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Intercropping in Fruit Orchards: Growing More from Every Patch of Land

*Sahana S[1], Prajna Maruthi Naik[2] and Viresh Alamel[3]
[1]Department of Silviculture and Agroforestry, College of Forestry, Vellanikkara, KAU, Thrissur – 680656, Kerala, India
[2]Department of Forest Biology and Tree Improvement, College of Forestry, Sirsi
[3]Department of Forest Resource and Management, College of Forestry, Sirsi
*Corresponding Author's email: dhundubi2000@gmail.com

Fruit orchards are long-term investments. Once fruit trees are planted, several years may pass before they reach full production. During this period, considerable space between the trees often remains available for use. If this open space is left unmanaged, farmers may lose an opportunity to obtain additional income, improve soil health and make better use of available land and resources. **Intercropping offers a practical way to use this space productively.** It involves growing suitable short-duration crops between rows of perennial fruit trees without disturbing the main orchard crop. Vegetables, pulses, herbs, tuber crops and other compatible crops can be selected according to the age of the orchard, climate, soil, water availability and spacing of the fruit trees. The idea is simple: instead of depending entirely on one crop, different crops are grown together so that the available land, sunlight, water and nutrients are used more efficiently. When properly planned, intercropping can provide additional food and income, improve soil fertility, support beneficial insects and reduce some pest problems. However, intercropping is not simply a matter of planting any crop in the vacant space. Fruit trees remain the primary crop and the intercrop must be selected and managed so that it does not interfere with their growth. Successful intercropping therefore depends on understanding the relationship between the fruit trees and the crops grown beneath and between them.

Why Intercropping Makes Sense in Fruit Orchards

A fruit orchard is a multi-year production system. Young trees occupy relatively little space during their early years, leaving substantial areas between them. Even in mature orchards, the inter-row space can sometimes be used for compatible crops, depending on canopy development, light availability and water conditions. Intercropping allows farmers to obtain returns from this otherwise underutilized space. Short-duration crops can provide income while the perennial fruit trees are developing. In addition, some intercrops contribute organic matter and nutrients to the soil, while flowering crops and herbs can create a more diverse environment that supports pollinators and beneficial insects. The approach is particularly useful where land is limited and farmers need to obtain multiple benefits from the same area. Instead of viewing an orchard as a single-crop system, intercropping encourages farmers to manage it as a productive combination of perennial and seasonal crops. Vegetables, pulses, tubers and herbs are among the crops that can be integrated into suitable orchards. Examples include potato with litchi, elephant-foot yam with guava, soybean with apple and yam with pomegranate in coconut-based systems.

The Fruit Tree Always Comes First

The most important principle of orchard intercropping is that the **fruit tree is the main crop**. The intercrop should support the orchard system rather than compete strongly with the fruit trees. Adequate space should therefore be maintained around the base of each fruit tree. A radius of about **120 cm from the trunk** should be kept free for proper management of the tree. Intercrops should not be allowed to interfere with the root zone or compete excessively for essential resources. The choice of intercrop is particularly important. Crops that grow very tall or produce excessive vegetative growth can compete with fruit trees for sunlight and space. Similarly, crops that consume large quantities of water and nutrients may reduce the resources available to the fruit trees. For this reason, highly exhaustive or long-duration crops are generally unsuitable in many orchard situations. Crops such as sugarcane, pigeon pea, maize and sorghum are specifically discouraged where their growth and resource requirements could adversely affect the fruit trees. A good intercrop should ideally be relatively short-duration, manageable, compatible with the orchard environment and capable of producing an economic return without putting excessive pressure on soil moisture and nutrients.

Choosing the Right Intercrop

There is no universally suitable intercrop for every fruit orchard. A crop that performs well under one orchard system may not perform equally well elsewhere. Selection should consider the fruit species, tree age, canopy size, spacing, soil type, rainfall, irrigation availability and the expected duration of the intercrop. In young orchards, more sunlight reaches the ground, allowing a wider range of seasonal crops to be cultivated. As the fruit-tree canopy expands, however, shade increases and the choice of intercrops becomes more limited. Vegetables can be particularly attractive because they are generally short-duration and can provide relatively quick returns. Leguminous crops are also valuable because they can contribute to soil fertility and diversify farm production. Herbs such as basil and mint can provide additional products while also creating flowering resources for beneficial insects. The most suitable crop is therefore not necessarily the one that gives the highest individual yield. The better choice is the crop that provides a useful return without reducing the productivity and health of the main fruit trees.

Vegetables: An Opportunity Between Fruit Trees

Vegetables are among the most practical intercrops for suitable fruit orchards. Their relatively short growing period allows farmers to produce and sell crops within the same season. They can also provide an additional source of food for the farm household. Examples of vegetable-based orchard systems include litchi with potato and mango-based systems involving crops such as bottle gourd, lady's finger and maize. Such combinations can make productive use of the inter-row space during periods when the fruit trees themselves are not providing sufficient returns. Vegetable intercrops can also contribute residues and organic matter to the soil after harvest. When crop residues are properly managed, they can improve soil organic matter and contribute to better moisture retention. However, vegetable cultivation requires careful irrigation and nutrient management. If the orchard is already experiencing water stress, adding a water-demanding vegetable crop may increase competition. Therefore, irrigation planning should consider the combined needs of both the fruit trees and the intercrop.

