



Review Article

INTERCROPPING IN FRUIT ORCHARDS: A WAY FORWARD FOR DOUBLING THE FARMER'S INCOME

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Abstract: Intercropping is the growing of two or more dissimilar crops simultaneously on the same piece of land. Intercropping can improve the crop productivity due to increased plant efficiency for utilization of sunlight with an adequate spatial distribution of various plant architectures. In young fruit orchards, growing economic crops in inter spaces of the fruit trees during first few years is referred as intercropping. It enables farmers to utilize not only the vacant space efficiently but also enable them to earn additional income from the same piece of land. They also act as a cover crop and the land benefits by the cultivation, irrigation, manuring given to the intercrops. Vegetables, being short duration, shallow rooted, bushy or climbing types with very low plant height makes them ideal companion of perennial large fruit trees. These are the best inter crops in terms of per unit area productivity and profitability when compared with cereals, millets or any other crop. Water requirements of the vegetable intercrops should not clash with those of the main fruit trees and should be kept well away from the main fruit trees and irrigated independently. The intercropping should be stopped when trees develop wide canopy and less space is available between two rows for raising secondary crop and also trees have shading effects on secondary crop. Thereafter, green manuring or cover cropping should be only practiced. It can be concluded that intercropping of short duration vegetables in fruit orchard not only maximize the resource utilization in terms of land, labour and other inputs but also play a pivotal role in minimizing the risk of crop failure by ensuring and enhancing the net income per unit of area. In this way, the sustained promotion of cultivation of high value fruits and other horticulture crops along with improvement in infrastructure can help enhance farmers' income and net profitability.

Keywords: *Intercropping, Horticultural system*

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Introduction

Agricultural diversification is an important instrument for the economic growth of farm households. India's main focus was only on the policies related to grains and cereals, till the launch of National Horticulture Mission, 2005-06. It is only after this, that the country started paying attention towards extracting the real potential of the horticultural sector [1]. As per the Ashok Dalwai Report on doubling Farmer's income (2017), crop diversification and intensification are being hailed as one of the most crucial component for achieving the goal of doubling farmer's income by year 2024 [2]. India is facing a big challenge in balancing its dual objectives of food security and crop diversification to increase farm income. Due to the perishable nature of horticultural products and their short life-span, the growth of this sector has been constrained. Added to it are India's low crop productivity, limited irrigation facilities and underdeveloped infrastructural support like cold storages, markets, roads, and transportation, which have increased the woes of Indian horticulturists. As India begins to market its agricultural produce across political boundaries, it can add new dimensions to its commercial viability in agriculture.

Changes in cropping patterns are responsive to these factors. In the recent past, India has experienced a considerable degree of crop diversification towards the horticulture sector and commercial crops and there has been a shift in the area away from food grains-rice, coarse cereals and pulses-towards oilseeds, cotton, fruits and vegetables. Within the horticulture sector also, besides spices, fruits and vegetables are the major crops where the area under cultivation has increased [3]. This gain in area under horticulture and mainly under fruits and vegetables is a collective impact of diversification of the production pattern of producers and increased demand of the consumers due to shift in their consumption pattern [4].

Crop diversification for sustainability in agriculture

India being a land of small and marginal farmers, studies has been advocating that 'small farmers are going to feed India'. Therefore, it is important to mobilize them and help them to diversify to meet the increasing domestic demand of horticultural products. Small farmers are the key to initiate the horticultural revolution and with technical change and increase in the international competitiveness, large-scale operations and vertical integration take place. The diversification towards horticultural sector needs to be planned as it offers an attractive option and a major source of pushing up growth of the agricultural sector. Appropriate management of the issues involved on the production, marketing and policy fronts can bring about the desired growth levels in the agricultural sector. In the year-round cultivation, even if a small proportion of land is diversified towards horticultural commodities, and more importantly towards vegetables, then the income level of farmers can largely improve. Besides the issue of improving income, diversification is also needed to meet the increasing domestic demand of fruits and vegetables. But there are various supply-side constraints which are keeping the per unit productivity and per unit availability low. The horticultural sector is constrained by traditional production techniques, huge post-harvest losses and poor marketing strategy. Inefficiency in pest management, poor access to credit, high cost of production, lack of information and poor infrastructure add to these constraints. These constraints can actually erode the benefits that may accrue from diversification. Thus, on the production front, the most crucial factor impacting the growth of horticulture sector is the low and declining productivity. The declines in productivity as well as the low productivity rates, as compared to the world's highest yields are quite visible in literature.

