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CULTIVATING SUSTAINABILITY: A COMPREHENSIVE REVIEW OF ORGANIC FARMING PRACTICES FOR NUTRIENT-RICH FRUIT PRODUCTION IN INDIA

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ABSTRACT

As a sustainable and ecologically beneficial method of farming, organic farming is becoming more and more popular in India. The goal of this review is to present a thorough examination of organic farming methods, with a particular emphasis on how they affect nutrient-dense and sustainable fruit production in India. By thoroughly examining fundamental ideas, nutritional advantages, environmental sustainability, obstacles, and potential future paths, this review aims to make a significant contribution to the current conversation in India about organic agriculture. In India, the practice of organic farming is not new; it dates back thousands of years. This farming method's main goal is to cultivate the land and raise crops in a way that maintains the soil's life and health by using organic wastes (crop wastes from farms and animals, waterways and other biological materials) combined with helpful microorganisms (biofertilizers) to release nutrients into crops for higher sustainable output in a pollution-free, environmentally friendly environment. The main issue facing India since gaining independence has been producing enough food to feed the country's expanding population. To meet the demands of the global market for organic production, it is necessary to select appropriate crops and products on a regional basis. Due to its obligations, the entire region cannot afford to switch to organic food at one time. To guarantee the security of food and nutrition this will lead to wealth and peace in the area as well as plenty of job opportunities. According to the Food and Agriculture Organization (FAO), "Organic agriculture" is a unique production management system that supports and improves the health of agro-ecosystems, including biodiversity, the biological cycle and soil biological activity. This is achieved by employing mechanical, biological, and agronomic techniques on the farm while excluding any synthetic off-farm inputs.

Key words : Farm inputs, Fruit production, Organic farming, Organic wastes.

Introduction

The world's climate is changing, and this has led to a rapid rise in the human population, which has raised the demand for plant-based foods and sources of energy (Varshney *et al.*, 2011). Since a diet based on cereal grains, root and tuber crops and legumes typically lacks a wide range of products like fibre, vitamins, provitamins, or other micronutrients and compounds that exist in fruit

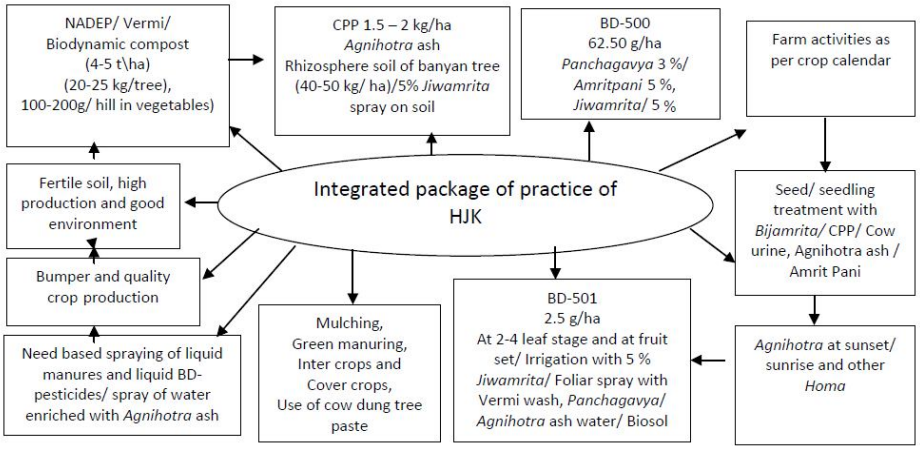

Fig. 1 : Schematic presentation for a package of the practice of *Homa* Jaivik Krishi.

