demerits of Using Composts

Agricultural use of composts remains low for several reasons:

- The product is weighty and bulky, making it expensive to transport.
- The nutrient value of compost is low compared with that of chemical fertilizers and the rate of nutrient release is slow so that it cannot usually meet the nutrient requirement of crops in a short time, thus resulting in some nutrient deficiency

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- The nutrient composition of compost is highly variable compared to chemical fertilizers.
- Agricultural users might have concerns regarding potential levels of heavy metals and other possible contaminants in compost, particularly mixed municipal solid wastes. The potential for contamination becomes an important issue when compost is used on food crops.
- Long-term and/or heavy application of composts to agricultural soils has been found to result in salt, nutrient, or heavy metal accumulation and may adversely affect plant growth, soil organisms, water quality, animal and human health.

Methods of composting

I. NADEP method of composting

- The NADEP method of making miracle compost was first invented by a farmer named *N.D. Pandharipande* (also popularly known as "*Nadepkaka*") living in Maharashtra (India).
- The method, which has become quite popular among the farmers in Western India, now bears his name.
- The NADEP method of making compost is unique not because it is successful in making good compost, which other methods can also lay claim to its real secret lies in the large quantities of compost the process can deliver with a minimum of human effort within a specific period of time.
- The process basically involves placing select layers of different types of compostable materials in a simple, mud-sealed structure designed with brick and mud water.
- The system permits conversion of approximately 1 kg of animal dung into 40 kg of rich compost which can then be applied directly to the field.
- The multiplication factor is significant in view of the fact that in the tropics, there is rapid decomposition of organic materials in the soil.
- This organic matter must be replaced and replenished if agricultural fertility is not to go on declining.
- The problem is scarcity of compostable materials, particularly animal dung is prevailing within the country. (A good proportion of animal dung is dried and used as fuel in many rural areas.) Thus, even if all available organic materials, including dung, were religiously and scrupulously collected, they would still not be sufficient to replace the organic constituents of the vast quantities of India's fast-degrading soils.
- The NADEP method of composting actually enables the farmer to get around the difficulty of generation of mass and to increase the quantity of compost rapidly within a given frame of time and without any significant additional expense.

Name of person or institution responsible for the practice or experience is Dr. Kumarappa Gowardhan Kendra

- *The NADEP method of organic composting was developed by a Gandhian worker called Narayan Deorao Pandharipande of* Maharastra *(Pusad).*
- Compost can be prepared from a wide range of organic materials including dead plant material such as crop residues, weeds, forest litter and kitchen waste.
- Compost making is an efficient way of converting all kinds biomass into high value fertilizer that serves as a good alternative to farmyard manure, especially for crop-growing households without livestock.

Description

- This method of making compost involves the construction of a simple, rectangular brick tank with enough spaces maintained between the bricks for necessary aeration.
- The recommended size of the tank is 10 ft (length) × 6 ft (breadth) × 3 ft (height) with 9 inch thick wall made up of brick or stone masonry. For circulation of air, proper holes of 7inches (preferably) are left on all the four sides of the tank wall. Plastering of inner-outer wall & floor of the tank should be done by dung and mud mixture.

ESTABLISHMENT ACTIVITIES

Raw materials required for filling NADEP tank

- Agricultural waste (Dry & green): 1350 to 1400 kg
- Cattle dung or biogas slurry: 98 to 100 kg
- Fine sieved soil: 1675 kg
- Water: 1350 to 1400 litres
- The important technique in the manufacture of NADEP compost is that the entire tank should be filled in one go, within 24 hours and should not go beyond 48 hours, as this would affect the quality of the compost.

- Thatched roof, Brick Wall Flooring, Air Vents, Green-farm technologies for small and marginal farms Resources Center for Sustainable Development as shown in figure 1.
- *Before filling,* the tank is plastered by dilute cattle dung slurry to facilitate bacterial activity from all four sides. It is also filled in definite layers each layer consisting of the following sub layers.

Sub-layer-1

- 4 to 6 inch thick layer of fine sticks, stems, (To facilitate aeration) followed by 4 to 6 inch layer of dry and green biomass.

Sub-layer-2

- 4 kg Cow dung is mixed with 100 litres of water and sprinkled thoroughly on the agricultural waste to facilitate microbial activity.'

Sub-layer-3

- 60 kg of fine dry soil is spread uniformly over the soaked biomass for moisture retention and acts as a buffer during biodegradation. Thus the proportion of organic materials for each layer is 100 kg organic biomass, 4 kg cowdung + 100 litres water +60 kg soil. In this way, approximately 10 -12 layers are filled in each tank. After filling the tank, biomass is covered with 3 inch thick layer of soil and sealed with cow dung +mud plaster.

Maintenance

- After 15-30 days of filling the organic biomass in the tank gets automatically pressed down to 2 ft.
- The tank is refilled by giving 2-3 layers over it and is resealed.
- After this filling the tank is not disturbed for 3 months except that it is moistened at intervals of every 6-15 days.
- The entire tank is covered with a thatched roof to prevent excessive evaporation of moisture.
- Under no circumstances should any cracks be allowed to develop. If they do, they should be promptly filled up with slurry.

Benefits

- Reduced cash expenses on chemical fertilizer, improved soil fertility, increased crop yield.
- Supports organic crop production, reduced dependence on outside inputs.
- From each NADEP tank approximately 2.5 tons of compost is prepared within 90-120 days.
- The use of compost reduced the need for mineral fertilizer thus reducing production costs and outside dependence.

Fig. 1 a. NADEP tank construction

Fig. 1b. NADEP tank filled with Agricultural waste (Dry & green), Cattle dung or biogas slurry, Fine sieved soil& sprinkled with water.

II. BANGALORE method of Composting

In the **Bangalore method** of composting, dry waste material of 25 cm thick is spread in a pit and a thick suspension of cow dung in water is sprinkled over for moistening. A thin layer of dry waste is laid over the moistened layer. The pit is filled alternately with dry layers of material and cow dung suspension till it rises 0.5 m above ground level. It is left exposed without covering for 15 days. It is given a turning, plastered with wet mud and left undisturbed for about 5 months or till required.

In Bangalore method, there is aerobic decomposition to start with, following by anaerobic fermentation. The Bangalore compost is not so

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thoroughly decomposed as the Indore compost or even as much as the Coimbatore compost, but it is bulkiest.

Compost is a rich source of organic matter. Soil organic matter plays an important role in sustaining soil fertility, and hence in sustainable agricultural production. In addition to being a source of plant nutrient, it improves the physico-chemical and biological properties of the soil. As a result of these improvements, the soil:

(i) becomes more resistant to stresses such as drought, diseases and toxicity;

(ii) helps the crop in improved uptake of plant nutrients; and

(iii) possesses an active nutrient cycling capacity because of vigorous microbial activity.

These advantages manifest themselves in reduced cropping risks, higher yields and lower outlays on inorganic fertilizers for farmers.

III. INDORE method of composting

In the Indore method of composting, organic wastes are spread in the cattle shed to serve as bedding. Urine-soaked material along with dung is removed every day and formed into a layer of about 15 cm thick at suitable sites. Urine-soaked earth, scraped from cattle sheds is mixed with water and sprinkled over the layer of wastes twice or thrice a day. Layering process continued for about a fortnight. A thin layer of well decomposed compost is sprinkled over top and the heap given a turning and reformed. Old compost acts as inoculum for decomposing the material. The heap is left undisturbed for about a month. Then it is thoroughly moistened and given a turning. The compost is ready for application in another month.

Table 1. Dung and urine produced by animals per day

Animal	Urine (ml / kg live wt)	Quantity of dung (kg) per day
Horse	3-18	9-18
Cattle	17-45	18-30
Buffaloes	20-45	25-40
Sheep and goats	10-40	1-2.5
Pigs	5-30	3-5
Poultry	-	2.5-3.5

Table 2. Nutritive value of animal solid and liquid excreta

Animal	Dung (mg/g)			Urine (%)		
	N	P	K	N	P	K
Cattle	20-45	4-10	7-25	1.21	0.01	1.35
Sheep and goat	20-45	4-11	20-29	1.47	0.05	1.96
Pig	20-45	6-12	15-48	0.38	0.1	0.99
Poultry	28-62	9-26	8-29	-	-	-

IV. COIMBATORE method of composting

In **Coimbatore method**, composting is done in pits of different sizes depending on the waste material available. A layer of waste materials is first laid in the pit. It is moistened with a suspension of 5-10 kg cow dung in 2.5 to 5.0 litre of water and 0.5 to 1.0 kg fine bone meal sprinkled over it uniformly. Similar layers are laid one over the other till the material rises 0.75 m above the ground level. It is finally plastered with wet mud and left undisturbed for 8 to 10 weeks. Plaster is then removed, material moistened with water, given a turning and made into a rectangular heap under a shade. It is left undisturbed till its use.

V. VERMICOMPOSTING

Vermicomposting is the process converting organic wastes into manure rich in high nutritional content by earthworms. The manure is in the form of worm castings. The castings are rich in plant loving nutrients like nitrogen, potassium, phosphorous, calcium and magnesium. Vermicompost, apart from supplying nutrients and growth enhancing hormones to plants, improves the soil structure leading to increase in water and nutrient holding capacities of soil. The vermicomposting unit should be made near a dairy unit as shown in the figure 2 and in the area of availability of raw materials with concentration of fruit and vegetable and floriculture units. About 0.5-1 acre of land will be needed to set up a vermiculture production cum extension centre. The centre will have at least 8-10 sheds each of about 180-200 sq.ft. It should also have a bore well, and pump set or watering arrangement. Vermicomposting is done in small scale and large scale units by following methods:

- Bed Method: This is an easy method in which beds of organic matter are prepared.
- Pit Method: In this method, the organic matter is collected in cemented pits. However, this method is not prominent as it involves problems of poor aeration and waterlogging.

