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Tuber Crops-Based Integrated Farming System in Manipur

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Manipur, nestled in the northeastern corner of India, is a land of rich cultural heritage and diverse agricultural landscapes (Keisam and Sharma, 2024). This picturesque state, with its lush hills and fertile central valley, offers an ideal environment for a wide array of crops. In this verdant region, the Central Agricultural University (CAU) has launched a groundbreaking initiative through the All India Coordinated Research Project (AICRP) on Tuber Crops. This project promotes an integrated farming system (IFS) centered around tuber crops, aiming to enhance productivity, profitability, and sustainability. This article explores the comprehensive package and practices of tuber crops-based IFS tailored to Manipur's specific conditions.

Understanding the agricultural landscape of Manipur

Manipur spans an area of 22,327 sq. km, predominantly comprising hills (20,089 sq. km) and a central alluvial valley (2,238 sq. km). The state's temperate climate, influenced by the southwest monsoon, results in rainfall ranging from 1,000 mm to 3,500 mm annually. The soil in Manipur is broadly categorized into red ferruginous soil in the hilly regions and alluvial soil in the valley. This diverse agro-climatic condition supports the cultivation of various crops, making it an ideal setting for implementing an integrated farming system (Roy *et al*., 2018).

The concept of integrated farming systems (IFS)

Integrated farming systems (IFS) represent a holistic approach designed to optimize resource use, enhance farm productivity, and ensure sustainability (Singh *et al*., 2020). By interlinking various agricultural enterprises, IFS allows farmers to efficiently utilize by-products and waste materials from one component as inputs for another (Dar *et al*., 2018). This synergy not only reduces production costs but also minimizes environmental impact, making it a sustainable farming practice.

Tuber crops: A focus of AICRP in Manipur

Tuber crops such as cassava, sweet potato, yam, and colocasia are integral in Manipur's agricultural landscape. These crops are valued for their high nutritional content, resilience to adverse climatic conditions, and potential for high yields (Byju and Jaganathan, 2023). The AICRP on Tuber Crops at CAU, Imphal centre has been instrumental in promoting the cultivation and integration of these crops into farming systems, enhancing food security and economic stability for farmers in the region (Devi, 2012).

Objectives of IFS for tuber crops

The key objectives of a tuber crop-based integrated farming system include:

1. Maximization of Yield: Achieving steady and stable income at higher levels through the optimization of yields from all components of the farming system.

2. Rejuvenation of Productivity: Enhancing the productivity of the system to achieve agro-ecological balance.
3. Reduction of Chemical Use: Minimizing the use of chemical fertilizers and harmful agrochemicals to provide pollution-free, healthy produce and a cleaner environment.
4. Resource Utilization and Conservation: Efficiently utilizing and conserving available resources and recycling farm residues within the system to maintain sustainable production without harming the environment.
By adopting these practices, farmers in Manipur can enhance their farming sustainability, productivity, and profitability, while contributing to environmental conservation and community well-being.

Package and practices for tuber crops-based integrated farming system

1. Site Selection: The ideal site for tuber crops should be well-drained soil with good fertility with a pH range of 5.5 to 6.5. In Manipur, red ferruginous soil in the hills and alluvial soil in the valley (Jayanthi et al., 2015) are particularly suitable.
2. Soil Preparation: Land is prepared by ploughing and harrowing to a fine tilth. Break the clods and level the land. Incorporate organic matter such as farmyard manure or compost to enhance soil fertility and structure.
3. Crop Selection: The selection of tuber crops depends on factors such as soil type, climate, and market demand. Common tuber crops grown in Manipur include:

- **Cassava:** Drought-tolerant and grown for its starchy roots.
- **Sweet Potato:** Known for its high nutritional value and thrives in sandy loam soils.
- **Yam:** Prefers loamy soils and is cultivated for its edible tubers.
- **Colocasia:** Grows in upland and lowland areas, requiring well-drained soils.

4. Crop Rotation: Rotating tuber crops with legumes, cereals, and vegetables helps to improve soil fertility and control pest and disease cycles, thus maintaining soil health (Kebede, 2021).
5. Planting Techniques

- **Cassava:** Plant stem cuttings at an angle of 45 degrees, with two-thirds of the cutting buried. Maintain a spacing of 90 cm between rows and 90 cm between plants.
- **Sweet Potato:** Plant vine cuttings on ridges or mounds, spaced 60 cm between rows and 20 cm between plants.
- **Yam:** Plant tuber pieces or mini-setts in prepared mounds or ridges, with 90 cm between rows and 90 cm between plants.
- **Colocasia:** Plant corms or cormels in furrows or mounds, spaced 60 cm between rows and 45 cm between plants.