Legumes: Small Crops with a Big Soil Benefit

Leguminous intercrops have a special place in orchard systems because they can contribute to soil fertility. Crops such as peas, beans, black gram and pigeon pea can add diversity to the production system, and suitable legumes can contribute nitrogen through biological nitrogen fixation. The benefits extend beyond nitrogen. Legume residues can add organic material to the soil, and their presence can help diversify the biological activity of the orchard. However, even legumes must be selected carefully because their water, nutrient and growth

requirements should not interfere with the fruit trees. In mango-based systems established on relatively poor red and lateritic soils, the integration of intercrops such as pigeon pea and black gram was associated with improvements in soil properties. These systems illustrate how fruit-based agroforestry can offer an alternative to monocropping in areas where agricultural productivity is limited.

A Mango Orchard That Produces More Than Fruit

A field-based example from Jhargram in Paschim Medinipur, West Bengal, illustrates the potential of combining mango with seasonal crops. The system was developed in an area where red and lateritic soils and poor land management contributed to low crop productivity. Conventional monocropping also provided limited opportunities for income and employment. Mango trees were established at 10 m × 10 m spacing, and different seasonal crops were grown between them. The intercrops included pigeon pea, black gram, bottle gourd, lady's finger and maize during the kharif season, while mustard was grown during the rabi season. The results were encouraging. Mango trees showed better growth in the agroforestry system, while the combination of fruit trees and seasonal crops provided additional economic returns. In the fifth year, the mango-based system recorded an income of approximately ₹1.864 lakh per hectare per year, while the bottle-gourd-based system generated about ₹1.666 lakh per hectare per year. The soil also responded positively. Improvements were observed in organic carbon, soil pH and the availability of nitrogen, phosphorus and potassium. Pigeon pea and black gram were particularly useful for improving soil fertility. This example highlights an important advantage of intercropping: the farmer does not have to depend on the fruit harvest alone. Seasonal crops can provide returns while the orchard develops, while appropriate intercrops can also contribute to maintaining the productivity of the land.

Apple Orchards: Combining Income with Soil and Biodiversity Benefits

Intercropping is not limited to tropical fruit orchards. It can also be adapted to temperate fruit-growing systems when suitable crops and management practices are used. An example from **central Punjab** involved a 10-year-old apple orchard covering 10 hectares under semi-arid conditions. The inter-row spaces were used to grow legumes such as peas and beans, vegetables such as lettuce and spinach, and herbs including garlic, basil and mint. A portion of the orchard maintained under apple monoculture served as a comparison. The system was evaluated for soil fertility, pest populations, crop production, biodiversity and water use. Soil samples were collected to assess nitrogen, phosphorus and organic matter. Pest populations were monitored regularly, while the harvested apples, vegetables and herbs were weighed to assess production. The results indicated improvements in several aspects of orchard performance. Soil nitrogen increased by 15%, which was associated with the presence of leguminous crops such as peas and beans. Organic matter increased by 12%, while plant biodiversity increased by approximately 30%. The greater plant diversity also created favourable conditions for pollinators and beneficial insects. Flowering herbs such as basil and mint attracted useful insects, while the presence of natural predators contributed to the reduction of some pest populations. Pest populations such as aphids and spider mites were reported to decline by approximately 25% in the intercropped plots. Garlic and mint were also useful in reducing the presence of some common orchard pests, potentially lowering the dependence on chemical pest-control measures.

More Diversity, More Natural Pest Control

One of the interesting benefits of orchard intercropping is its potential to make the farm environment biologically richer. A monoculture provides relatively uniform vegetation, whereas an intercropped orchard contains several types of plants with different structures, flowering periods and resource requirements. This diversity can provide food and shelter for pollinators and natural enemies of pests. Ladybirds, lacewings and other beneficial insects can help regulate pest populations naturally. However, intercropping should not be considered an automatic replacement for pest management. Some pests may also benefit from

additional vegetation if the system is poorly planned. Regular monitoring is therefore important. Farmers need to observe both the fruit trees and intercrops and respond quickly when pest populations begin to increase. The objective is to create a balanced orchard ecosystem where beneficial organisms are encouraged while conditions favourable to serious pests are minimized.

Better Use of Water and Soil

Water is one of the most important resources determining the success of orchard intercropping. Fruit trees have long-term water requirements, while seasonal crops add another demand. Poorly planned irrigation can therefore create competition, particularly during dry periods. The apple-orchard example demonstrated that water-use efficiency improved by approximately 20% under intercropping combined with drip irrigation and better soil-moisture retention. Improved organic matter also contributed to the ability of the soil to retain moisture. This highlights an important point: intercropping and irrigation management must be planned together. Drip irrigation, mulching, appropriate crop selection and maintenance of soil organic matter can help reduce unnecessary water loss. In water-limited regions, farmers should prioritize drought-tolerant and relatively low-water-demand intercrops and ensure that the fruit trees receive adequate moisture during critical growth stages.