Bed method is followed for commercial production of vermicompost. It is the common method of vermicomposting. In this method, the beds are prepared in tanks. The vermi unit should be located in a raised ground to avoid waterlogging condition during rainy season. The vermi tanks are made up of brick or stone masonry. The dimension of each tank is 10feet × 6feet × 3feet with 9inch brick or stone masonry wall. The floor is made up of brick or stone masonry. Plastering of inner-outer wall & floor of the tank should be done by dung and mud mixture. The tank should be surrounded with a drain of size (0.3m ×0.3m) as a bio-control measure against the attack of earth work enemies especially ants. The base of the tank should be connected with a small tank with the help of a PVC pipe for collection of vermiwash. The pipe may be provided with a valve. The end of the pipe towards vermin-tank should be covered with a plastic net to prevent the exit of earthworms as shown in the figure 3. For commercial production, series of tanks are made with a shed. The roof of the shed may preferably be thatched or covered with a polythene sheet. While designing the sheds adequate room has to be left around the beds for easy movement of the labour attending to the filling and harvesting the beds.

However, HDPE vermibeds are commercially available with sizes 6feet ×4feet ×2feet, 10feet ×4feet ×2feet and 12feet ×4feet ×2feet with HDPE shed.

Fig. 2 a. Cowshed provides raw material for vermicompost unit

The process of composting crop residues using earthworms comprise spreading the agricultural wastes and cow dung in layers as 1.5 m wide and 0.9 m high beds of required length. Earthworms are introduced in between the layers @ 350 worms per m^3 of bed volume. *Eisenia fetida, Eudriluseugeniae, Perionyx excavatius* are some of the species of earthworms used for rearing to convert organic wastes into manure. The beds are maintained at about 40 - 50% moisture content and a temperature of 20 - 30^{0}C by sprinkling water over the beds. The earthworms being voracious eaters consume the biodegradable matter and give out

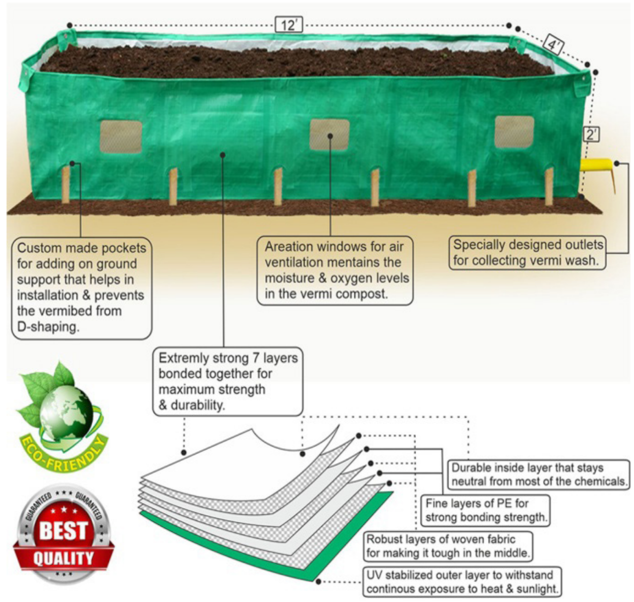

Fig. 2 b. HDPE vermibeds

a part of the matter as excreta or vermi-castings. The vermi-casting containing nutrients is rich manure for the plants.

When the commercial scale production is aimed at in addition to the cost of production, considerable amount has to be invested initially on capital items with the construction of series of beds. The high variability in the unit capital cost is due to the fact that large units require considerable expenditure on machinery and transport particularly when the source of raw materials is away from the site of production facility and the finished product has to be transported to far off places before being marketed. However, in most of the cases, the activity is viable and bankable. Following are the items required to be considered while setting up a unit for production of vermi-compost.

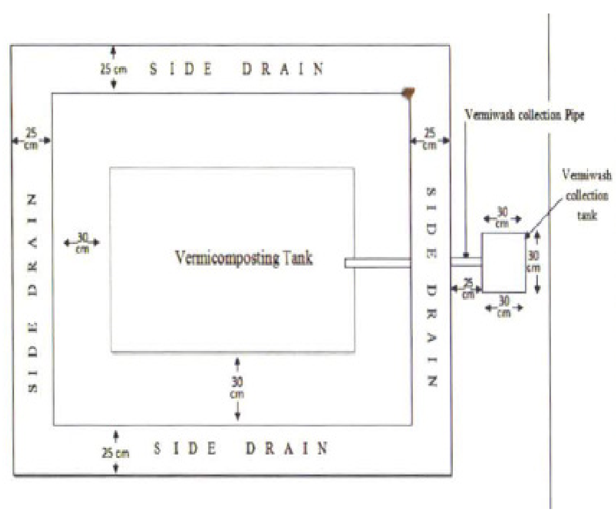

Fig. 3a. Sketch of Drawing of a standard vermin unit

ISSN : 2279-0454

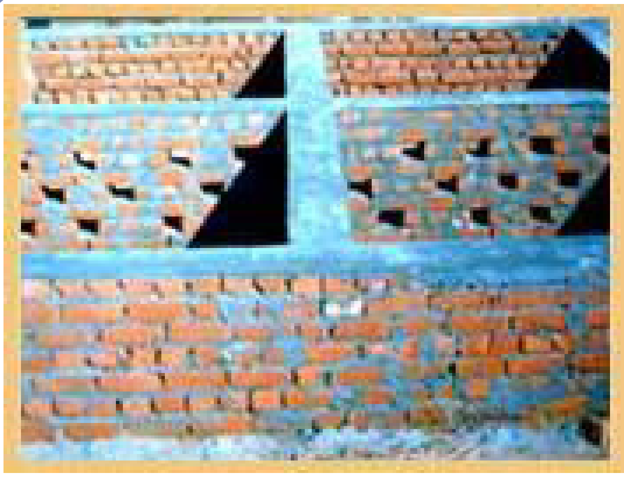

Fig. 3b. Verml beds are made of brick masonry without the provision of vermiwash collection

Composting materials and laying the same into vermin-tank

Composting materials consist of raw materials and cow dung in ratio of 60:40 i.e. biomass 60 parts by weight and cowdung 40 parts by weight are mixed and kept for partial decomposition for a period of about one month so that temperature of the composting materials comes below 30^0C prior to the transfer of composting materials into the vermi-tank. The same may be prepared in a pit outside the vermin-tank. The earthen pit may be lined with a polythene sheet which should be protected from sun and rain. The following steps are followed:

- Now prepare fine bedding by adding partially decomposed cow dung, dried leaves and other biodegradable wastes collected from fields and kitchen. Distribute them evenly on the sand layer.
- Continue adding both the chopped bio-waste and partially decomposed cow dung layer-wise into the tank up to a depth of 0.5-1.0 ft.
- After adding all the bio-wastes, release the earthworm species over the mixture and cover the compost mixture with dry straw or gunny bags.
- Sprinkle water on a regular basis to maintain the moisture content of the compost.

The following raw materials are needed for preparation of vermicompost. Any biodegradable wastes can become raw materials.

- Raw cow dung
- crop residues
- Weed biomass
- Vegetable waste
- Leaf litter
- Hotel refuse
- sugarcane trash
- Waste from agro-industries
- Biodgradable portion of urban and rural wastes
- banana psedostem and water hyacinth

Harvesting

The compost will be ready in 60 to 90 days and the material becomes moderately loose, crumbly with dark brown colour. It will be black, granular, lightweight and humus-rich. Presence of earthworm castings (vermicompost) on the top of the bed is also an indicator and vermicompost can be harvested. Stop watering two to three days before emptying the beds to facilitate separating the worms from the compost (80 per cent of the worms will move to the bottom of the bed). The harvested material should be placed in a heap in the sun so that most of the worms move down to the cool base of the heap. In the two or four pit system, watering should be stopped in the first chamber so that worms will automatically move to another chamber where the required environment for the worms are maintained in a cyclic manner and harvesting can be done continuously in cycles.

Separation of earth worms

- The worms can be separated by using sieves/ meshes.
- The earthworms and the thicker material, which remains on top of the sieve, are recomposted.
- The smell of the compost is earth-like.
- Any bad odour if formed is a sign that fermentation has not reached its final goal and that the bacterial

CAU Farm Magazine (Vol. 13, No. 1)

processes are still going on.

- A musty smell indicates the presence of mold or overheating which leads to loss of nitrogen.
- If this happens, aerate the heap better or start again, adding more fibrous material and keeping the heap drier.
- The compost is then sieved before being packed.

Machinery

Farm machinery and implements are required for cutting (shredding) the raw material in small pieces, conveying shredded raw material to the vermi-sheds, loading, unloading, collection of compost, loosening of beds for aeration, shifting of the compost before packing and for air drying of the compost, automatic packing and stitching for efficient running of the unit. Costs of providing necessary implements and the machinery have to be included in the project cost.

Transport

For any vermi-composting unit transport arrangement is a must. When the source of raw material is away from the production unit, an off-site transport becomes major item of investment. A large sized unit with about 1000 tonnes per annum capacity may require a 3-tonne capacity mini-truck. With small units particularly with the availability of raw material near the site, expending on transport facility may become infructuous. On-site transport facilities like manually drawn trolleys to convey raw material and finished products between the storage point and the vermi-compost sheds could also be included in the project cost.