For all the fresh fruits and vegetables, the potential yield is manifold higher than the existing yields. But certain activities taken up in contract farming mode give better yields. This further implies that if the farming is taken up in an organized manner and use of inputs, their application, and harvesting techniques are imparted to the producers, then the yield levels can be raised. On the marketing side, the general constraints faced by this sector are timely delivery, grading, packaging, quality of produce, poor market infrastructure, agro-processing plants, marketing credit, proper market organization, proper pricing, uniform grading and standardization of weights and measures; inadequate and poor dissemination of market information and poor post-harvest handling; and low and declining productivity. The marketing costs are also included in the calculations of BCR for fruits and vegetables. If the markets are brought closer to the farm-gate or in the supply chain, and the produce is directly procured from the farm-gate, then it will be more beneficial for the farmers, as they will be getting better prices for the fresh quality produce, and in addition, the cold storage facility in the transportation would preserve the quality further, so that the consumers get better quality produce. It would further lower down the post-harvest losses and thus, the quantity saved in the process will be an addition to the net availability. The infrastructure to increase efficiency and linkages between all the stakeholders of the supply chain are not efficient. This is affecting the growth potential of the horticultural sector. Timely availability of inputs and development of organized input market and infrastructural, storage and distribution facilities will add to the productivity. The management of these constraints will add to the productivity of this sector. Development of cold-chain network will greatly help in reducing the post-harvest losses of fruits and vegetables. The horticultural sector can be linked to futures market along with strengthening of the institution of contract farming. The government should create a positive environment that will ensure a mutually beneficial relationship between the farmers and the organized sector. Along with investment in infrastructure, development of extension activities and linkages with farmers is also important areas where government can play influential role. The development of horticultural sector should be accompanied with the growth of agro-processing industry. Volumes saved in post-harvest losses are the surpluses generated, without additional cost. Additional non-farm rural employment can also be generated by the development of horticulture-based agro-processing units. This sector needs to be developed as an organized industry and has to be managed collectively by all the stakeholders, may be with farmers as the entrepreneurs. The modern agriculture stresses on efficient use of available resources-land, light water and nutrients. Thus, it is need of hour to utilize the resources within a given time by raising two or more crop simultaneously by exploiting the space more effectively by planting crops of varying architecture. The demand and consumption of vegetables is increasing at faster rate in modern time due to increasing population and considering these as protective foods in human nutrition. Their cultivation is of utmost importance to the growers of north India because it offers tremendous potential of bringing higher income per unit area and time.

Role of cropping systems/ inter cropping in context

Cropping system refers to the principles and practices of cropping pattern followed on a farm and their interaction with farm resources, technology, other farm enterprises, aerial and edaphic environment to suit the regional or national or global needs and production strategy. In other words, a cropping system refers to a combination of crops in time and space [5]. Cropping systems involving vegetable are generally practiced near urban or peri-urban areas and have higher cash flow. With higher cropping intensities higher returns are expected, but lower cropping intensity with high market value crops results in higher price than the crops of low market value with high cropping intensities. In general, cropping system is the form and sequence of crops grown on a given area of land over a period of time. The term cropping system is often used interchangeably with multiple cropping, which in fundamental nature represents an idea of maximum crop production per unit area of land within a year or some other relevant time unit with minimum land degradation [6,7].

Cropping systems approach enables to address issues pertaining to:

(a) System productivity maximization on annual basis,

(b) Resources utilization with advanced efficiency by considering various interactions and direct, residual and cumulative effect in soil, plant and environmental system,

(c) Intensive input use *vis-a-vis* quality of environment, and

(d) Sustainability of farm resources and environment in long term perspective.

Intercropping: Intercropping is the growing of two or more dissimilar crops simultaneously on the same piece of land. Base crop necessarily should be distinct/ definite in row arrangements. In vegetables, for successful intercropping system in a geographical location, effective cultural practices must be determined with respect to plant population. For instance, in a sweet corn and cowpea based intercropping there was no effect on the number of ears of sweet corn per plant but yield increase as the plant population density increased.