crops, fruits play a crucial role in improving the quality of human life (Heslop-Harrison, 2005). Utilizing on-farm agronomic, biological and mechanical techniques, organic farming is a comprehensive production management approach that promotes and increases the health of the agro-ecosystem, including biodiversity, biological cycles, and soil biological activity removing all artificial off-farm inputs (FAO, 2012; Codex, 2007). It highlights the use of management techniques over off-farm inputs, keeping in mind that regional conditions necessitate locally tailored solutions. The cultivation and processing of agricultural products (food and fibre) is referred to as organic farming. It forbids the application of chemical pesticides and fertilizers, plant growth regulators, and additions to animal feed. Organic farming prohibits the use of genetically modified organisms (GMOs). The use of organic matter to improve soil qualities, reduce health risks connected with the food chain and achieve closed nutrient cycles essential components of sustainable agriculture is the focus of the organic farming system. Additionally, it is seen as just practical because it offers a special combination of cheap external inputs and technologies, environmental protection and input/output efficiency, it is an alternate and intriguing choice for sustainable agriculture in developing nations (Augustine *et al.*, 2013). The criteria for organic certification heavily influence how organic crops are produced. The rules generally permit the use of natural items and processes while prohibiting the use of synthetic products and procedures. Because of this, an organic grower's toolkit is far smaller than a conventional grower's. This is particularly true for pest management, where a focus on prevention is required due to the lack of resources or restricted instruments for controlling insect outbreaks. Fertility management techniques may need to adapt in response to natural fertility sources including manures, organic amendments, and mineral powders.

In accordance, with the criteria provided by the USDA research team, organic farming "Organic farming" is a system that relies, to the greatest extent practicable, on crop rotation, crop residues, animal manures, off-farm organic waste, mineral-grade rock additives and the biological system of nutrient mobilization and plant protection. Organic farming avoids or largely excludes the use of synthetic inputs (such as fertilizer, pesticides, hormones, feed additives, etc.). Producing fruit organically entails more than just avoiding synthetic fertilizers and pesticides. Benign neglect falls short of NOP production requirements. An integrated strategy for the proactive and perceptive management of a farming system is called organic agriculture. For tilth, productivity and nutrient cycling, good soil management is the first step. It uses a proactive, integrated strategy for pest control to safeguard the orchard's health and yield.

❖ **Approaches for organic farming**

1. Nature farming- 'do nothing' approach

2. Ecological agriculture- tools used are biofertilizers, botanical pesticides, bio-control agents, stress-resistant varieties, vermi-compost etc.

3. Rishi Krishi

- Angara - bhoomi sanskar, to make soil fertile.
- Amrit pani - for seed treatment.
- Pancha gavya - for vegetative and reproductive growth.
- Biodynamic farming- for micronutrient supply.

Planning of the Organic Orchard

Site selection : Like other crops, fruit trees grow vigorously and productively in healthy soil.In areas that are unsuitable for regular tillage, such as hillsides and rocky soils, trees can yield profitable crops. Examine your location thoroughly, assessing its slope, soil, and aspect, water table proximity, wind and air circulation patterns, frost patterns, maximum and minimum temperatures, length of growing season, distribution of yearly precipitation, and availability of water for irrigation. The majority of these are beyond your control, so make sure your planting strategy takes into account the site's natural features. Farmers can make improvements to the soil over time, but they are unable to significantly alter

temperatures, the direction of the predominant wind, or the subsurface layers.

Climate : The climate of the chosen site is critical. Different fruit trees have specific temperature and chilling hour requirements. Ensure that the climate is suitable for the particular fruit varieties you plan to cultivate. Some fruits require a certain number of chilling hours during winter to break dormancy and produce fruit in the spring.

Soil quality : Conduct a soil test to analyze key soil characteristics such as fertility, texture, and drainage. Fruit trees generally thrive in well-drained soil with good fertility. Adequate organic matter in the soil is crucial for providing nutrients and maintaining soil structure conducive to healthy root growth.

Topography : The topography of the land matters. Choose a site with gentle slopes to facilitate proper water drainage. Avoid low-lying areas, where water might accumulate, as excess moisture can lead to root diseases and adversely affect tree health.