Nutritive value of vermicompost

The nutrients content in vermicompost vary depending on the waste materials that are being used for compost preparation. If the waste materials are heterogeneous one, there will be wide range of nutrients available in the compost. If the waste materials are homogenous one, there will be only certain nutrients available. The composition of vermicompost is as follows:

Table 3. Composition of vermicompost

Sl. No.	Nutrition Content	Percentage
1	pH	7.43
2	Organic carbon	9.5 – 17.98%
3	Nitrogen	0.5 – 1.50%
4	Phosphorous	0.1 – 0.30%
5	Potassium	0.15 – 0.56%
6	Sodium	0.06 – 0.30%
7	Calcium and Magnesium	22.67 to 47.60 meq/100g
8	Copper	2 – 9.50 mg kg-1
9	Iron	2 – 9.30 mg kg-1
10	Zinc	5.70 – 11.50 mg kg-1
11	Sulphur	128 – 548 mg kg-1

Storing and packing of vermicompost

The harvested vermicompost should be stored in dark, cool place. It should have minimum 40% moisture. Sunlight should not fall over the composted material. It will lead to loss of moisture and nutrient content. It is advocated that the harvested composted material is openly stored rather than packed in over sac. Packing can be done at the time of selling. If it is stored in open place, periodical sprinkling of water may be done to maintain moisture level and also to maintain beneficial microbial population. If the necessity comes to store the material, laminated over sac is used for packing. This will minimize the moisture evaporation loss. Vermicompost can be stored for one year without loss of its quality, if the moisture is maintained at 40% level.

Operational Costs

In order to operate the unit, expenditure on some items have to be incurred on a recurring basis. Presence of cowshed near the vermicompost unit reduces operational cost of production of vermicompost. These items include salaries of the staff, wages to the labourers, cost of raw material, fuel cost on transport of raw materials and finished goods, packing material cost, repairs and maintenance, power, insurance, etc. The number of office personnel and labourers have to be decided breaking each activity into a number of sub-activities and for each sub-activity estimating the work involved and the capacity of the labour to finish the work in a given time. The number of persons should be so chosen to keep them engaged throughout by providing enough persons at various work points like stores, vermi-tanks and equipping them with adequate number of implements to avoid undue waiting.

Vermiwash

Vermiwash is a mixture of earthworm urine and water applied for keeping the biomass in the composting tank in a moist condition. The vermiwash is reddish in colour with alkaline in reaction and carries the dissolved nutrients present in the vermicompost. The composition of vermiwash is given in Table 4.

ISSN : 2279-0454

Table 4. Composition of vermiwash

pH	EC (dS/m)	Total N (mg/lt)	Total P (mg/lt)	Total K (mg/lt)
7.87	0.09	1482	189	1513

VI. Use of Mushroom bed wastes for composting

After the harvest of mushroom, the mushroom beds can be used for composting in the NADEP tank or in the vermicompost unit. It is observed that the mushroom bed wastes are not well suited by the earth worms used in the vermicompost unit. However, these wates can be used in the NADEP tank for composting.

Mushroom Unit

Mushroom beds after harvest

Conclusion

The NE region is a natural choice for promotion of organic farming due to the reason that the farmers of the region are reluctant to use chemical fertilisers for their crops. This practice has been followed since generations. Sikkim is the first declared organic state in the country. The scope of organic farming in the region compelled the line departments and extension wing of Central agricultural University, State Agricultural University and ICAR regional centres to aware the various methods of composting (NADEP method, BANGALORE method, INDORE method , COIMBATORE method and Vermicomposting**)** by using local available materials as a substitute of chemical fertilizers to increase the productivity of crops especially fruits and vegetables and selected underutilised grain crops like millets and buckwheat. Low-cost composting units by using the local available bamboo (*Dendrocalamus hamiltonii* Nees, *Bambusa pallida* Munro), tokopata (*Livistona jenkinsiana* Griff), etc. have a lot of scope among the farmers of NE region. This will boost the availability of economic organic fertilizers in the form of farm made compost for growing organic crops. This will improve the economy of the NE region.

NAPIER GRASS: AN ECO-FRIENDLY AND LOW-COST ALTERNATIVE FEED FOR FISH, POULTRY AND PIGS

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Feed constitutes a significant portion of operational costs for fish, livestock, poultry, and piggery farms, often ranging from 50% to 70% of total expenses, depending on the intensity of farming operations. To reduce these costs, cultivating feed crops and grasses such as Napier grass has become an economically viable and sustainable solution, especially for medium and large-scale farms. This strategy not only decreases dependency on commercial feed but also provides flexibility in managing feed resources. Traditionally cultivated for dairy cattle, Napier grass has emerged as a promising feed alternative for other animals and even freshwater fish farmers, especially in regions like Manipur, where agriculture and aquaculture are integral to livelihoods. Over the past decade, research has highlighted the versatility of Napier grass, opening new opportunities to use it as a cost-effective, sustainable feed across multiple farming systems.

Experimentation on Napier Grass varieties at Central Agricultural University, Imphal

The experiment conducted by the AICRP (All India Coordinated Research Project) on Forage Crops and Utilization at the CAU campus in Imphal, aimed at evaluating different varieties of Napier Grass for key attributes such as adaptability, yield and their suitability as feed for various livestock and aquaculture, including fish, pigs and poultry. The experiment involved the following varieties of Napier grass:

Co-3

Co-4

Co-5

Super Napier

Red Napier

BNH-11

RBN-9

Co-6

Findings and Applications

Napier grass serves as an effective and sustainable feed source for fish, poultry and pigs. Its benefits extend beyond feeding, as it enriches pond ecosystems and supports natural food chains. Farmers can cultivate Napier grass along pond bunds or use it directly in ponds with cow manure to enhance plankton growth, which is a natural and cost-effective food for herbivorous fish. This integrated approach reduces feed costs and promotes a more sustainable farming system.

A. Suitability for Different Livestock

1. **For Fish:** All the varieties of Napier grass (CO-3, CO-4, CO-5, CO-6, RBN-9, BNH-11, Red Napier and Super Napier) were found suitable for aquaculture.

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Specifically, they served as supplemental feed for herbivorous fish **species**. Their high fibre content made them an excellent choice for fish that primarily feed on plant-based materials.

2. **For Pigs and Poultry: CO-4, Red Napier and RBN-9** were particularly noted for their effectiveness as feed for pigs and poultry. These varieties stood out due to their nutrient composition, softness, and digestibility, making them highly suitable for improving the health and growth of these animals.

B. Nutritional Profile of Napier Grass

Napier grass has a robust nutrient composition, making it an excellent feed alternative for livestock, poultry birds and aquaculture:

- ❖ Crude Protein: 8–12%, essential for growth and muscle development in animals.
- ❖ Crude Fiber: 26–28%, supporting digestion and maintaining gut health.
- ❖ Total Digestible Nutrients (TDN): 55–58%, contributing to energy supply for fish, pigs and poultry.

C. Cost-Effective Supplement

- ❖ Reduces Feed Costs: Napier grass is an affordable feed option compared to commercial fish feeds, especially for small-scale farmers. It can partially replace costly feed inputs in herbivorous fish diets.
- ❖ High Biomass Yield: With its rapid growth and high productivity, Napier grass ensures a consistent and abundant supply, making it a sustainable feed option for aquaculture.

D. Applications in Fish Feeding

- ❖ Direct Feeding: Chopped young Napier grass can be offered to herbivorous fish like grass carp, which naturally graze on vegetation.
- ❖ Fermented Grass: Fermentation improves the digestibility and palatability of Napier grass, making it suitable as a supplementary feed.
- ❖ Biofloc Systems: Napier grass can be composted or fermented to produce biofloc, a nutrient-rich microbial feed that supports fish growth and pond health.

E. Application in Birds and Pigs Feeding

- ❖ Optimal Harvest Time: Napier grass should be harvested at 45 days or when its leaves and stems are tender. This ensures that the grass is at its peak in terms of nutrient content, making it ideal for feeding purposes.
- ❖ Shredding for Digestibility: Before feeding, the grass is shredded into small pieces to enhance its palatability and ease of digestion. This is particularly important for birds such as ducks, swans, and chickens, as well as for pigs, to ensure better nutrient absorption.
- ❖ Mixed Feeding for Balance: Napier grass can be mixed with protein-rich feeds to create a balanced diet. This combination provides essential nutrients needed for the growth and health of birds and pigs, addressing both fibre and protein requirements in their diet.

F. Environmental Benefits

- ❖ Waste Reduction: Using Napier grass as a feed or compost reduces agricultural waste, promoting sustainability in farming systems.
- ❖ Eco-Friendly Option: Incorporating Napier grass into fish farming reduces reliance on commercial feeds, which often have higher carbon footprints due to production and transportation.

Limitations and Recommendations

- ❖ Balanced Diet Required: Napier grass is a valuable feed resource but does not provide a fully balanced diet for fish, poultry, or pigs. To meet their complete nutritional requirements, it must be supplemented with protein-rich feeds like fishmeal or soybean meal. This ensures proper growth, health, and development, as these animals require a mix of nutrients that Napier grass alone cannot supply. Integrating it with other feed sources promotes optimal productivity in livestock and aquaculture systems.

- ❖ Processing for Digestibility: Chopping or fermenting Napier grass improves its palatability and digestibility, making it more suitable as feed for poultry, pigsnd fish. These processes break down the tough fibers, reducing the risk of indigestibility and ensuring better nutrient absorption.
- ❖ Appropriate Usage: Napier grass is more suitable as a feed source for herbivorous species, as they can efficiently utilize plant-based nutrition. Carnivorous fish, on the other hand, require protein-rich animal-based feeds and typically do not benefit from plant-based options like Napier grass.

"PURPLE BLOOMS IN NORTH-EAST: UNLEASHING INDIA'S SAFFRON POTENTIAL"

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Saffron (*Crocus sativus* L.) popularly referred to as "Golden Spice" belonging to the Iridaceae family, originated from Greece to Southwest Asia. In India it is popularly known as "kesar" and is the most expensive spice where production of 1kg of these stigmatic lobes requires about 1,10,000–1,70,000 flowers. The bright red stigmatic lobes of saffron is rich in various components such as asfranal, picrocrocin (imparts taste), and crocin (responsible for color).

Saffron has numerous health benefits such as, reducing cardiovascular and Alzheimer's disease, alongside its medicinal, anti-inflammatory, anti-oxidant property and is widely used as spice and coloring agent in food and beverages.

HARVESTING GOLD

Northeast India's untapped saffron potential

The Northeastern states with fertile soil, higher altitude, cool dry winters and temperate like climate in most of the regions mimic the climate of Kashmir, a major saffron producing region. The region's diverse agro-climatic zones offer unique opportunities for experimenting with new crops and saffron fits well into the agricultural landscape.

