
Horticultural Crops Suitable for Coconut Planting Systems

**Malathi .G ^{1*}, Sankar .V ², Senthil Kumar .R ², Jegathambal .R ³ and
Chandrasekaran .N ⁴**

¹ Associate Professor (Horticulture), Krishi Vigyan Kendra, Sandhiyur, Salem, Tamil Nadu, India.

² Principal Scientist, Division of Social Sciences and Trainings, ICAR-IIHR, Hessaraghatta Lake Post, Bengaluru, India.

³ Programme Coordinator, Krishi Vigyan Kendra, Sandhiyur, Salem, Tamil Nadu, India.

⁴ Professor (SS&AC), Krishi Vigyan Kendra, Sandhiyur, Salem, Tamil Nadu, India.

Corresponding author's e-mail: malathihort@gmail.com

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ABSTRACT

Intercropping between coconut palms significantly enhances coconut yield without root competition. This mutually beneficial practice boosts overall profitability. Many horticultural crops of annuals and perennials including fruits, vegetables, spices, plantation crops, medicinal plants, green manure crops and cover crops can be grown as inter crops in coconut plantations. In essence, intercropping optimizes coconut plantation productivity, offering diversified income streams and enhancing overall agricultural sustainability.

INTRODUCTION

Intercropping between coconut palms significantly enhances coconut yield without root competition. This mutually beneficial practice boosts overall profitability. Coconut plantations, viable for intercropping until 8 years post-planting and after 20 years, optimize land use. Coconut seedlings, spaced 7.5 to 9.0 meters apart, leave ample room for additional crops. Studies show that only 28% of land is utilized by coconut trees, with 80% of root activity within 2 meters of the trunk. This leaves exploitable space for other crops.

Coconut palms' leaf structure and orientation allow light penetration, with older palms receiving 43% of normal sunlight. This facilitates the growth of shade-tolerant crops in interspaces. Intercropping compatible crops like tubers, flowers, medicinal plants, fruits, vegetables, and spices is economically superior to mono-cropping. High-density multispecies cropping systems (HDMSCS) involving crops such as banana, pineapple, clove, and pepper have been successfully established.

In essence, intercropping optimizes coconut plantation productivity, offering diversified income streams and enhancing overall agricultural sustainability.

VEGETABLE CROPS

Vegetable crops, being short-duration and shade-tolerant with efficient photosynthesis and biological fixation, are well-suited for intercropping in fruit plantations. Intercropping vegetables optimizes resource and space utilization, improves soil and orchard nutrient status, reduces fruit drop, and enhances fruit yield and quality. Additionally, it provides farmers with additional income and maximizes land utilization.

Experiments conducted at CPCRI, Kasaragod, have shown that vegetables like snake gourd, bottle gourd, ridge gourd, coccinia, and cucurbits are compatible with coconut. Intercropping with vegetables generates additional employment of 215 to 365 man-days per hectare per year. Cucumber stands out as an excellent vegetable intercrop for coconut plantations in the Andamans. Ridge gourd and sponge gourd are also recommended as suitable intercrops in coconut plantations in these islands.

In South India, additional revenue can be generated from coconut plantations by planting vegetables such as colocasia, amorphophallus, yams, and others. If there is still space and sunlight available, vegetables like dolichos cowpea, sweet potato, amaranthus, coriander, chili, cassava, moringa, bhendi, brinjal, radish, and more could be grown successfully.

For vegetable crops, specific varieties like Arka Garima, Arka Suman, and Arka Samrddhi for cowpea, Arka Suguna and Arka Arunima for amaranthus, Arka Isha for coriander, Arka Anupama for palak, Arka Haritha and Arka Meghana for chili, Arka Anand and Arka Harshitha for brinjal, Arka Anamika and Arka Nikita for bhendi, and Arka Nishant for radish are recommended for cultivation under coconut plantation, depending on sunlight and shade availability.

In general, intercropping vegetable crops with coconut not only enhances agricultural productivity but also offers diversified income opportunities for farmers.

FRUIT CROPS

The practice of cultivating biennial and perennial crops such as banana, papaya, pineapple, mango, jackfruit, lime, and lemon alongside coconut is widespread among small farmers. A fruit-based cropping system combining coconut, black pepper, and pineapple has been identified as highly successful in West Bengal. Among the various mixed crops tested, banana emerges as the most crucial intercrop for coconut gardens. It responds well to similar irrigation and manuring practices as coconut and is relatively resistant to pests and diseases, except for the burrowing

nematode in certain areas. Banana intercropping is predominantly practiced under rain-fed conditions. Approximately 1000 banana plants can be cultivated per hectare of coconut plantation (with 125 palms per hectare).