Water availability : Ensure that the site has a reliable water source for irrigation. Sufficient water is essential for the establishment and growth of fruit trees. Consider installing an efficient irrigation system to meet the water needs of the orchard.

Sunlight exposure : Fruit trees require full sunlight for optimal growth and fruit production. Select a site that receives ample sunlight throughout the day to ensure that the trees can photosynthesize and produce high-quality fruit.

Wind exposure : Assess the wind patterns in the area. Strong winds can damage trees and affect fruit quality. Implement windbreaks or use natural barriers to protect the orchard from excessive wind exposure.

Proximity to pollinators : Ensure that there are enough pollinators, such as bees, in the vicinity to facilitate the pollination of fruit blossoms. Proximity to natural habitats or other flowering plants can attract and support pollinators, enhancing fruit sets.

Pest and disease history : Investigate the history of pests and diseases in the area. Opt for a location with a relatively low risk of pest and disease problems. Organic orchards rely on natural and sustainable management practices, so minimizing the risk of infestations is crucial.

Accessibility : Consider how easily you can access the orchard for various management activities. A well-planned layout and access points are essential for tasks such as planting, pruning, harvesting and pest control.

Regulatory considerations : Check local zoning regulations and obtain necessary permits for establishing an orchard. If you plan to pursue organic farming, ensure compliance with organic certification standards, as there may be specific requirements and practices to follow.

Future expansion : Plan for the future growth of the orchard. Ensure that the selected site allows for expansion without significant limitations, taking into account factors such as available space and potential changes in land use.

Fruit crop and variety selection

Selecting the right fruit crop and variety is crucial for successful fruit cultivation. Several factors should be considered when making these choices, as they can significantly impact the yield, quality, and overall success of your orchard or garden. Here are some key considerations:

Climate and soil conditions : Different fruit crops have specific climate and soil requirements. Consider the temperature range, chilling hours and frost susceptibility. Assess the soil pH, drainage and fertility to ensure they match the crop's preferences.

Local adaptation : Choose fruit crops that are well-adapted to your local growing conditions. Local varieties or those proven to thrive in similar climates often perform better.

Disease resistance : Look for varieties that are resistant to common diseases in your area. Disease-resistant varieties can reduce the need for chemical treatments and promote sustainable cultivation.

Pollination requirements : Some fruit crops are self-pollinating, while others require cross-pollination. Understand the pollination needs of the chosen crop and ensure the availability of compatible pollinators.

Yield and fruit quality : Consider the expected yield and quality of the fruit. Some varieties may produce larger quantities but sacrifice taste or texture. Balancing yield and quality is important.

Dwarf or standard varieties : Depending on available space and cultivation goals, choose between dwarf, semi-dwarf, or standard varieties. Dwarf varieties are suitable for small spaces and easier maintenance.

Harvest time : Different fruit varieties have varying harvest times. Choose a mix of varieties that ripen at different times to extend your harvest season and ensure a consistent supply.

Market demand : If you are growing fruits for commercial purposes, consider the market demand for different varieties. Popular and unique varieties that align

with consumer preferences can be more profitable.

Chill hours : Certain fruit crops, especially deciduous fruit trees like apples and cherries, require a certain number of chill hours during winter for proper bud development. Ensure your region provides the necessary chilling requirements.

Pest tolerance : Choose varieties that are tolerant to common pests in your area. This reduces the need for pesticide applications and promotes a healthier ecosystem.

Cultural practices : Consider your willingness and ability to implement necessary cultural practices, such as pruning, thinning, and training. Some varieties may require more intensive care than others.

Grafting compatibility : If you plan to use grafted plants, ensure that the rootstock is compatible with the scion. Grafting can influence tree size, disease resistance, and overall performance.