Extensive research has identified promising sites for large-scale cultivation, involving local farmers, and promising economic opportunities in the regions of Sikkim, Arunachal Pradesh, Mizoram, and Meghalaya. This initiative aims to leverage the favorable climate and fertile lands to bridge the gap between supply and demand, potentially surpassing traditional saffron producing famed saffron fields of Pampore in Kashmir. India's north-eastern region is undergoing a remarkable transformation into a saffron cultivation hub through the ambitious "Mission Saffron". This initiative signifies an evolution in India's agricultural landscape, showcasing the power of innovation in agriculture and contributing to India's self-reliance in saffron production. This endeavor has ignited excitement within the Saffron community as new possibilities unfold in these fertile lands.

FACTORS MAKING NORTHEAST INDIA AN IDEAL REGION FOR SAFFRON FARMING

Cool, temperate climate

Saffron thrives best in temperate dry condition at an altitude ranging from 1500-1800m above MSL. Temperature plays a major role in growth and flowering, Areas covered with snow are particularly suitable for flowering. Optimum temperature for flowering and corm development is 23 ^{0}C -27 ^{0}C where many regions in the northeastern states, particularly those at higher altitudes**,** experience these temperature ranges. Regions like Tawang, Mechuka**,** West Kameng in Arunachal, and the Khasi hills of Meghalaya are known for their cool temperatures and dry winters, which are perfect for saffron cultivation.

Well drained fertile soil

Saffron thrives in well-drained sandy loam soil with an optimum pH of 6.8-7.8. Mixing of sand with well

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decomposed farm yard manure for porous texture is also followed. The volcanic soil and rich, fertile ground in the hilly regions of the Northeast make them ideal for saffron cultivation. The region's naturally diverse soil types, especially in areas like Nagaland and Sikkim, are well-suited for saffron, allowing farmers to grow this crop with relatively low input.

Low rainfall during the flowering season

Excessive rainfall during the blooming season can lead to flower rot, compromising both the yield and quality of the saffron crop. Northeast India's unique climate, however, provides a favorable environment, with a distinct monsoon season followed by dry winter months, allowing for optimal saffron flowering in October and November.

Organic farming tradition

The north eastern states are renowned for their tradition of organic farming, which aligns perfectly with the growing global demand for organic, chemical-free produce. Saffron is an organic crop by nature, requiring minimal fertilizers and pesticides. This makes it an attractive option for farmers already familiar with organic farming practices in the region.

The trial cultivation was done in Chug, Dorjeeling, Shergaon, Walong and Mechuka districts of Arunachal Pradesh; Laitkor, Mairang, Nongshilliang, Thangsning, Umpling and Upper Shillong districts of Meghalaya; Ailwang, Lunglei and North Vanlaiphai district of Mizoram and Lachung, Phengla, Sajong and Yuksom in Sikkim. Most of these places are situated on high altitudes.

Cultivation potential in Arunachal Pradesh

Many parts of Arunachal Pradesh fit into the profile of saffron cultivation, particularly in districts like Shiyomi, Tawang and West Kameng where the altitude and temperature range are ideal for growing saffron.

The blooming of saffron flowers, which occurs from late autumn to early winter, requires specific climatic conditions. Arunachal Pradesh's temperate climate, characterized by relatively dry winters and seasonal rains, provides an ideal setting for this sensitive flowering phase.

Saffron Cultivation

Saffron cultivation is a labor-intensive process, but with careful attention, it can yield a high-return crop. The process typically includes:

Planting: Flowering size corms should be more than 10gm or 2.5 cm in diameter, The larger mother corms produce more daughter corms in annual cycle, which also increases the potential for higher yield in subsequent year. Planting time for saffron is from middle of September to October.

Manures and fertilizers: FYM may be incorporated as basal dose @ 15-20 t/ha. A fertilizer dose of 45:60:60kg NPK/ha is best for higher yield of flowers as well as corms. Full dose of P and K along with $1/3^{rd}$ N should be applied at time of planting. Remaining N applied in 2 split doses i.e. half dose at 1 month after planting and remaining half dose in the month of January.

Irrigation: Water requirement of saffron is low. Irrigation interval of 15 days during end of September to October is most crucial for proper growth in corms.

Flowering and harvesting: The crocus flowers bloom in October to September, and this is when the saffron threads are carefully harvested by hand. The yield starts from first year but the economical yield starts from third year onwards. The flowers must be plucked early in the morning before they fully open to prevent any damage.

Crop productivity: Saffron yield varies from 1.5 to 15 kg/ha based on plant density. In Indian saffron productivity is 1.5-3 kg/ha/year.

Drying: After harvest, the saffron stigmas (the red threads) are carefully separated and dried. Proper drying is essential to ensure the saffron retains its flavor and potency.

Post-harvest processing: Saffron threads are typically graded based on their color, aroma, and moisture content. High-quality saffron has a deep red hue and a strong fragrance, with minimal moisture content.

Storage of corms: Uprooted corms may be stored at 23-25 ^{0}C and 65% to 75% relative humidity for 2 months, and subsequently stored at 17 ^{0}C for 50 days. Storage of corms at $2^{0}C$ after flower initiation results in abortion of flower. Storage at freezing temperature damages the corms.

Fig. 1. General field view of saffron cultivation

Fig. 2. Saffron Harvesting in Shi-Yomi district of Arunachal Pradesh

Government support and initiatives

To encourage saffron cultivation in Northeast, both state and central governments have shown support. The Indian government's National Saffron Mission, which aims to promote saffron cultivation outside Kashmir, has included regions like Northeast as potential areas for saffron cultivation.

In Arunachal Pradesh, the state government has also launched initiatives to support the adoption of high-value crops like saffron. These include providing subsidies for corm procurement, offering training to farmers, and facilitating market linkages for the sale of saffron. Additionally, research institutions and agricultural universities are working on developing region-specific techniques to improve yields and quality.

Economic potential and future outlook

Northeast India is poised to reap significant economic benefits from saffron cultivation, driven by rising global demand. By embracing saffron farming, local farmers can mitigate the risks associated with traditional crops, while creating new opportunities for rural employment and income generation. This initiative aligns with the state's broader objectives of promoting sustainable agriculture, boosting the rural economy, and improving the livelihoods of local communities.

Conclusion

Saffron's cultivation in Northeast is not just an exciting agricultural endeavor but also a step toward economic transformation for the region. With its perfect climatic conditions, government support, and the growing global demand for high-quality saffron, North-East is poised to become a significant player in India's saffron production. As the spice slowly takes root in these verdant states, it could herald a new chapter in India's saffron story, one that is enriched by the unique landscapes and culture of the northeast.

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MULCHING IN TOMATO: A SUCCESSFUL TECHNOLOGY FOR BOOSTING PRODUCTION IN EAST GARO HILLS OF MEGHALAYA

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Fig.1: Harvesting of Tomato at Rangmalbadim Village

INTRODUCTION

Mulching is the practice of covering soil surface with organic or synthetic material to improve the soil and promote plant growth. The main benefits of mulching is Moisture Retention (Reduces evaporation and keeps soil moist and plants need less irrigation and conserve water); Weed Control (Suppresses weed growth by blocking sunlight); Soil Temperature Regulation (Keeps soil cooler in summer and warmer in winter); Soil improvement (Mulch improves the soil structure and increases the amount of organic matter in the soil).; Aesthetic Appeal(Enhances the visual appeal of gardens and landscapes); Improves
quality of produce; Prevents soil erosion & runoff; Reduces soil compaction due to heavy rains. A mulch cover enhances the activity of soil organisms such as earthworms. They help to create a soil structure with plenty of smaller and larger pores through which rainwater can easily infiltrate into the soil, thus reducing surface runoff. As the mulch material decomposes, it continuously releases nutrients, thus fertilizing the soil also increases organic matter content in the soil which helps in creating good soil with stable crumb structure. Thus, the soil particles will not be easily carried away by erosive agent. Therefore, mulching plays a crucial role in preventing soil erosion.

In East Garo Hills, moisture stress condition mostly occur under rain fed condition and soil erosion problem exist, mulching could be a better option to address the issues of water stress and soil erosion. In view of the benefits of mulching and prevailing condition in the district, the present study was conducted to assess the effect of different mulching material on tomato (Solanum lycopersicum) on yield and overall fruit quality as compared to traditional farming methods in East Garo Hills district of Meghalaya through on-farm testing (OFT) of Krishi Vigyan Kendra, East Garo Hills at farmers' field.

MATERIAL & METHODOLOGY

Study Area

The East Garo Hills district is a highly disected hilly terrain with geographical area of 1517 Km^2 and located at 25.53º N Latitude and 90.59º E Longitude. The district headquarter is located at Williamnagar with altitude of 262 m above mean sea level.. The District is bounded by South Garo Hills on the south, West Garo Hills on the west, West Khasi Hills on the east and North Garo Hills on the north. The district falls under Agro-Climatic Zone (Planning Commission) of Eastern Himalayan Region (II). The district has an average annual rainfall of around 2500 mm with average rainy days of 150. Major soil in the area is Red and lateritic sandy loam soils. The Simsang River, the longest river in the Garo Hills, flows through the southern part of the district and plays a very important role in the livelihood of the people and it's the main water source in the district for various purposes including agriculture. For the present study, three different villages of East Garo Hills District viz. Rangmalbadim, Upper Baiza and Asabibra were selected to implement the trials.