6. Integrated Nutrient Management

- **Organic Amendments:** Apply well-decomposed farmyard manure or compost @ 10-15 t/ha during land preparation.
- **Green Manuring:** Incorporate green manure crops, such as cowpea or sunn hemp, to improve soil fertility and structure.
- **Inorganic Fertilizers:** Apply balanced doses of nitrogen, phosphorus, and potassium (NPK) based on soil test results. For cassava, the recommended dose is N:P:K @ 75:50:75kg per hectare. For sweet potato, the recommended dose is N:P:K @ 50:25:50kg per hectare and for colocasia, the recommended dose is N:P:K @ 80:60:80kg per hectare.

7. Irrigation Management
Efficient irrigation management is crucial for maximizing yields:

- **Cassava:** Requires minimal irrigation, with supplemental watering during prolonged dry spells.

- **Sweet Potato:** Needs regular irrigation, especially during the establishment and tuber development stages. Drip irrigation is recommended for efficient water use.
- **Yam:** Requires consistent soil moisture, particularly during tuber initiation and development. Mulching helps conserve soil moisture.
- **Colocasia:** Needs frequent irrigation, especially in early growth stages. Maintain adequate soil moisture throughout the growing season.

8. Pest and Disease Management

Integrated pest management (IPM) practices are essential for minimizing crop losses:

- **Cassava:** Monitor for pests like cassava mealybug and cassava mosaic disease. Use resistant varieties and practice crop rotation.
- **Sweet Potato:** Watch for pests such as sweet potato weevil and vine borer. Use pheromone traps and biological control agents.
- **Yam:** Monitor for pests like yam beetle and anthracnose. Use healthy planting material and practice crop rotation.
- **Colocasia:** Check for pests like colocasia leaf blight and taro beetle. Use resistant varieties and maintain good field sanitation.

9. Harvesting and Post-Harvest Management

Timely harvesting and proper post-harvest management are crucial:

- **Cassava:** Harvest 9-12 months after planting. Avoid damaging tubers during harvest to prevent spoilage.
- **Sweet Potato:** Harvest 3-4 months after planting. Cure tubers by exposing them to high humidity and temperatures for a few days to improve shelf life.
- **Yam:** Harvest 6-8 months after planting. Store tubers in a cool, dry place to prevent spoilage.
- **Colocasia:** Harvest 6-8 months after planting. Store corms in a cool, dry place to prevent spoilage.

Benefits of tuber crops-based IFS in Manipur

1. **Resource Optimization:** IFS maximizes the use of on-farm inputs and minimizes purchased inputs, enhancing productivity. Byproducts from one enterprise, such as poultry manure, can be used as inputs for another, like fish feed, reducing production costs and improving farm efficiency.
2. **Increased Productivity:** IFS enhances economic yield per unit area and time through crop intensification and the integration of allied enterprises. This method optimizes the use of space and time, significantly increasing overall productivity.
3. **Improved Profitability:** Utilizing produce or waste from one component as input for another lowers production costs and increases profitability. This system enhances the benefit-cost ratio by minimizing the role of intermediaries and maximizing farm-level resource use.
4. **Environmental Sustainability:** IFS reduces reliance on inorganic fertilizers, pesticides, and herbicides, mitigating soil and environmental pollution. By effectively utilizing byproducts, the system maintains soil productivity and sustains the production base over time.
5. **Balanced Nutrition:** Linking diverse components in IFS produces various nutritional sources such as proteins, carbohydrates, fats, minerals, and vitamins, addressing malnutrition issues prevalent in the average Indian diet. Tuber crops can replaced 40-60 % of conventional feeds in piggery rearing (Singh, 2012).
6. **Effective Recycling:** The stability of IFS comes from the effective recycling of produce and waste materials among components. This recycling reduces production costs and increases net farm income.

7. **Enhanced Nutrient Management:** IFS meets crop nutrient requirements through on-farm resources, applying nutrients based on whole cropping patterns and sequences, thereby minimizing nutrient losses.
8. **Boosted Soil Microbial Productivity:** Intercropping in IFS stimulates the transfer of beneficial rhizospheric microorganisms among component crops, enhancing microbial numbers and biomass, which boosts soil health and productivity.
9. **Employment Generation:** Integrating crop and livestock enterprises significantly increases labor demand, providing year-round employment opportunities and reducing underemployment, especially for family labor.

Conclusion

The integrated farming system based on tuber crops, initiated by AICRP (Tuber Crops) at CAU in Manipur, stands as a sustainable and profitable agricultural model. This approach optimizes resource use, enhances productivity, and ensures environmental sustainability, providing a viable solution to farmers' challenges in Manipur. The comprehensive package and practices outlined in this article serve as a guide for adopting this innovative farming system, paving the way for a prosperous and sustainable agricultural future in Manipur. The integration of tuber crops into farming systems showcases the innovative and forward-thinking approach of CAU and AICRP, addressing not only the immediate needs of food security and economic stability but also ensuring long-term sustainability and environmental conservation. As Manipur continues to embrace these practices, it sets a benchmark for other regions, proving that sustainable agriculture is not just a dream but a viable and achievable reality.