**Annuals and perennials grown as intercrops in Sri Lankan
Coconut plantations**

Crop	Common name	Botanical name
Fruit crops	Pineapple	<i>Ananas comosus</i>
	Banana	<i>Musa spp.</i>
	Papaya	<i>Carica papaya</i>
	Pomegranate	<i>Punica granatum</i>
	Guava	<i>Psidium guajava</i>
	Mango	<i>Mangifera indica</i>
	Rambutan	<i>Nephelium lappaceum</i>
	Durian	<i>Durio zibethinus</i>
	Dragon fruit	<i>Hylocereus undatus</i>
	Lemon	<i>Citrus limon</i>
Vegetable crops	Chilies	<i>Capsicum frutescens</i>
	Snake gourd	<i>Trichosanthes cucumerina</i>
	Drumstick	<i>Moringa oleifera</i>
	Brinjal	<i>Solanum melongena</i>
	Bottle gourd	<i>Lagenaria siceraria</i>
	Okra	<i>Abelmoschus esculentus</i>
Spice and beverage crops	Pepper	<i>Piper nigrum</i>
	Clove	<i>Syzygium aromaticum</i>
	Cardamom	<i>Elettaria cardamomum</i>
	Nutmeg	<i>Myristica fragrans</i>
	Cinnamon	<i>Cinnamomum verum</i>
	Cocoa	<i>Theobroma cacao</i>
Tubers and root crops	Cassava	<i>Manihot esculenta</i>
	Sweet potato	<i>Ipomoea batatas</i>
	Yam	<i>Dioscorea alata</i>
	Taro	<i>Xanthosoma sagittifolium</i>
	Ginger	<i>Zingiber officinale</i>
Cereals and millets	Turmeric	<i>Curcuma longa</i>
	Maize	<i>Zea mays</i>
	Finger millet	<i>Eleusine coracana</i>
	Foxtail millet	<i>Setaria italica</i>
Legume crops	Sorghum	<i>Sorghum bicolor</i>
	Groundnut	<i>Arachis hypogaea</i>
	Soybean	<i>Glycine max</i>
	Pigeon pea	<i>Cajanus cajan</i>
	Cowpea	<i>Vigna unguiculata</i>
	Green Gram	<i>Vigna radiata</i>
	Gliricidia	<i>Gliricidia sepium</i>

Pineapple can be effectively grown as an intercrop under both rain-fed and irrigated conditions. In irrigated settings, each fruit can reach a size of about 1.5 kg, while under rain-fed conditions, the size is reduced to half (0.71 kg). In a multi-storeyed cropping system, around 4000 kg of pineapple per hectare can be harvested, and even more when pineapple is the sole intercrop.

Two emerging fruit crops attracting farmers as profitable intercrops in coconut gardens are mangosteen and rambutan. Farmers in coastal Karnataka and certain parts of Kerala have successfully experimented with these crops as companion plants in coconut gardens. Additionally, the nutritious fruit avocado has found success as an intercrop in coffee plantations in parts of Tamil Nadu, Kerala, and Karnataka, and it may also thrive in widely spaced coconut plantations.

In general, integrating various fruit crops with coconut cultivation not only diversifies income sources but also maximizes land utilization, contributing to the overall sustainability and profitability of small-scale farming operations.

SPICE CROPS

In recent years, tree species such as clove, nutmeg, and cinnamon have been introduced and planted in the center of four coconut palms spaced 7.5 meters apart. However, the suitability and compatibility of mixed cropping systems have often been overlooked. Consequently, issues such as competition with coconut trees for soil moisture during stress periods, insufficient sunlight penetration, increased pest infestation, and disease occurrence have been observed.

In mixed-cropping systems, it is essential to select crops that are preferably shade-tolerant, as sunlight penetration beneath the coconut canopy may be insufficient. This ensures optimal growth conditions for both the coconut palms and the intercropped species, leading to improved overall agricultural productivity and sustainability.

PLANTATION CROPS

In South India, additional revenue can be generated from coconut plantations where there is sufficient sunlight infiltration at the base, by implementing the following strategies:

- Cultivating pepper vines within the palm basins, allowing them to grow and yield.
- Growing cocoa as a perennial secondary crop.
- Intercropping with areca palms.
- Planting banana and/or tapioca as annual crops.

Efforts are also underway to cultivate coffee, rubber, and fast-growing unbranched forest species between coconut rows. These initiatives aim to diversify income sources and optimize land use within coconut plantations.

FLOWER CROPS

According to the recommendations of CPCRI in Kasargod, certain varieties of Heliconia such as Heliconia stricta 'Iris', H. bihai x H. caribaea 'Kawauchi', Heliconia stricta 'Sunrise', and H. orthotropa 'She' have been identified as suitable intercrops in coconut plantations. A combination of 'She' and 'Sunrise' varieties can be planted in a 1:1 ratio to ensure year-round

production of inflorescences. The observed 11-17% increase in coconut palm yield over three years, particularly in palms affected by diseases in the early and middle stages, can be attributed to the complementary resource utilization of both crops and the improved microclimate.