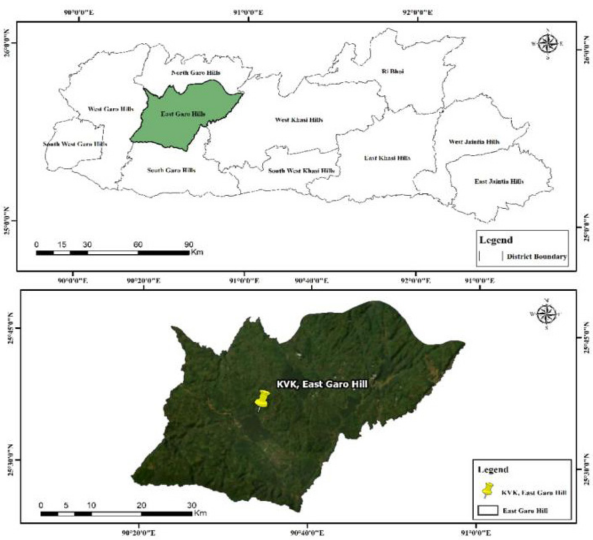

Fig.2: Location Map of East Garo Hills

Methodology

In the present investigation, 09 trials were conducted in 03 selected villages with a plot size 12 m x 0.9 m. The transplantation of tomato (Variety Bioseed 2304) was done with plant to plant spacing of 30 cm. Farm yard manure (FYM) was applied at the rate of 10 t/ha. Irrigation of the plants was done manually.

TREATMENT DETAILS

T1- Black plastic mulching (21 micron of 1.20 m width);
T2- Straw Mulching (5 cm thickness);
T3-Farmers practice (No mulching)

RESULTS & DISCUSSION

For assessing the effect of different mulching material on tomato, key parameters viz. yield per hectare, weed growth, weeding cost (Rs/ha), average fruit weight and Benefit Cost ratio (B:C) were calculated as shown in Table 1and its graphical representation is shown in figure 6.

Fig. 3: Trial at Rangmalbadim Village

Fig. 4: Trial at Upper Baiza Village

Fig. 5: Trial at Asabibra Village

Table 1: Results of assessing different mulching material on Tomato

Parameters	T1- Black plastic mulching	T2- Straw Mulching	T2-Farmers practice
Avg. Yield (Kg/ ha)	2.25×10^4	1.54×10^4	0.77×10^4
Weed growth	Very less	less	high
Weeding Cost Rs./ha throughout the season @ Rs. 400/Day/Labour	41.67×10^4	83.3×10^4	166.67×10^4
Avg. fruit weight (Kg)	0.07	0.06	0.05
B:C ratio	1.45	1.41	0.35

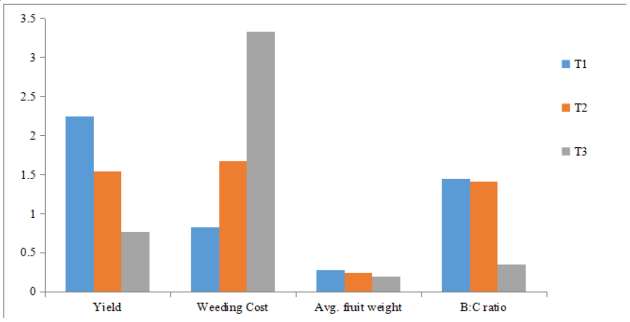

Fig. 6: Graphical Representation of Various Parameters of T1, T2 and T3

From the Table 1 and figure 6, it is shown that the treatment T1 with black plastic mulch is better in all the parameters taken as compared to T2 and T3. Average yields from black plastic mulched plots were higher by 46 % compared to plots with straw mulch. The emergence of weed was quite suppressed in plastic mulch as compare to farmer practice. There is 75 % and 50 % saving in weeding of T1 and T2 with respect to T3, respectively. Additionally, the quality of fruits was notably superior in black plastic mulched plants with average fruit size (Kg) of 0.07, 0.06 and 0.05 for T1, T2 and T3, respectively. The B.C ratio was found to be 1.45, 1.41 and 0.35 for black plastic mulching, straw mulching and Farmers practice, respectively.

CONCLUSION

The findings underscore the advantages of plastic mulching as an effective agronomic practice in the region, providing valuable insights for local farmers aiming to enhance their agricultural productivity amidst varying climatic conditions. The study contributes to sustainable agricultural practices in the hilly terrains of Meghalaya, demonstrating the potential of plastic mulching in optimizing resource use and crop performance. Thus, results indicated that plastic mulching significantly enhanced plant growth, improved moisture retention, weed suppression, and temperature regulation in the soil. Average yields and the quality of fruits including size and color, was notably superior in black plastic mulched plots compared to straw mulch and farmer practice.

CULTIVATION OF TOMATO VAR. ARKA RAKSHAK- A CASE STUDY

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Before Intervention

Tomato is one of the important vegetable crops grown in South Garo Hills district of Meghalaya. However, low adoption of hybrids and other factors such as occurrence of pests, diseases and abiotic factors results in low yield of the crop. Among biotic factors, diseases like tomato leaf curl virus, bacterial wilt and early blight cause yield loss up to 70-100%. The Indian Institute of Horticultural Research (IIHR), Bengaluru developed the triple disease resistant tomato hybrid Arka Rakshak which is resistant to the three prominent diseases with the initial yield potential of 75-80 t/ha. Fruits of the hybrid are square round, large (90-100 g), deep red with very firm fruits and suitable for fresh distant marketing.

The farmers under Chokpot C&RD block of South Garo Hills district in Meghalaya have been cultivating tomato traditionally since many years. However, they use local varieties and seeds purchased from local market. The crops were often affected by severe pests and diseases and hence they suffered major losses. Diseases like early blight and bacterial wilt are the major problem in the area and the yield is also very less. They also faced other problems such as lack of suitable varieties, low technical knowledge and low-quality produce.

Intervention of KVK

During the baseline survey and field visit, it was found that the farmers were practising traditional method of tomato cultivation with the locally available seeds and varieties. They were facing problems such as low production, high pest and disease infestation, *etc.* KVK, South Garo Hills, after identifying the problems, procured tomato seeds Arka Rakshak variety from ICAR-IIHR, Bengaluru and conducted OFT on “Management of tomato leaf curl virus, bacterial wilt and early blight disease of tomato" for two years (2020-21 & 2021-22) and it was later transferred to FLD programmes for two years (2022 & 2023). The farmers were given various capacity development and method demonstration programmes on scientific production and adoption of plant protection measures by KVK, South Garo Hills. As a result, the farmers received good quality tomatoes with increased yield.

Success point/ After Intervention

- The farmers started cultivating Arka Rakshak which has a good level of resistance against three diseases *viz*., tomato leaf curl virus, bacterial wilt and early blight disease.
- The area under tomato cultivation var Arka Rakshak has increased to 10 ha.
- The farmers obtained higher yield and net return.

Initiative of KVK

- KVK, South Garo Hills procured Arka Rakshak seeds from ICAR-IIHR, Bengaluru and distributed to the farmers of the region.
- Capacity development and method demonstration programme on scientific cultivation and management of tomato were organised.
- OFT and FLD programmes on "Management of tomato leaf curl virus, bacterial wilt and early blight disease of tomato" were undertaken.
- Field Days were organised by KVK, South Garo Hills

Impact of Technology:

Initially, farmers relied solely on local varieties or those purchased from the market, achieving an average yield of 215 q/ha and a net return of just Rs 1,40,000/-.

After the introduction of the Arka Rakshak variety, farmers achieved an average yield of 415 q/ha and a net return of Rs 3,05,000/-. In the first year, only three farmers from three villages cultivated Arka Rakshak. However, after experiencing its superior quality, the number of farmers grew to 80, and the number of villages expanded to 10. The farmers witnessed tremendous increase in production (Table 1). The farmers prefer this variety for it has good keeping quality and taste and is suitable for fresh distant marketing.

Table 1: Change of parameters in adopting Arka Rakshak

Parameters	Before Intervention	After Intervention
No. of villages adopting Arka Rakshak	0	10
No. of farmers adopting Arka Rakshak	0	80
Area under Arka Rakshak cultivation in the district (ha)	0	10
Average yield (q/ha)	215*	415
Change in Net Return (Rs/ha) per annum	1,40,000*	3,05,000

**Average yield and net return before intervention is of Local variety.*

The data presented in Table 2 indicated a disease incidence of 35% bacterial blight, 25% leaf curl virus, and 40% early blight of tomato crops of the region. However, after intervention, Arka Rakshak recorded no cases of bacterial blight, just 1% incidence of tomato leaf curl virus, and 6% early blight disease.

Table 2: Performance of Arka Rakshak in disease incidence (%)

Disease	Disease Incidence (%)	
	Before Intervention	After Intervention
Bacterial Wilt	35	0
Tomato Leaf Curl	25	1
Early Blight	40	6

Conclusion

The disease resistant variety helped the small and marginal tomato growers in the area to get better yield and market prices. Arka Rakshak variety is best suited to the agro-climatic conditions of the district, and it was concluded that it can be a better option for tomato growers in the district to save on the additional cost of managing bacterial blight, leaf curl virus, and early blight diseases.

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RAISING AWARENESS AMONG FISH FARMERS: THE USE AND ABUSE OF ANTIBIOTICS IN AQUACULTURE

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Introduction

Aquaculture, the farming of aquatic organisms such as fish, shellfish, and algae, has rapidly grown into a critical component of global food production. With the world's growing population and increasing demand for protein-rich foods, aquaculture offers a sustainable solution for feeding millions of people. However, the intensification of fish farming practices has brought with it challenges, particularly regarding disease management. To maintain the health of fish stocks and ensure optimal production, antibiotics have become a commonly used tool in aquaculture. When used responsibly, antibiotics can be highly effective in controlling bacterial infections, thereby preventing massive economic losses for fish farmers. However, the misuse and overuse of antibiotics pose significant risks, both to human health and the environment, making it essential to raise awareness about responsible practices among fish farmers.

Antibiotics in aquaculture are primarily used for three purposes: treating bacterial diseases, preventing outbreaks, and promoting faster growth. While disease treatment and prevention are essential, the use of antibiotics as growth promoters is a controversial practice that has been banned or restricted in many countries. Fish, like all living organisms, are susceptible to infections, especially when reared in high-density farming environments where the risk of disease transmission is elevated. In such cases, antibiotics can be administered through feed or water to prevent the spread of harmful bacteria. This practice, when carefully monitored and controlled, plays a vital role in maintaining the health of aquaculture stocks.