Since, fruit trees require a significant time and financial commitment and are perennial, it is crucial to begin with establishing your orchard. Using the best varieties available for your area and target markets. An early investment in research might pay off greatly for the producer. Nurseries, other nearby growers and Cooperative Extension can provide information on species and cultivars. Numerous land-grant institutions maintain field stations where a wide variety of fruit trees have been planted and data and observations have been collected over several years. You can get the priceless chance to witness the trees developing, discuss production issues like pests and illnesses with the experiment station manager and even sample the fruit by paying a visit to such a location.

Components for Nutrient management in organic fruit production

Nutrient management is crucial in organic fruit production to ensure healthy plant growth, high yields, and the sustainability of the farming system.Organic farmers rely on natural and organic sources of nutrients, as synthetic fertilizers are not allowed. Here are key components for nutrient management in organic fruit production:

Table 1 : Yield and quality of organically and conventionally produced mango fruits.

Cultivar	Av. yield (Kg/tree)	Acidity (%)	TSS (^{0}B)
Conventional produced Dashehari	56.54	0.20	17.25
Biodynamic production Mallika	90.00	0.16	19.20
Amrapali	35.00	0.11	21.60
Langra	80.00	0.18	19.20
Dashehari	95.00	0.16	21.50

Compost : Compost is a valuable organic amendment that improves soil structure, water retention, and nutrient content.It provides a slow release of nutrients and helps enhance soil microbial activity.

Cover crops : Cover crops, such as legumes and grasses, can be planted during the offseason to add organic matter to the soil and fix nitrogen.They prevent erosion, suppress weeds, and create a more favorable environment for beneficial soil organisms.

Crop rotation : Rotate fruit crops with nitrogen-fixing crops and other non-host crops to break pest and disease cycles. Different crops have different nutrient needs, and rotation helps maintain soil fertility and balance.

Green manure : Green manure involves growing specific crops and incorporating them into the soil while they are still green. Leguminous green manure crops, like clover and vetch, add nitrogen to the soil.

Organic fertilizers : Utilize organic fertilizers derived from plant and animal sources, such as bone meal, blood meal, fish emulsion and seaweed extracts. These materials provide a range of essential nutrients in a form that is readily available to plants.

Mulching : Mulching with organic materials such as straw, wood chips, or compost helps retain soil moisture, suppress weeds and gradually release nutrients as the mulch breaks down.

Crop residues : Leave crop residues on the field after harvest to return organic matter and nutrients to the soil.This practice promotes soil health and microbial activity.

Biological amendments : Beneficial microorganisms, such as mycorrhizal fungi and bacteria, can be introduced to enhance nutrient uptake by plant roots and improve soil structure.

pH management : Regularly monitor and adjust soil pH to ensure that nutrients are available to plants. Lime or sulfur can be used to raise or lower pH, respectively.

Nutrient budgeting : Develop a nutrient management plan that considers the nutrient requirements of specific fruit crops and the nutrient content of organic amendments. Regularly test the soil to assess nutrient levels and adjust management practices accordingly.

By combining these components, organic fruit

Fig. 2 : Representation of different components of nutrients.

producers can create a sustainable and nutrient-rich environment for their crops while adhering to organic farming principles. It's important to note that practices may vary based on specific fruit types, local climate, and soil conditions. Regular monitoring and adaptation of nutrient management strategies are key to successful organic fruit production.

Biofertilizer : Biofertilizers are substances containing living microorganisms, typically bacteria, fungi, or archaea, that enhance the nutrient availability and uptake of plants. Unlike chemical fertilizers, which provide nutrients directly to plants, biofertilizers work by promoting the natural processes in the soil that facilitate nutrient cycling and improve plant growth.

