XXI Biennial National Symposium of Indian Society of Agronomy, 24–26 October, 2018 at MPUAT, Udaipur, Rajasthan

# Doubling farmers' income through palm based cropping under different agro-climatic regions of India

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Coconut (*Cocos nucifera L.*) is one of the most important tropical crops in the world, and is grown in more than 93 countries in an area of 12.19 million hectares, with an annual production of 61,165 million nuts. Indonesia is the largest coconut producing country, followed by the Philippines. India, with 2.08 million hectares and annual production of 23,904 million nuts occupies the third place (2016-17). Bestowed with most congenial agro climatic conditions, diverse soil types and abundant water resources, coconut cultivation in India is making inroads and the area under the crop attained more or less a linear growth pattern. In India, coconut is cultivated mainly in the coastal tracts of Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Odisha, West Bengal, Pondicherry, and Maharashtra and in the islands of Lakshadweep, Andaman and Nicobar. Of late, coconut cultivation has been introduced to suitable locations in non-traditional states including Assam, Gujarat, Madhya Pradesh, Rajasthan, Bihar, Tripura, Manipur, and Arunachal Pradesh and in the hinterland regions of the coconut growing states. The plantation sector in India is dominated by millions of small and marginal farmers, mainly confined to the economically and ecologically vulnerable regions. Coconut is an important plantation crop of India with a profound influence on the rural economy by supporting the livelihoods of 20 million people in the country.

**Coconut based intercropping systems**

About 80 per cent of coconut in the world is cultivated by small farmers, and these small holdings are mainly committed to coconut monocrop, which normally occupy the land for about a century. Under such monocropping system, majority of the coconut holdings do not generate adequate income and employment for the dependent families. From the land utilization point of view, a pure stand of coconut utilizes 22 per cent of the area at a spacing of 7.5 x 7.5 m, and the remaining area can be utilized for growing variety of useful seasonal crops. The rooting pattern of coconut indicates that over 95 per cent of the roots are found in the top 0-120 cm, of which 19 and 63 per cent of roots are confined to top 0-30 cm and 30-90 cm depth, respectively (Maheswarappa *et al.,* 2000) which suggests feasibility of growing intercrops. Coconut based cropping system depicts the arrangement of multispecies utilizing the available space, both horizontally and vertically, effectively on a sustainable manner. Multispecies cropping under coconut, particularly during the early growth stage (> 5 yr) and after the age of twenty five years of plantation ensure maximum resource utilization and higher additional income per unit area of soil, water and light. Intercropping results in improvement of the soil properties and biological activities in the root region. Overall the soil environment is modified for the better crop growth and development.

In recent years, the farmers are experiencing the non-profitability of coconut cultivation due to fluctuating prices of coconut and increasing incidence of pests and diseases in addition to low and erratic rainfall. Adoption of cropping system practices in coconut gardens will increase the productivity and income by ensuring effective and efficient utilization of soil space and solar radiation. A large variety of annual/ biennial/ perennial food, fruit, fodder, flower, vegetable, tuber, spice and medicinal and aromatic crops can be grown as intercrops in coconut garden depending on the agro-climatic condition of the area. The crops selected for intercropping should be shade loving or shade tolerant and offers minimum competition for light, water and nutrients by utilizing these resources from different layers of atmosphere and soil. The productivity of land is increased in the intercropping due to yield of intercrops in addition to coconut yield.

**Cropping and farming systems effect on doubling farmers income (DFI)**

Coconut or arecanut based inter/mixed, multistoried multi-species cropping as well as mixed farming systems have been developed by integrating livestock to increase total productivity. The coconut based cropping system using multispecies cropping of coconut with black pepper, banana, nutmeg, pineapple, ginger, turmeric and elephant foot yam generated a net income of Rs. 3.7 lakh/ha, which is 164% higher than that of coconut mono-crop (₹1.4 lakh), while the coconut based mixed farming system (CMFS) comprising coconut,

black pepper, banana, cross bred cows, poultry birds, goat, and pisciculture generated a net return of Rs. 5.5 lakh/ha, reflecting 293% higher than coconut monocrop. Arecanut based cropping system with cocoa, banana and black pepper as component crops generated net returns as high as ₹8.8 lakh/ha, which is 132% higher than that of arecanut monocrop (₹ 3.80 lakh). On the other hand, cropping systems like arecanut + vanilla, arecanut + medicinal and aromatic plants, and arecanut + cocoa have generated 68%, 53%, and 26% higher net returns respectively over arecanut monocrop. Arecanut based mixed farming system with dairying, freshwater aquaculture and fodder grass (Hybrid Napier) components generated net returns up to ₹6.6 lakh/ha, which is 74% higher than that of arecanut monocrop.