However, the problem arises when antibiotics are misused - either through overuse, incorrect dosages, or the use of unapproved drugs. The indiscriminate use of antibiotics can lead to the development of antibiotic-resistant bacteria, a phenomenon that poses a grave threat to both aquatic life and human health. These resistant bacteria can spread to the broader environment, infecting other marine species or even being transferred to humans through the consumption of contaminated fish. Once these antibiotic-resistant bacteria enter the food chain, they can render standard treatments for bacterial infections ineffective, leading to severe public health crises.

Moreover, the release of antibiotic residues into the environment through water runoff or improper waste management further compounds the issue. Antibiotics can accumulate in water bodies, affecting the surrounding ecosystems by disrupting microbial communities that play a critical role in maintaining the balance of aquatic environments. Fish farmers, as stewards of the industry, must recognize the broader implications of antibiotic misuse and adopt practices that prioritize both the health of their stock and the environment.

Raising awareness among fish farmers about the responsible use of antibiotics is essential for the sustainability of the aquaculture industry. Education and training in best practices, along with adherence to regulatory guidelines, can help mitigate the risks associated with antibiotic misuse. By implementing preventive measures such as improving water quality, managing fish densities, and using alternatives like probiotics and vaccines, fish farmers can reduce their reliance on antibiotics. In doing so, they not only safeguard the health of their fish stocks but also contribute to the long-term sustainability of aquaculture as a vital food source for future generations.

Approved Antibiotics in Aquaculture

The lists of approved antibiotics and their usage include:

1. **Oxytetracycline Dihydrate** (**Terramycin®** 200 for Fish): Used to treat bacterial diseases such as furunculosis, bacterial hemorrhagic septicemia, and pseudomonas infections. The dosage ranges from 50-75 mg/kg of fish for 10 days, with a 21-day withdrawal period.

2. **Florfenicol** (**Aquaflor®**): Approved for controlling mortality due to bacterial diseases such as *Enteric septicemia* and coldwater disease in fish. The dosage

is typically 10 mg/kg of fish for 10-12 days, with a withdrawal period of 12 to 15 days.

3. **Sulfadimethoxine and Ormetoprim** (**Romet 30®**): Administered to treat enteric septicemia and furunculosis in fish. The dosage is 50 mg/kg of fish for 5 days, with a 3-day to 42 days.

These drugs are added to feed, and fish farmers must follow the specific dosage and withdrawal periods to ensure safety and efficacy.

The Risks of Antibiotic Misuse

Despite their benefits, the misuse of antibiotics in aquaculture carries significant risks:

1. **Development of Antibiotic-Resistant Bacteria**: One of the most pressing concerns is the development of antibiotic-resistant bacteria. When antibiotics are used excessively or improperly, bacteria can adapt and become resistant to the drugs. These resistant strains can spread to other aquatic environments, to humans through the consumption of fish, or via direct contact, posing a serious threat to public health.

2. **Environmental Impact**: Antibiotics released into the environment can disrupt natural ecosystems. Residues can persist in water and sediment, affecting non-target organisms, such as beneficial bacteria, and leading to imbalances in aquatic ecosystems. This contamination can also extend to terrestrial environments through water runoff and agricultural use of contaminated fish waste.

3. **Residue in Fish Products**: Antibiotics used in aquaculture can accumulate in fish tissues, leading to residues in the final product. Consuming fish with antibiotic residues poses potential health risks to consumers, including allergic reactions and the transfer of antibiotic-resistant bacteria.

4. **Economic Consequences**: The overuse of antibiotics can lead to increased costs for farmers. As bacteria become resistant, more expensive and potentially more toxic drugs are required to manage diseases. Furthermore, the presence of antibiotic residues in fish products can lead to trade restrictions and market losses, as many countries have strict regulations on antibiotic use and residue limits.

Best Practices for Antibiotic Use in Aquaculture

To minimize the risks associated with antibiotic use, fish farmers should adopt the following best practices:

1. **Preventative Measures**: Focus on preventing disease through good management practices, including maintaining water quality, controlling stocking densities, and ensuring proper nutrition. Vaccination programs can also reduce the need for antibiotics.

2. **Responsible Use**: Use antibiotics only when absolutely necessary, and always under the guidance of a qualified veterinarian. Follow prescribed dosages and treatment durations to avoid under- or overuse.

3. **Alternatives to Antibiotics**: Explore alternatives to antibiotics, such as probiotics, prebiotics, and herbal remedies, which can help maintain fish health without contributing to antibiotic resistance.

4. **Monitoring and Record-Keeping**: Keep detailed records of antibiotic use, including the type of drug, dosage, duration, and the reason for treatment. Monitoring and record-keeping are essential for managing antibiotic use and meeting regulatory requirements.

5. **Compliance with Regulations**: Adhere to national and international regulations regarding antibiotic use in aquaculture. Ensure that your products meet the required residue limits and avoid using banned or restricted antibiotics.

Promoting Responsible Antibiotic Use in Aquaculture: AINP-AMR New Awareness Initiative at Tripura

The All-India Network Project on Antimicrobial Resistance in Fisheries and Livestock (AINP-AMRFL) formerly INFAAR (Indian Network for Fisheries and Animal Antimicrobial Resistance) project, spearheaded by the National Bureau of Fish Genetic Resources (NBFGR) and the Indian Council of Agricultural Research (ICAR) with support from the Food and Agriculture Organization (FAO), India is a national network dedicated to monitoring antimicrobial resistance (AMR) in the fisheries and animal husbandry sectors across India. With a strategic aim to control AMR spread by promoting judicious use of antibiotics,

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the network recently expanded by establishing a new center at the College of Fisheries, Central Agricultural University (CAU) in Tripura. This center emphasizes educating fish farmers on the critical issues surrounding antibiotic use in aquaculture. Recognizing that overuse and misuse of antibiotics in fish farming can lead to severe AMR problems, this article aims to equip farmers with knowledge and practices to ensure safer, more sustainable fish production. By spreading awareness on responsible antibiotic usage, this initiative contributes to AINP-AMR broader objective of building a robust AMR surveillance and mitigation framework across India's aquaculture sector.

Conclusion

In conclusion, the responsible use of antibiotics in aquaculture is critical to ensuring the sustainability and health of both aquatic ecosystems and human populations. While antibiotics play a crucial role in managing bacterial diseases in fish farming, their misuse can lead to severe consequences, including the development of antibiotic-resistant bacteria, environmental contamination, and potential health risks to consumers. It is essential for fish farmers to be aware of these dangers and to adopt best practices that prioritize responsible antibiotic use. This includes following prescribed dosages, adhering to withdrawal periods, and considering alternative methods such as probiotics, vaccines, and improved farm management practices.

Moreover, regulatory compliance and ongoing education are key to preventing antibiotic misuse in aquaculture. Governments, industry stakeholders, and farmers must collaborate to promote the safe and judicious use of antibiotics. By doing so, the aquaculture industry can continue to thrive as a sustainable source of food while safeguarding public health and environmental integrity. Ultimately, raising awareness and fostering a culture of responsibility among fish farmers will not only protect their livelihoods but also ensure the long-term viability of aquaculture as a crucial component of global food security.

FISH-MUSHROOM INTEGRATED FARMING MODEL IN SOUTH GARO HILLS, MEGHALAYA: A CASE STUDY

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Before intervention

Fish farmers in South Garo Hills, Meghalaya primarily engage in semi-intensive fish farming. However, due to lack of scientific fish culture and management knowledge significantly hampers fish production in the region. Additionally, challenges such as the unavailability of quality fish seeds and feed, along with high transportation costs, further complicate fish farming efforts. To enhance farmers' income by effectively utilizing the available resources, integrated farming system, such as the fish-mushroom integrated farming model, has been introduced in South Garo Hills, Meghalaya.

Intervention of KVK, South Garo Hills

The Krishi Vigyan Kendra (KVK), South Garo Hills, CAU (I), Meghalaya, conducted training programs focused on integrated fish farming, method demonstrations and farmer-scientist interactions to enhance knowledge and skills related to scientific fish farming systems. Additionally, KVK provided essential inputs such as quality fish seeds, mushroom spawn, polythene bags etc. to support the implementation of these technologies in farmers' fields under the On-Farm Testing (OFT) program.

Success point

- Farmers can get additional income from mushroom.
- Waste of one component of integration i.e spent mushroom substrate is utilized in fish production.

- Utilized the available pond dykes to its maximum potential.
- The spent substrate used as a good soil conditioner and as pond manure for the production of plankton, which reduces the use of supplementary feeds.

After intervention

After adopting new technology i.e. fish-mushroom integrated farming, farmers have successfully increased their farm income from both fish and mushroom production. They could reduce the input cost of fish culture by utilizing the waste spent mushroom substrates to produce fish food organisms in the pond thereby reducing the feed input for fish culture. Additionally, farmers have generated additional income by cultivating mushrooms on the pond embankments. This innovative approach has not only enhanced their overall profitability but also optimized resource use in their farming practices.

In this model, semi-intensive fish farming was integrated with the mushroom culture. The shed for mushroom culture were constructed on pond embankments/dykes which get the required moisture from pond water, thus this model minimizes the time require for moisturizing the mushroom bed and ensure easy availability of water round the year.

Initiative of KVK

- Conducted training programme to transfer the technology,
- Distributed inputs like quality fish fingerlings, mushroom spawn, polythene bags, etc.
- Method demonstration of mushroom cultivation,
- Water testing, pond preparation, pond management, fish health management etc.