Weed management

Generally, direct mechanical and thermal approaches are combined with cultural or husbandry techniques as the primary weed control measures in organic farming. The following are examples of husbandry practices: using stale seedbeds, adjusting soil conditions (*e.g.*, via irrigation), using different cultivation techniques, using pre plant mulches for high-value crops, and using cultivars specifically adapted for organic agriculture. Rigging up potatoes, inter row cultivation in cereals and root crops, post-emergence harrowing to reduce weeds in cereal crops and heat treatment of weeds (infra-red or direct flame) before crop emergence and in between rows are examples of mechanical and thermal intervention. The capacity of various crops to outcompete weeds varies. The crop's allelopathic qualities, or its ability to produce chemicals either directly or indirectly through the microbial breakdown of residues, which inhibit weed germination and growth nearby, maybe the cause of some of these variations in competitive performance.

Pest and Disease Management

In organic systems, pests usually don't pose a big threat since robust plants with balanced nutrition and rich soil are more resilient to insect attacks. However, significant pest damage can occasionally be observed in organic crops, especially in vegetables like brassicas and carrots, which are especially vulnerable to root fly damage. Large horticultural holdings, where a single crop species may be farmed over several hectares, might have

Table 2 : List of commonly produced Bio-fertilizers.

Name of biofertilizers	Suitable crops	Benefits	Suitable remarks
BlueGreen Algae (BGA)	Wet lands like rice.	BGA fixes 20 to 30 kg N/ha.	Can be used for fishes as feed. Reduces the soil alkalinity.
Mycorrhizae	Several trees and ornamental plants	Enhances uptake of S, Zn, P and water. Also 30-50% increases yield.	Usually inoculated to seedlings.
Phosphate solubilizers (there are two fungal and two bacterial species)	Application of soil for all kind of crops.	Increases production from 5 to 30%.	Rock phosphate can mix.
Azospirillum	Non-leguminous crops i.e. oats, sugarcane, jowar, rice etc.	Increases production from 10 to 20%.	Produces substances that promotes the growth.
Rhizobium strains	Legumes like soybean, pulses, groundnut	Adds 50-200 kg N/ha and 10-35% increases yield.	Results obtained better with fodders
Azotobactor	Treatments of soil for non-leguminous crops and also crops under dryland.	Adds 20-24 kg N/ha. 10-15% icreases yield.	Also controls certain pathogens and diseases.

Table 3 : Some biocontrol agents for pest and diseases in fruit crops.

S. no.	Fruit crop	Insect-Pest / Disease	Biological Control agent
1.	Apple	Apple Wooly apple aphid (*Eriosoma lanigerum*) San Jose scale (*Quadraspidiotus perniciosus*) Gray mold (*Botrytis ruehle*)	*Aphelinus mali* *Encarsia perniciosi* *Pseudomonas fluorescens*
2.	Banana	Anthracnose (*Colletotrichum musae*) Monilinia rot (*Monilinia laxa*)	*Trichoderma harzianum* *Aureobasidium pullulans*
3.	Mango	Mango mealy bug (*Drosicha mangiferae*)	*Cryptolaemus montrouzieri*
4.	Papaya	Stem-end rot (*Botryodiplodia theobromae*) Papaya mealy bug (*Paracoccus marginatus*)	*Trichoderma viride* *Acerophagus papayae*
5.	Citrus	Cottony cushion scale (*Icerya purchase*) Green mold (*Penicillium digitatum*) Stem end rot (*Botryodiplodia theobromae*)	*Citrus Rodolia cardinalis* *Trichoderma viride* *Bacillus subtilis*

especially serious pest problems. In organic farming systems, the primary focus of pest management measures is prevention as opposed to treatment. Crop rotation is especially effective against pests that are less migratory or have a limited host range. Aphids are highly migratory and frequently non-specific pests; therefore, rotation design has little to no effect on them. In organic systems, regulations allow for the use of natural pesticides as reactive treatments for pest outbreaks in certain situations. However, cultural pest prevention techniques, such as the use of break crops in balanced rotations, will continue to be the most effective method of pest control.

