

Horticultural Crops Suitable for Coconut Planting Systems

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By growing crops in between coconut palms, there would considerably yield an increase in coconut and the root system is not competitive. Thus, the combination of crops has a mutually beneficial effect and there is the profitability of the whole cropping program. Coconut plantation (up to 8 years of planting and after 20 years of age) offers excellent scope for intercropping and hence in utilizing the available land resources in an optimum manner. Coconut seedlings are planted 7.5 meters to 9.0 meters wider apart. The wider spacing between the crops gives grower an opportunity for raising other crops, either annuals as intercrop or perennials as mixed crop as a source of additional income. Studies reveal that only 28 % of the land is occupied by the coconut trees and more than 80 % of the root activity was confined to a lateral distance of 2 m from the trunk. Thus, the remaining area could be profitably exploited for cultivating other crops. The venetian leaf structure and leaf orientation of the palms permit light penetration to the interspaces. The solar energy received by the crops under coconut canopy in older palms spaced 7-10 m apart is 43% of the normal sunlight. This light penetration facilitates growth of many shade tolerant crops in the interspaces. Coconut based cropping systems involving cultivation of compatible crops like tubers, flowers, medicinal and aromatic crops, fruits, vegetables, spice crops, in the interspaces of coconut is economically superior to coconut monocropping. Coconut-based high-density multispecies cropping systems (HDMSCS) involving many crops like banana, pineapple, clove, and pepper was established.

Vegetable crops

Vegetable crops are short durational and shade loving crops with high efficiency of photosynthesis and biological fixation. This ensures their suitability for growing as intercrops under fruit plantation. Intercropping of the vegetables ensures efficient resource and space utilization including improvement

of soil and orchard nutrient status, reduction in fruit drop and enhancing fruit yield and quality. It also provides additional income to farmers and helps in maximization of land use.

The experiment conducted at the CPCRL, Kasaragod have indicated that vegetables like snake gourd (*Trichosanthes anguina* L.), bottle gourd (*Lagenaria siceraria* (Molina) Stardl.), ridge gourd (*Luffa acutangula* Roxb.) and coccinia (*Coccinia indica* L. Voigt) and cucurbits are compatible with coconut. Intercropping with vegetables was found to generate additional employment of 215 to 365 man-days/ha/year. Cucumber is one of the best vegetable intercrops for coconut plantations in the Andamans. Ridge gourd and sponge gourd can also be recommended as suitable intercrops in coconut plantations of these islands. In South India, additional revenue could be obtained from coconut plantation (where there is sufficient infiltration of sunlight to the base) by planting. In vegetable crops colocasia, amorphophallus, yams etc could be grown successfully and if there is still space and sunlight vegetables like Dolichos cow pea, sweet potato, amaranthus, coriander, chilli, cassava, Moringa, bhendi, brinjal, radish etc could be grown. In case of vegetable cowpea Arka Garima, Arka Suman and Arka Samrddhi, Amarnathus - Arka Suguna and Arka Arunima, Coriander - Arka Isha, Palak - Arka Anupama, Chilli - Arka Haritha and Arka Meghana, Brinjal - Arka Anand and Arka Harshitha, Bhendi - Arka Anamika and Arka Nikita and Radish - Arka Nishant may be recommended to grown under Coconut plantation depending upon the availability of sunlight and shade.

Fruit crops

The practice of growing biennial and perennial crops like banana, papaya, pineapple, mango, jack fruit, lime and lemon etc., along with coconut is prevalent in the holdings of small farmers. Fruit based cropping system with coconut, comprising of coconut,

Table 1: 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>
Vegetable crops	Lemon	<i>Citrus limon</i>
	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>
	Cassava	<i>Manihot esculenta</i>
Tubers and root crops	Sweet potato	<i>Ipomoea batatas</i>
	Yam	<i>Dioscorea alata</i>
	Taro	<i>Xanthosoma sagittifolium</i>
	Ginger	<i>Zingiber officinale</i>
	Turmeric	<i>Curcuma longa</i>
Cereals and millets	Maize	<i>Zea mays</i>
	Finger millet	<i>Eleusine coracana</i>
	Foxtail millet	<i>Setaria italica</i>
	Sorghum	<i>Sorghum bicolor</i>
Legume crops	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>

black pepper, pineapple was found best under West Bengal condition. Among the mixed crops tested, banana is found to be the most important intercrop for coconut garden. It responds to similar irrigation and manuring systems as coconut and also comparatively free from serious pests and diseases except the burrowing nematode in certain pockets. Banana as intercrop is mostly grown under rain fed conditions. About 1000 banana plants could be raised/ha of coconut garden (125 palm/ha). Pineapple could be successfully raised as an intercrop both under rainfed and irrigated conditions. Under irrigated conditions, the size of each fruit would be about 1.5 kg; while as a rainfed crop, the size is reduced to half (0.71 kg). About 4000 kg pineapple/ha can be harvested in the multi-storeyed cropping system and much more when only pineapple ingrown as inter-crop. Two new conventional fruit crops that attract the farmers as money spinning intercrops in coconut garden are Mangosteen and Rambutan. Farmers in costal Karnataka and some parts of Kerala have already successfully tried these crops in coconut garden as companion crops. Nutritious fruit Avocado is mostly grown successfully as an inter crop in coffee plantation in parts of Tamil Nadu, Kerla and Karnataka and this fruit may be grown in widely space coconut plantation.