Impacts of Technology

Farmers can increase their income by integrating fish and mushroom farming, reducing reliance on a single crop that may be less profitable. Farmers can diversify their production by growing both fish and mushrooms, leading to higher overall yields and income from the same available area by reducing the cost of supplementary feeds for fish culture. Both fish and mushrooms tend to have higher market prices compared to conventional crops. So, this integration helps to improved household incomes. Before adoption of this integration model farmers' source of income was from fish only. Overall, the adoption of fish-mushroom integrated farming in South Garo Hills holds promise for enhancing the socio-economic for local farmers. Farmers can harvest about 1990 kg/ha of fish as well as 192 kg of mushroom with an annual net income of Rs. 2.79 lakh/ha.

Table 1: Change of parameters on adopting Fish-Mushroom Integrated Farming Model

Parameters	Before interven-tion	After inter-vention
Number of Villages practicing Fish-Mushroom integrated farming model	0	6
Number of Farmers in-volved in Fish-Mushroom integrated farming model	0	6
Units under Fish-Mush-room integrated farming model	0	6
Average fish harvest (kg/ha)	1586.8	1989.68
Average mushroom har-vest (kg)	0	192
Average Net income per annum (Rs./ha)	1,49,113.6	2,79,329.6

Table 2: Year wise OFTs in South Garo Hills

Year	No. of pond cov-ered	No. of village covered	No. of farmers benefitted
2022	3	3	3
2023	3	3	3

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Conclusion

The fish-mushroom integrated farming model represents a promising approach to sustainable agriculture, offering economic and environmental benefits. By combining aquaculture with mushroom cultivation, farmers can enhance productivity, reduce waste, and contribute to food security. As this model gains traction, it may pave the way for more integrated farming systems in the South Garo Hills region. By integrating fish and mushroom farming, farmers can create a more resilient and profitable integrated fish farming system.

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 virus 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 of the Asfarviridae family. It is a large icosahedral, enveloped virus that contains a linear, double-stranded DNA genome having length between 170to 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 disinfectants based on phenolic and iodide compounds are 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 arise from 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 small holder 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. Small holder 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.

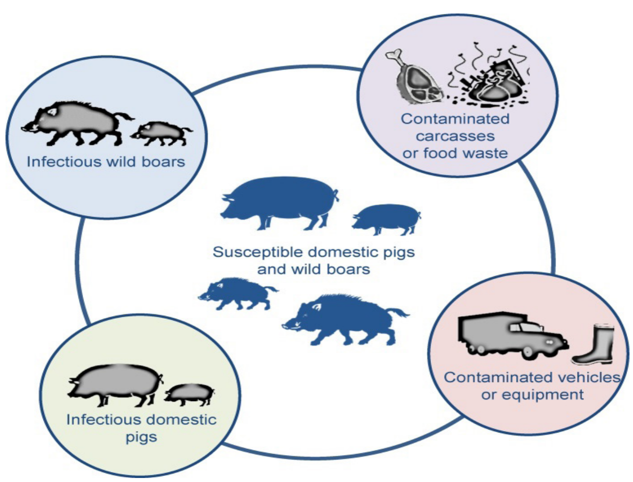
TRANSMISSION AND SPREAD OF ASFV

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, urine or saliva from infected pigs.

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



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

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CLINICAL SIGNS

There are different forms of clinical presentations of ASF; namely, per-acute, acute, sub-acute, and chronic associated with virulence of virus (Yoo *et al*, 2020).

- **Per-acute 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/haemorrhagic spots on ears, abdomen, hind legs, and generalized reddening of skin (chest, abdomen, tail, and leg)
  - Blood from nose/mouth, and bloody faces.
- **Sub-acute 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.

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

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.

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 equipments are needed.

The ELISA is frequently used to screen large numbers 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 programme consists 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 of manure, vehicle disinfection, insect and rodent extermination)
- ❖ Veterinary control of all swine livestock transfers (with individual identification of every animal moved for finishing or breeding purposes)
- ❖ Health certification of every animal used for herd replacement
- ❖ Destruction of every seropositive animal
- ❖ Formation of mobile veterinary field teams exclusively dedicated to support the programme

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, biosecurity, 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

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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, biosecurity 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, biosecurity, 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.

PRESENT STATUS OF RABIES AND ITS ELIMINATION PROGRAMME IN INDIA WITH SPECIAL REFERENCE TO NORTH EASTERN STATES

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Introduction

Rabies is a neglected zoonosis transmitted through the bite of a rabid animal mostly by dogs in India which is almost hundred percent fatal yet hundred percent preventable by timely vaccination. As per WHO (2024) estimates globally, there are 59,000 human deaths due to dog-mediated rabies and India only accounts for 36 percent of the world's Rabies deaths. Unfortunately, India contributes one-third of the global burden due to Rabies and two-thirds of the Rabies burden in the South East Asia. Although the true burden of Rabies in India is

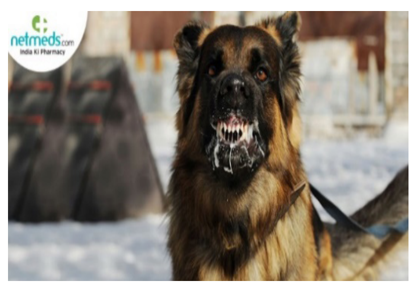

Figure 1: Rabid dog showing hypersalivation.

not fully known, it causes 18,000-20,000 deaths every year. Rabies is endemic in all States/ Union territories except Andaman and Nicobar, and Lakshadweep Islands. Ninety six percent of the mortality and morbidity due to Rabies is associated with dog bites. About 30-60 percent of reported Rabies cases and deaths in India occur in children under the age of 15 years as the dog bites that occur in children often go unrecognized and unreported.

Current Status of Rabies in India/ North East India

The top five states with annual dog bite cases in 2023 are Maharashtra (435126), Tamil Nadu (404488), Gujarat (241846), Bihar (219806), and Karnataka (208656) (IHIP, 2022-23). Among the North Eastern states, the animal bite cases and human deaths due to Rabies are summarized in Table No.1.

Table 1: Number of animal bite and Rabies death cases in North Eastern States of India

Sl. No.	States	Number of Animal bite cases (Year)	Number of human deaths in Rabies (Year)	References
1.	Arunachal Pradesh	3757 (2023)	6 (2023)	https://sansad.in/getFile/annex/262/AU1058.pdf?source=pqars (2023) https://arunachaltimes.in/index.php/2024/03/07/six-rabies-related-deaths (2023)
2.	Assam	83176 (2023)	33 (2023)	https://sansad.in/getFile/annex/262/AU1058.pdf?source=pqars (2023) https://jbfsociety.org/state-govt-in-slumber-as-rabies-death-rises (2024)
3.	Manipur	2511 (2023)	04 (2024)	https://sansad.in/getFile/annex/262/AU1058.pdf?source=pqars (2023) https://www.ifp.co.in/manipur/manipur-rabies-death-toll-reaches-four (2024)
4.	Meghalaya	8374 (2023)	27 (2023-24)	https://sansad.in/getFile/annex/262/AU1058.pdf?source=pqars (2023) https://www.eastmojo.com/meghalaya/2024/09/27/meghalaya-records-27-rabies-deaths-in-two-years-most-cases-from-rural-areas (2024)
5.	Mizoram	1035 (2023)	01 (2022)	https://sansad.in/getFile/annex/262/AU1058.pdf?source=pqars 2023) https://www.undp.org/india/publications/state-action-plan-dog-mediated-rabies-elimination-mizoram
6.	Nagaland	569 (2023)	NA	https://sansad.in/getFile/annex/262/AU1058.pdf?source=pqars (2023)
7.	Sikkim	6069 (2023)	NA	https://sansad.in/getFile/annex/262/AU1058.pdf?source=pqars (2023)

Cause and transmission of Rabies:

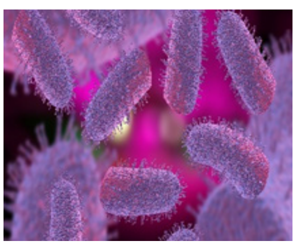

Figure 2: Rabies Virus purified from an infected cell culture.

Bullet-shaped Virus called lyssavirus under the family Rhabdoviridae causes Rabies. The virus most commonly spreads through the bite of an infected mammal including domestic and wild ones (mainly dogs), but transmission can occur from saliva through broken skin or mucous membranes as well.

Symptoms of Rabies in human

The Rhabdovirus travels through the peripheral nervous system finally targeting the central nerves leading to encephalomyelitis. In humans, the initial symptoms are non-specific like fever, malaise, headache *etc*. Then these symptoms progress to anxiety, next to agitation, and further to frank confusion or disorientation. One very consistent symptom after a rabid bite is tingling at the bite site within the first few days. The virus travels back to the peripheral nervous system, particularly affecting highly innervated areas like salivary glands. The Rabies victims experience "frothing," or hyper salivation along with intense pharyngeal muscle spasms at the mere sight, taste, or sound of water. This is called "hydrophobia." Finally, the victim dies quickly due to complete nervous system failure, may be within 10 days. However, the incubation period following an animal bite can last 10 days to 3 months, and even to years. Determining factors for the onset time include the viral load, location of exposure, and wound severity. Once clinical features are seen, rabies is universally fatal.

Inactivation and killing of Rabies virus

Figure 3: Antiseptic solution

The inactivation or killing of the virus in contaminated materials is not a difficult job.

The following methods can be applied to kill the virus.

1. Drying and Sunlight Exposure.
2. Washing of the bite wound with soap (carbolic acid) and

water for at least 15 minutes.

3. Heating at 60°C (140°F) or higher for 30 minutes.
4. Boiling at 100°C (212°F) for a few minutes.
5. By using chemical disinfectants like Alcohol (70% Ethanol), Bleach (1% Sodium Hypochlorite), Quaternary Ammonium Compounds, and Formalin (10%).
6. Ultraviolet (UV) radiation.