Heliconia stricta 'Iris' is recommended as an intercrop during the early stages of coconut plantations, especially in areas with low light intensity (30 to 35%), to enhance farmers' livelihoods. *Alpinia* 'Jungle King' is another suitable option for intercropping in coconut gardens, as it produces flowers throughout the year except during April-May. The inflorescences produced by these plants meet market standards, with lengths exceeding one meter and a spike circumference of 20cm.

Some plantations also incorporate orchids as intercrops. In coastal humid tropics, sequential cropping of *Tagetes* and *Gomphrena* on 30% of the area under coconut-based farming systems ensures year-round income, with a benefit-cost ratio of 2.6.

MEDICINAL CROPS

Various medicinal crops such as *Aloe vera*, *Asparagus*, *Swertia*, *Ashwagandha*, and *Mentha* were intercropped in coconut plantations to assess total system productivity. It was observed that cultivating medicinal crops alongside coconut significantly increased overall system productivity. The highest system productivity of 8.62 tons of copra per hectare was recorded in the coconut and *Asparagus* system. This was followed by the coconut and *Aloe vera* combination, as well as the coconut and *Rauwolfia* intercrop, which outperformed coconut monocropping with 2.8 tons of copra per hectare.

GREEN MANURE CROPS

The cultivation of leguminous green manure crops in the basins of mature coconut plantations, along with the incorporation of the generated biomass, has resulted in the substitution of nitrogen fertilizer for coconut by up to 30 percent. Additionally, incorporating green manures improves soil physical, chemical, and biological properties, reduces weed growth, and minimizes runoff. Suitable leguminous species for green manuring in coconut gardens include *Pueraria phaseoloides*, *Mimosa invisa*, *Calopogonium mucunoides*, cowpea (*Vigna unguiculata*), sunhemp (*Crotalaria juncea*), horse gram (*Macrotyloma uniflorum*), daincha (*Sesbania aculata*), and *Sesbania spinosa*. These crops contribute approximately 15-25 kg of biomass and 100-200 g of nitrogen to coconut basins during the growth period.

COVER CROP IN COCONUT PLANTATION

Mucuna, also known as Velvet bean or Magical bean, has been widely adopted by farmers in Tamil Nadu, Kerala, and Karnataka as a cover crop in coconut plantations, particularly during the monsoon season. The primary reason for its adoption is weed suppression, along with improving the yield of standing or succeeding crops in various situations. The use of cover crops like *Mucuna* is an eco-friendly technology for effectively and sustainably controlling all weed species, including the highly invasive *Cyperus*. Being a legume, *Mucuna* also significantly enhances soil physical, chemical, and biological properties, thereby promoting the growth and

productivity of subsequent crops. Therefore, it is highly recommended to use *Mucuna* either in rotation with any vegetable crop or as a cover crop in tree orchards and plantation crops.

As a short-duration leguminous crop, *Mucuna* leaves behind more than 25 tons per hectare of biomass at the end of the cropping season, which substantially improves soil health. Its carbon sequestration potential is estimated to be 28.52 kg CO₂ per hectare per day. Furthermore, the biodegradation of *Mucuna* residues significantly increases soil phenolic acids, which helps control the germination of weed seeds.

The utilization of leguminous cover crops such as *Pueraria phaseoloides*, *Mimosa invisa*, and *Calopogonium* species as green manures to supply biologically fixed nitrogen and easily decomposable biomass to coconut plantations, thereby substituting 50% of nitrogen fertilizer, has been standardized. Additionally, growing *Glyricidia* as a green manure crop and using its biomass as green manure has been found to be an ideal soil management practice in coconut plantations on littoral sandy soils.

IIHR (Indian Institute of Horticultural Research) offers various varieties of *Mucuna* for cultivation like Arka Dhanvantri, Arka Subhra, Arka Aswini and Arka Charka.

CONCLUSION

Coconut plantations, viable for intercropping until 8 years post-planting and after 20 years, optimize land use. Coconut seedlings, spaced 7.5 to 9.0 meters apart, leave ample room for additional crops. Only 28% of land is utilized by coconut trees, with 80% of root activity within 2 meters of the trunk. Hence, there is ample scope for exploiting space for other crops as inter crops to get additional income. Intercropping compatible crops like tubers, flowers, medicinal plants, fruits, vegetables, and spices is economically superior to mono-cropping. High-density multispecies cropping systems (HDMSCS) involving crops such as banana, pineapple, clove, and pepper have been successfully established.