Intercropping Can Strengthen Farm Income

One of the strongest reasons for adopting intercropping is economic. Fruit orchards often require several years of investment before they provide their maximum returns. Seasonal intercrops can provide income during this period and continue to contribute to farm revenue where conditions remain suitable. The apple orchard example recorded a 25% increase in overall revenue from intercropping, while apple production remained stable. Vegetables and herbs provided additional income before the main apple harvest. This is particularly valuable for small and medium farmers who may need regular income rather than waiting for a single annual harvest. Income diversification can also reduce the economic risk associated with dependence on one crop. However, profitability depends on local market prices, labour costs, input requirements, irrigation expenses and crop yields. Therefore, farmers should consider both gross returns and the additional costs involved before selecting an intercrop.

The Challenges Should Not Be Ignored

Intercropping is not without limitations. The same resources that make the orchard productive like soil, water, nutrients and sunlight are also shared by the fruit trees and intercrops. During dry periods, competition for water can become particularly serious. As fruit-tree canopies become larger, competition for sunlight also increases. Dense intercrops can interfere with orchard operations and may make harvesting, pruning or pest management more difficult. Some intercrops can also harbour pests or diseases that later affect the fruit trees. Therefore, regular field observation is essential. The apple orchard example particularly highlighted competition for water and light during dry periods. Proper irrigation and pruning were necessary to maintain a balance between the trees and intercrops. Some pest species also increased initially, demonstrating the importance of careful monitoring. These challenges do not mean that intercropping should be avoided. Instead, they show why crop selection and management are more important than simply adding more crops to the orchard.

Making Orchard Intercropping Successful

A successful orchard-intercropping system begins with understanding the orchard itself. Before introducing a crop, farmers should assess tree age, spacing, canopy development, soil condition, irrigation availability and local climate. The fruit trees should always receive priority in terms of space, water and nutrients. A sufficient area around the trunk should remain free of intercrops, and the intercrop should be maintained at a manageable distance from the trees. Crop selection should favour short-duration and compatible species. Legumes can be considered where improvement of soil fertility is an objective, while vegetables and

herbs may be suitable where additional income and biodiversity are priorities. Water management should be planned for the combined system. Drip irrigation can help deliver water more efficiently, while mulching and organic matter management can support moisture retention. Regular monitoring is equally important. Farmers should observe crop growth, pest populations, soil moisture and the condition of fruit trees throughout the season. If an intercrop begins to compete strongly with the orchard, it should be modified or removed rather than allowing the main fruit crop to suffer.

Recommendations for Better Orchard Intercropping

For sustainable and profitable orchard-based intercropping, the following practices can be encouraged:

- Give first priority to the fruit trees when planning space, water and nutrients.
- Maintain adequate space around the base of fruit trees and avoid disturbing their major root zone.
- Select short-duration and compatible intercrops according to the age and canopy of the orchard.
- Prefer suitable legumes where improving soil fertility is an important objective.
- Use vegetables and herbs where they can provide additional income without excessive competition.
- Avoid highly exhaustive and aggressively growing crops that compete strongly with fruit trees.
- Adjust the intercrop according to seasonal rainfall and irrigation availability.
- Use drip irrigation and mulching wherever appropriate to improve water-use efficiency.
- Maintain soil organic matter through suitable crop residues and organic inputs.
- Monitor pest and disease populations regularly in both the fruit trees and intercrops.
- Encourage flowering plants and suitable herbs that can support pollinators and beneficial insects.
- Modify or discontinue an intercrop if it begins to reduce fruit-tree growth or productivity.
- Consider local market demand, labour availability and production costs before selecting commercial intercrops.
- Promote orchard-based agroforestry systems that combine income generation, soil improvement, biodiversity and resource conservation.

Conclusion

Intercropping provides an opportunity to make fruit orchards more productive, diverse and economically resilient. Instead of allowing the space between fruit trees to remain unused, farmers can grow carefully selected seasonal crops that provide additional food, income and ecological benefits. The success of intercropping, however, depends on maintaining the right balance. The fruit trees remain the primary crop, and every intercrop must be selected with their long-term growth in mind. Excessive competition for water, nutrients and sunlight can turn a potentially beneficial system into a problem. Appropriate spacing, crop selection, irrigation, pruning and regular monitoring are therefore essential. Experiences from mango-based systems demonstrate that combining fruit trees with suitable seasonal crops can improve farm income and soil fertility. Similarly, apple-based intercropping can increase biodiversity, support beneficial insects, improve soil properties and provide additional revenue while maintaining fruit production. Perhaps the greatest strength of intercropping is that it brings several objectives together on the same piece of land. The orchard can produce fruit, the inter-row space can produce seasonal crops, legumes can contribute to soil fertility, flowering plants can support biodiversity, and farmers can receive additional income. With careful planning and locally suitable crop combinations, intercropping can transform fruit orchards from single-purpose production units into diverse, productive and resilient agroforestry systems. The goal is not simply to grow more crops, but to make better use of land and natural resources while protecting the productivity of the fruit trees for years to come.