Intercropping can improve the crop productivity due to increased plant efficiency for utilization of sunlight with an adequate spatial distribution of various plant architectures.

The intercropping can be classified into following:

Row intercropping: This intercropping system at least one crop is planted in rows.

Mixed intercropping: There is no distinct row arrangement in such types of intercropping.

Stripe intercropping: Raising of two or more crops simultaneously in different stripes e.g., growing of one stripe of sweet corn and one strip of potato.

To evaluate the performance of intercrop components, the concept of land equivalent ratio (LER) is used. It measures the advantages of using intercropping systems on combined yield of both crops.

The distinct aspects of intercropping are:

- Detailed planning
- Timely planting of each crop
- Adequate fertilization at optimal rate and times
- Effective weed, pest and disease control
- Precaution in harvesting.

Planning for intercropping should involve selection of crop species, appropriate cultivars, water availability, plant population, spacing and labour requirements throughout the season, tillage requirements and predicted profitability of intercrops, timely planting, proper fertilization, pest and disease control. Sometimes vegetable crops are economically grown as intercrop in newly planted fruit crops like papaya, mango, coconut, etc. It is the best way to utilize lot of interspace available in widely spaced fruit crops. Intercrops earn running cost for maintaining base crop. They are allowed to grow till base crop start giving economic returns and trees develop good canopy. When trees develop wide canopy then less space is available between two rows for raising secondary crop and also trees have shading effects on secondary crop.

Intercropping under horticultural system

In young orchards, growing economic crops in inter spaces of the fruit trees during first few years is referred as intercropping. They also act as a cover crop and the land benefits by the cultivation, irrigation, manuring given to the intercrops. Water requirements of the intercrops should not clash with those of the main fruit trees. Vegetables are the best inter crops when compared to millets.

Important vegetables which can be grown as intercrops are:

Solanaceous vegetables: Tomato, Brinjal, Chillies and Capsicum (suitable for well growing established orchards, 3-4 years onwards)

Cruciferous vegetables: Cauliflower, Cabbage, Knolkhol, Broccoli (suitable for growing in newly establishing orchard, 0-3 years)

Cucurbitaceous vegetables: Bottle gourd, Bitter gourd, Cucumber, Muskmelon, Watermelon, Pumpkin (suitable for well growing established orchards, 3-4 years onwards)

Leafy vegetables: Spinach, Coriander, Fenugreek (suitable for growing in newly establishing orchard, 0-3 years)

Onion and Garlic (suitable for growing in newly establishing orchards as well as in established orchards)

Ginger and Turmeric (suitable for growing under high density orchards)
Leguminous vegetables: Peas and Beans (suitable for growing in poor fertility orchards)

Merits of intercropping

1. It reduces the risk of total crop failure due to crop diversification.
2. There is best utilization of interspaced available between two rows of main crop.
3. Efficient utilization of available resources.
4. Increases gross returns from per unit area.
5. Greater stability of yield over the seasons.
6. Better control over weeds, pests and diseases.
7. Prevent soil erosion.
8. There is reduction of insect/mite pest populations due to the diversity of crops grown and reduction of plant diseases because the distance between plants of the same species is increased due to the planting of other crops between them,

Demerits of intercropping

1. Intercrops require more agricultural inputs.
2. Creates obstruction in free use of machines for intercultural operations.
3. Allelopathic effect (harmful effect of one crop on the other due to biochemical exudation).

Conclusion

From the above discussion it can be concluded that diversification into production of fruits and vegetables, in general, and vegetables, in particular, is likely to benefit the farmers more as compared to other field crops. Moreover, intercropping of short duration vegetables in fruit orchard not only maximize the resource utilization in terms of land, labour and other inputs but also play a pivotal role in minimizing the risk of crop failure by ensuring and enhancing the net income per unit of area.

Application of research: The sustained promotion of cultivation of high value fruits and other horticulture crops along with improvement in infrastructure can help enhance farmers' income. It is, therefore, imperative to ensure diversification into horticulture by offering suitable incentives to farmers.

Research Category: Horticulture Research

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Author Contributions: All authors equally contributed

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Study area / Sample Collection: ACHR, Udheywalla, 180018

Cultivar / Variety / Breed name: Solanaceous vegetables

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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