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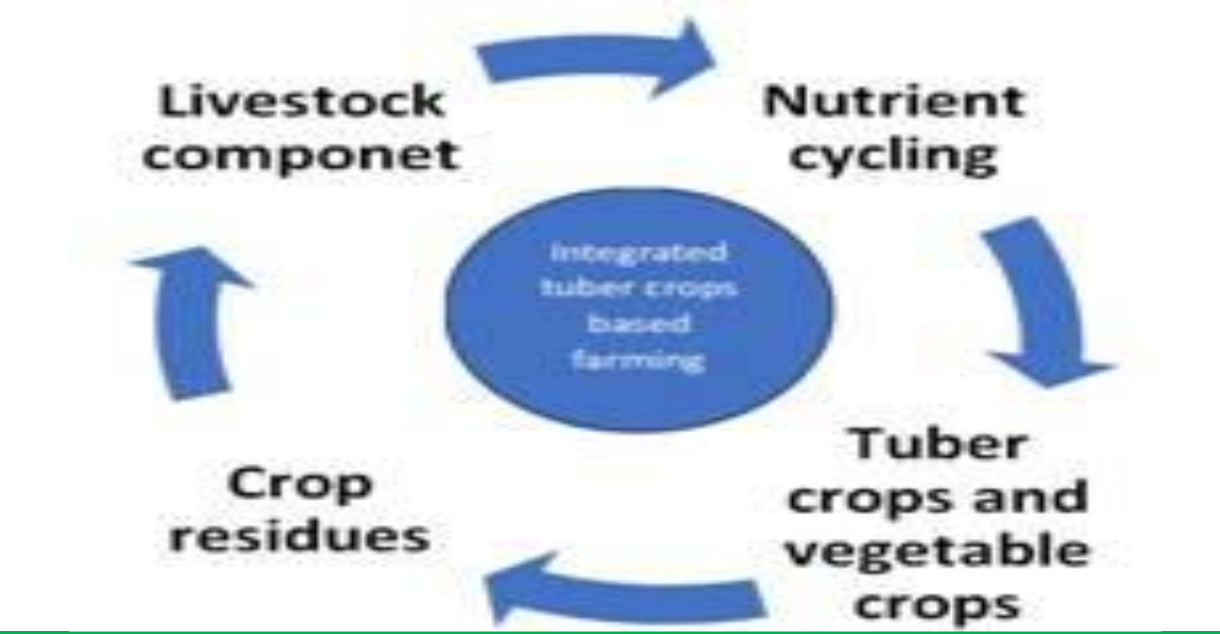

Figure 1: Different components of tuber crops based Integrated Farming System

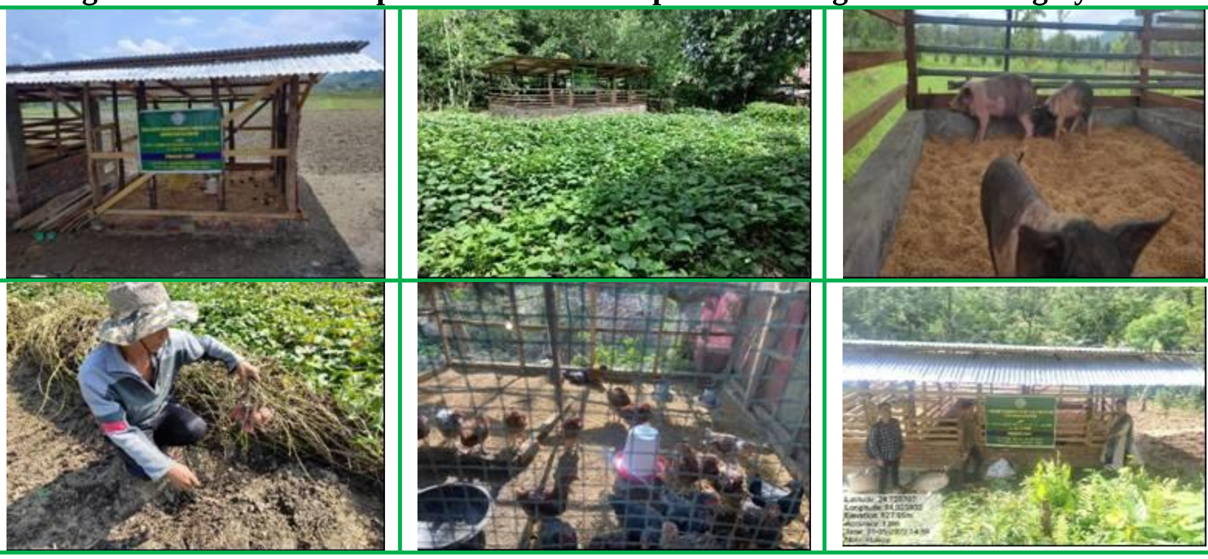

Figure 2: Different components of tuber crops based integrated farming system by AICRP (Tuber Crops), CAU, Imphal, Manipur