Management of Rabies

There is no effective treatment for Rabies. Prevention is the mainstay of treatment. Wound care is the first step in treating any individual with a feared Rabies exposure. Appropriate wound care alone is almost 100 percent effective if initiated within three hours of exposure. Recommendations include scrubbing the wound and surrounding area with soap having carbolic acid and water at least for 15 minutes. The puncture should be properly irrigated with an antiseptic solution. The stitching or scratching of the wound should be avoided. After cleaning the wound thoroughly, a virucidal agent such as Benzalkonium chloride or Povidone-iodine is recommended for application over the wound. The pre-exposure and post-exposure management of the Rabies virus is summarized in Table 2.

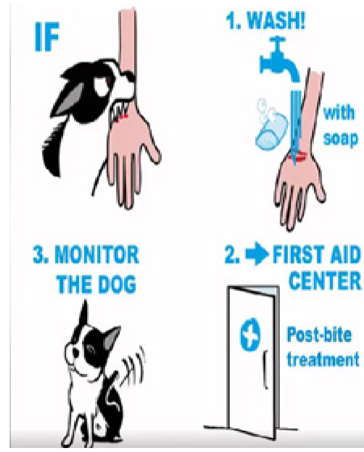

Figure 4: Depicting bite wound management

Table 2: Pre-exposure and Post-exposure management of Rabies virus

Human / Animal	Pre-exposure to bite	Post -exposure to bite
Human	**Primary vaccination:** A series of anti-Rabies vaccines, usually 2 doses in a week (typically on days 0, 7). 	**Wound Care:** As stated above **Anti Rabies vaccine:** Four doses over two weeks are recommended if the person is not previously vaccinated (days 0, 3, 7, 14) and 2 doses (days 0, 3) if previously vaccinated. 
	Booster vaccination: For the high-risk groups like veterinarians and travellers to endemic areas, booster doses are recommended every 2–3 years.	**Rabies Immune Globulin (RIG):** Administered along with the first dose of the vaccine for unvaccinated individuals. The dose of RIG is 20-40 IU, intramuscularly.
Animal	**Primary Vaccination:** Dogs and cats should receive Rabies vaccines. The livestock in India can be vaccinated as per local guidelines (usually annual or triennial).  **Booster Doses:** Dogs and cats may receive booster shots annually to maintain immunity.	**Quarantine or Euthanasia:** If bitten by a potentially rabid animal, unvaccinated animals may be euthanized or quarantined for months. **Vaccination:** For vaccinated animals exposed to Rabies, an immediate booster shot and observation for 45 days are recommended.

Other important steps towards Rabies control and elimination are -

a) Minimizing the population of unvaccinated stray dogs by Animal Birth Control (ABC) programme.
b) Active surveillance and reporting with vaccination drives.
c) Vaccination of entire dog population, 1[St] dose at the age of 3 months and booster after 21 days followed by annual vaccination.
d) Restriction on free movement of pet dogs before completing the anti-rabies vaccination.
e) Vaccination of high-risk groups like veterinarians, hunters, animal handlers, and lab workers.

Strategies adopted for the elimination of Rabies:

Global effort

In 2015, the united collaboration of the World Health Organization (WHO), the World Organization for Animal Health (WOAH), the Food and Agriculture Organization (FAO) of the United Nations, and the Global Alliance for Rabies Control (GARC) set the goal of "Zero human deaths due to dog-mediated Rabies by 2030", worldwide. Countries like Western Europe, Canada, the United States, Mexico, Japan & Latin America have already eliminated dog-mediated Rabies through successful canine Rabies vaccination and the one health approach. World Rabies Day is celebrated annually on 28th September to raise awareness about Rabies prevention and to highlight progress in defeating this horrifying disease.

Government of India's approach

The Ministry of Health & Family Welfare and The Ministry of Fisheries Animal Husbandry & Dairying, Government of India jointly launched the 'National Action Plan for Dog Mediated Rabies Elimination (NAPRE) from India by 2030', on 28th September 2021.

Under the National Health Mission through the National Free Drug Initiative, Ministry of Health and Family Welfare (MoH & FW) funds, States and Union Territories need to procure anti Rabies vaccines and Rabies immunoglobulin since the financial year 2020-21 for Rabies prevention. Anti-rabies vaccine and Rabies immunoglobulin are also under the state essential drug list and it is available free of cost in government hospitals, medical colleges, and anti-rabies clinics. However, approximately, the cost of one vial of Anti rabies vaccine (ARV) is Rs. 250 and the average cost of one vial of Rabies Immunoglobulin (RIG) is Rs. 350. Currently, in India two types of Rabies RIG are available i.e., Human Immunoglobulin (HRIG) and Equine Immunoglobulin (ERIG). Some of the commercially available Anti Rabies vaccines in India for human and animals are given in Table 3 and 4.

Table 3: Some commercially available Rabies vaccines for humans

Vaccine	Manufacturer	Cost
Abhayrab	Indian Immunologicals Ltd	Rs.397 (2 variants)
Rabipur	GlaxoSmithKlinePharmaceuticals Ltd	Rs. 349 (1 variant)
Vaxirab	Zydus Cadila	Rs. 337 to Rs. 397 (2 variants)
Xprab	Sun Pharmaceutical Industries Ltd	Rs. 397 (1 variant)
Zoonovac-V	Bharat Serums & Vaccines Ltd	Rs. 397 (1 variant)
Indirab	Bharat Biotech	Rs. 397 (1 variant)
Worab	Wockhardt Ltd	Rs. 310 (1 variant)
Verorab	Zuventus Healthcare Ltd	Rs. 310 to Rs. 337 (2 variants)
Rabivax-S	Serum Institute of India Ltd	Rs. 397 (1 variant)

Table 4: Some commercially available Rabies vaccines for animals

Vaccines	Manufacturers	Cost
Nobivac Rabies	MSD Animal Health	Rs. 220
Rabisin	Boehringer Ingelheim	Rs. 350
Raksharab	Indian Immunologicals Ltd	Rs. 170
Canigen Rabies	Virbac	Rs. 180
Biocan-R	Zydus Animal Health	Rs. 200

Conclusion:

For those who develop symptoms of Rabies, survival is rare. Once the symptoms appear, death is inevitable. Survival is assured for those rabid animal bite cases without symptoms but only with the Rabies vaccine and immunoglobulin injections as soon as possible after the bite.

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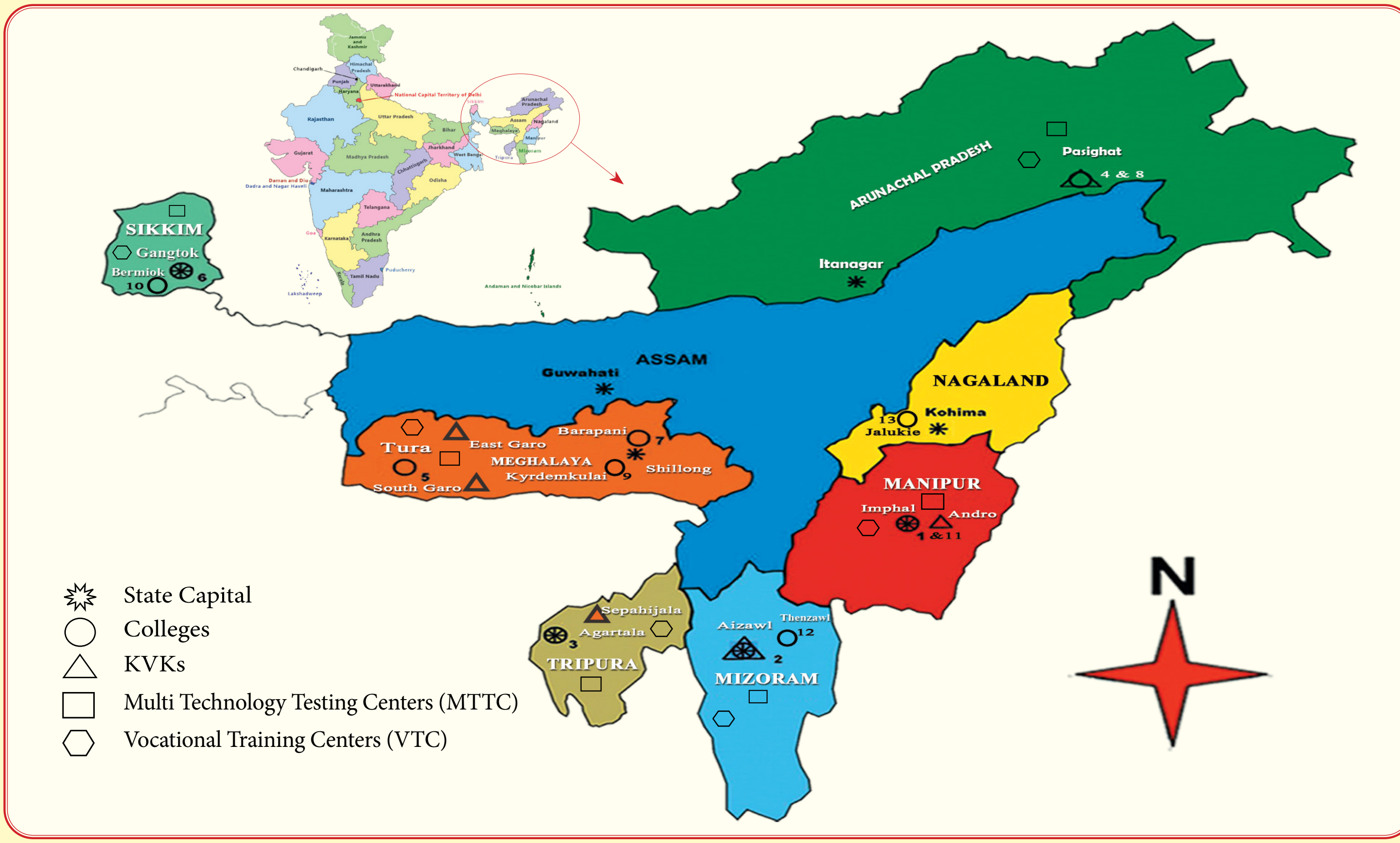

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