Spice crops

In recent years, tree species like clove, nutmeg and cinnamon have been introduced and planted in the center of four coconut palms spaced 7.5 m apart. However, the suitability/compatibility of mixed cropping systems has mostly been overlooked and as a result, the competition with coconut for soil moisture during the stress period, the incidence of sunlight, the infestation of pests, and occurrence of diseases have been observed. The crops selected for mixed-cropping should preferably be shade tolerant since the incidence of sunlight would be insufficient below the coconut canopy.

Plantation crops

In South India, additional revenue could be obtained from coconut plantation (where there is

sufficient infiltration of sunlight to the base) by planting:

- Pepper vines on palm basins and letting them grow and yield.
- Cocoa could be grown as a perennial secondary crop
- Areca palms could be intercropped
- Banana and/or tapioca could be planted as an annual crop.

Attempts are being made to grow coffee, rubber and forest species (un-branched and quick growing type) in between coconut rows.

Flower crops

As per the recommendations of CPCRI, Kasargod, *Heliconia stricta* 'Iris', *H.bihai* x *H.caribaea* 'Kawauchi', *Heliconia stricta* Sunrise and *H. orthotropa* 'She', are found to be suitable as intercrop in coconut plantations. A combination of varieties viz., 'She' and 'Sunrise' can be planted in 1:1 ratio for year-round production of inflorescences. The coconut palms (Disease Early and Middle) 11-17 % increase in yield in three years' time, was mainly due to complimentary use of resources by both crops and improved microclimate. *Heliconia stricta* 'Iris' can be recommended as an intercrop during early stage in coconut plantations where the light intensity is low (30 to 35%) for improving the livelihood of farmers. *Alpinia* 'Jungle King' is suitable for intercropping in coconut gardens. It produces flower throughout the year except during April-May. The inflorescences produced in these plants were of marketable standards with more than 1 meter in length and spike circumference of 20cm. In some plantations they intercrop orchids too. *Tagetes-Gomphrena* sequential cropping (30% area) under coconut-based farming system in coastal humid tropics fetches year-round income from the system with a BCR 2.6.

Medicinal Crops

Different medicinal crops like Aloe vera, Asparagus, Swertia, Aswagandha, Mentha were planted as intercrop in coconut plantation to find out the total system productivity. It was found that cultivation of medicinal crops under these systems

helped to increase the system productivity. Maximum system productivity (8.62 t copra/ha) was recorded in coconut and Asparagus system followed by coconut + Aloe vera and Coconut Rawalfia over coconut as monocrop 2.8 t copra/ha).

Green manure crops

Growing of leguminous green manure crops in the basin of adult coconut plantations and incorporation on of biomass generated resulted in substituting nitrogen fertilizer for coconut up to 30 per cent. Besides incorporation of green manures improve soil physical, chemical, biological properties. It reduces the weed growth and runoff. Suitable leguminous species for green manuring in the coconut garden are *Pueraria phaseoloides*, *Mimosa invisa*, *Calopogonium mucunoides*, cowpea (*Vigna unguiculata*), sunhemp (*Crotalaria juncea*), horse gram (*Macrotyloma uniflorum*), daincha (*Sesbania aculata*) and *Sesbania spinosa* etc. It contributes about 15-25 kg of biomass and 100-200 g of nitrogen in coconut basins during a growth period.

Cover crop in Coconut plantation

Mucuna or Velvet bean or Magical bean has been adopted by many farmers in Tamil Nadu, Kerala and Karnataka as cover crop in coconut plantation particularly monsoon season. The major reason for adoption is weed suppression also to improve the yield of standing/succeeding crops under various situations Use of cover crops like *Mucuna* is an eco-friendly technology for efficient and sustained control of all weed species including the most noxious *Cyperus*. Being a legume, *Mucuna*, also improved the soil physical, chemical and biological properties in a significant way which helped the subsequent crops to enhance growth and productivity. Therefore, it is highly recommended to use *Mucuna* in rotation with any vegetable crop or as a cover crop in tree orchards and plantation crops. Being a short duration leguminous crop *Mucuna* was found to leave behind > 25tons/ha of biomass at the end of the cropping season which helped to improve the soil health in a significant way. The carbon sequestration potential of *Mucuna* was worked out to be 28.52 Kg CO₂/ha/day.

The biodegradation of the *Mucuna* residues were found to increase the soil phenolic acids significantly which helped to control germination of weed seeds. 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, to substitute 50 % nitrogen

fertilizer, was standardized. Then, growing *Glyricidia* as green manure crop and using the biomass as green manure was found to be ideal soil management practices in coconut plantation of littoral sandy soils.

IIHR mucuna varieties available: Arka Dhanvantri, Arka Subhra, Arka Aswini and Arka Charka.

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