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FRUIT TREE-BASED AGROFORESTRY SYSTEMS: A CLIMATE-SMART FARMING SOLUTION

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Climate change poses serious challenges to fruit production, including rising temperatures, erratic rainfall, droughts, and extreme weather events. Fruit tree-based agroforestry, which integrates trees, crops, and sometimes livestock on the same land, offers a practical and sustainable solution to both mitigate climate change and adapt to its impacts. Compared to conventional monocrop orchards, agroforestry systems improve environmental sustainability while ensuring stable farm income.

Fruit trees such as mango, guava, sapota, citrus, jackfruit, and aonla are especially well suited for agroforestry because of their long life span, deep root systems, resilience to stress, and high market value. These trees can be combined with timber species, fodder crops, vegetables, pulses, spices, or medicinal plants, depending on local soil conditions, climate, and farmers' preferences. Such diversification reduces the risks associated with monocropping and ensures year-round income, even under uncertain climatic conditions.

Key Components of Agroforestry

Agroforestry systems are built on the careful integration of different components that interact positively with minimal competition for light, water, nutrients, and space.

- Trees play a central role by conserving soil moisture, improving soil fertility through leaf litter, reducing wind speed, and protecting crops from excessive heat. They also help regulate temperature and humidity, creating a favourable microclimate for crop growth.
- Annual crops such as cereals, pulses, vegetables, or fodder provide quick economic returns, often within three to six months of planting.
- Livestock, where included, adds further value by supplying manure for soil enrichment and generating income through milk, meat, and other by-products.

Together, these components enhance farm productivity, resilience, sustainability, and income stability.

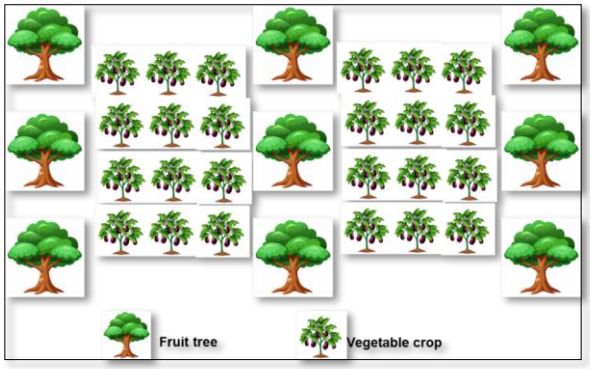

Figure. Layout of horti-olericulture based agroforestry system

Types of Fruit Tree-Based Agroforestry Systems

Several fruit tree-based agroforestry models are practiced across different regions:

- **Agri-Horticulture** – Fruit trees intercropped with annual field crops. Example: Mango + maize, banana + paddy
- **Horti-Olericulture** – Fruit trees grown with vegetables. Example: Mango +

tomato, banana + onion. Figure represents the layout/ schematic view of fruit tree based agroforestry system.

- **Horti-Pastures** – Fruit trees combined with forage or fodder crops, ideal for high-rainfall areas. Annona, guava, ber, pomegranate are compatible species with fodder grasses.
- **Horti/Silvo-Medicinal** – Fruit trees integrated with timber, legume, oilseed trees, and medicinal plants. Example: Mango + senna.
- **Horti/Silvo-Ornamental** – Fruit trees grown along with ornamental plants or flowers. Example: Persimmon + cut flowers
- **Horti-Silviculture** – Fruit trees combined with timber and nitrogen-fixing trees. Example: Guava + Leucaena leucocephala, Ber + Leucaena leucocephala
- **Silvi-Horti-Agri/Olericulture** – Timber trees, fruit trees, and annual crops grown together. Example: Teak + mango + brinjal
- **Horti-Entomoforestry** (Horti-Apiculture) – Fruit trees integrated with honeybee colonies. Example: Mango or jamun orchards with beehives for honey production and improved pollination

Mitigating climate change

The multi-layered canopy structure of agroforestry systems plays a crucial role in climate change mitigation and adaptation. Trees intercept rainfall, reducing soil erosion and surface runoff while enhancing rainwater infiltration and groundwater recharge. This improves water quality, water-use efficiency, and overall water management on farms.

Fruit tree-based agroforestry delivers several important ecosystem services:

1.Carbon Sequestration

Trees capture and store atmospheric carbon dioxide in their biomass and soil, helping reduce greenhouse gas concentrations.

2.Biodiversity Conservation

These systems provide habitats for birds, pollinators, natural enemies of pests, and soil microorganisms, strengthening ecosystem balance.

3.Soil Enrichment

Leaf litter, root activity, and nitrogen-fixing species enhance soil organic matter, nutrient availability, and soil structure.

4.Improved Air and Water Quality

Trees act as natural filters, trapping dust and pollutants and reducing nutrient leaching into water bodies.

Agroforestry-induced microclimate modification such as slightly lower temperatures and increased humidity can reduce heat stress on crops and suppress certain pest outbreaks. However, higher humidity may favour some foliar diseases like mildews and rusts, which can be effectively managed through integrated pest and disease management practices.

A Sustainable Path Forward

By combining food production, environmental protection and climate resilience, fruit tree-based agroforestry offers a climate-smart farming strategy for the future. With proper planning and species selection, these systems help farming communities adapt to climate variability, conserve natural resources, stabilize incomes and maintain long-term ecological balance.

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