Postharvest handling

A lot of fruits need to be handled in some way after harvest. These procedures, whether carried out on- or off-farm, are to be recorded in the organic plan of systems. After harvest, certified organic facilities must handle any off-farm handling. During washing, sizing, packing and storing, special precautions must be taken to avoid contaminating or combining organic and non-organic products. Produce must be tracked from its field of origin to the point of ultimate sale in a comprehensive audit trail. Growers who plan to use cleansers, shellacs, or waxes after harvest should study the National Organic Program Final Rule, the National List and OMRI lists, as well as speak with their certifiers.

Rapid antagonist activity is necessary because of the short periodof a day to a few days between harvesting and storing fruit. Fruit that has been refrigerated will see a decrease in metabolic rates in both the host and any accompanying bacteria. Based on the chosen temperature regime the focus of the hunt for antagonists to stop pathogens from invading postharvest wounds should be on quick colonizers of the wound site that are still capable of metabolism at low storage temperatures. Fruit deterioration can be inhibited through the use of biocontrol agents in the field, but the primary method is the postharvest administration of antagonists to stop pathogens from infecting fruit wounds after harvest. Using several applications of the antagonist in the orchard, field treatments have been successful against anthracnose caused by *Colletotrichum* sp. on mango and avocado and to a lesser extent against *Pezicula malicorticis* on apples. Antagonist applications before harvest may only be a supplement to their postharvest application, despite occasionally helping control postharvest decays from wound infection. Antagonists must be applied again to control postharvest decays that result from latent infection in the orchard.

Prospects of organic fruit production

The future prospects of organic fruit production were generally positive and several trends and factors were contributing to the growth of the organic fruit industry. However, it's important to note that the situation may have evolved since then consumer demand there has been a growing demand for organic products, including fruits, driven by increased awareness of health and environmental issues. Consumers are often willing to pay a premium for organic produce due to perceived health benefits and environmental sustainability. Health and environmental concerns with an increasing focus on health and environmental sustainability, consumers are becoming more conscious of the impact of conventional farming practices. Organic fruit production methods, which typically avoid synthetic pesticides and fertilizers, appeal to those looking for healthier and environmentally friendly food options. Government regulations and support many governments around the world have been introducing and promoting organic farming regulations and certification processes. This support helps legitimize and standardize organic practices, boosting consumer confidence and the overall growth of the organic sector.

Innovation and technology advancements in organic farming practices and technologies are improving efficiency and productivity in organic fruit production. Techniques such as integrated pest management, precision agriculture and organic soil amendments are being adopted to enhance yields and reduce environmental impact. Local and sustainable agriculture there is a growing trend toward supporting local and sustainable agriculture. Organic fruit production often aligns with these principles, as it typically involves smaller, local farms with a focus on environmentally friendly practices. Economic viability as the scale of organic fruit production increases, economies of scale and improved supply chain logistics are making organic farming more economically viable. This, in turn, attracts more farmers to transition to organic methods. Global market expansion organic fruit producers are increasingly targeting international markets, capitalizing on the global demand for organic products. As transportation and distribution networks improve, organic fruits can reach a broader consumer base. Climate change resilience organic farming practices often promote biodiversity and soil health, which can contribute to the resilience of agricultural systems in the face of climate change. This can be an attractive feature for farmers facing unpredictable weather patterns.

Conclusion

For some producers, growing organic fruit is a viable choice, but the success of the business will probably depend on many factors, including the location, size, kind of fruit, markets and managerial abilities. Generally speaking, The West's drier climates provide crops with fewer pest and disease issues. Thus, this area might be more suitable for the cultivation of organic fruits. In most parts of the country, growing strawberries, brambles, and bush fruits organically is probably easier than growing grapes and tree fruits. In any region, organic production is likely to have higher management requirements, thus the producer needs to be well aware of the specific site characteristics. An orchard's perpetual, mono-cultural nature can lead to issues with weed, disease, and pest control. However, if careful attention is paid to monitoring pest and disease life cycles, soil fertility and the application of a variety of management techniques, organic fruit production can be both profitable and satisfying.

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