**Coconut based integrated farming systems (CBIFS) for enhancing farmer's income**

The sustainability and profitability of the coconut based integrated farming system comprising coconut, pepper (trailed on the coconut trunk), banana (in the border of the plots), fodder grass-Hybrid Bajra Napier cv. Co5 (in the interspaces of coconut), dairy unit (seven cows of Holstein Friesian and one Jersey cross breed), poultry (100 broiler birds), goattery (20 does and two bucks) and aquaculture (1000 fingerlings) was assessed. From one ha of coconut based integrated farming system, 22,750 coconuts, 13,275 litres of cow's milk, 315 kg live weight of goat, 189 kg live weight of broiler birds, 2,535 kg banana, 525 kg pepper and 112 kg fish were obtained. The highest net returns of Rs. 6,10,503/- was realized in the CBIFS which received combined application of 50 per cent organics (25 kg/palm FYM/poultry/goat manure and cow dung slurry) produced from the system and 50 per cent inorganics (250:160:600 g of N,P,K/palm) with a B:C of 1.89. The same manual practice resulted in fodder yield of 144 t/ha/year which was comparable to fully organic treatments viz., FYM/poultry/goat manure (15 t/ha) + cow dung slurry (fodder yield of 133 t/ha/year) and significantly higher than the chemical fertilizers viz., NPK @ 45:30:24 kg/ha alone (96 t/ha/year). In coconut palms maintained under CBIFS receiving integrated nutrient management practices *i.e.* organic recycling and 50% of the recommended chemical fertilizers, an increase in yield (130 nuts/palm) by 10 per cent compared to mono-cropping (118 nuts/palm) was recorded. Adoption of coconut based integrated farming resulted in net income of ' 6, 10,503/- as compared to monocrop of coconut

**Coconut based cropping system effect on DFI**

The cropping system studies carried out in different parts of the country through All India Coordinated Research Project on Palms (AICRP on Palms) indicated improvement in nut yield of coconut and productivity and income of the cropping system. The soil fertility and uptake of nutrients by coconut was also improved with intercropping. In the studies at Ambajipeta, Andhra Pradesh conducted during 1999 to 2003, the crop combination of coconut + cocoa + cinnamon + pepper + pine apple + banana + elephant foot yam + colocasia + turmeric was found highly productive and remunerative. The cropping system studies conducted during 2004 to 2008 have also identified suitable intercrops with coconut like banana, drumstick, french bean, ladies finger and redgram for Karnataka and turmeric, ginger, banana, tapioca and pine apple for Maharashtra. Similarly, the crop combinations of coconut + black pepper + bottle gourd + cowpea was found suitable for Chhattisgarh; coconut + banana + tuberose and coconut + bitter gourd + bottle gourd for Orissa; coconut + black pepper + pine apple for West Bengal and coconut + black pepper + turmeric/ ginger for Assam. The high density multispecies cropping system (HDMSCS) is the growing of number of compatible crops in a unit area to meet the diverse needs of a farmer such as food, fuel, timber, fodder and cash. This system aims at maximizing production per unit of land area and is ideally suited for smaller holdings. The sustainability of production is well addressed in this system through efficient utilization of natural resources and biomass recycling. The productivity of land increases in the high density multispecies cropping system due to crop diversification and intensification. The results of the studies on HDMSCS conducted during 2008 to 2013 at different Centres of AICRP on Palms located in different parts of the country have indicated improvement in coconut yield and productivity of the land in the high density multispecies cropping systems (Table 3). The cropping systems of Coconut + Cocoa + Lime + Drumstick at Arsikere (Karnataka), Coconut + Cocoa + Banana + Pine apple + Tomato at Ambajipeta (Andhra Pradesh), Coconut + Cocoa + Banana + Pine apple + Drumstick at Aliyarnagar (Tamil Nadu), Coconut + Black pepper + Cocoa + Banana + Elephant foot yam at Veppankulam (Tamil Nadu), Coconut + Nutmeg + Cinnamon + Banana + Pine apple at Ratnagiri (Maharashtra), Coconut + Guava + Cinnamon + Banana + Colocasia + Mango ginger- Bottle gourd + Cowpea- Elephant foot yam at Jagdalpur (Chhattisgarh), Coconut + Guava + Banana + Pine apple at Bhubaneswar (Orissa) and Coconut + Turmeric + Pine apple + Lemon + Banana + Elephant foot yam at Kahikuchi (Assam) are highly productive and remunerative than monocrop of coconut. Growing of intercrops in high density multispecies cropping system improves the available nutrient status of soil due to addition and recycling of organic matter and the manures and fertilizers applied to intercrops. The results of the studies at different Centres of AICRP on Palms showed that the available N, $P_2O_5$ and $K_2O$ were higher in the cropping system compared to monocrop of coconut. Similarly, the NPK content in the index leaf of coconut was also higher in cropping system compared to monocrop of coconut. Thus, the productivity of coconut gardens can be improved and sustainability of production and income can be achieved by growing various compatible crops in coconut garden. The effective and efficient utilization of soil space and solar radiation can be ensured in the cropping

**Table 1.** Coconut and intercrops yield on net returns basis at different centres (Mean of 2016-17 and 2017-18)

| Treatments | Arsikere | | Veppankulam | | Mondouri | | Navsari | | Ratnagiri | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Yield (kg/ha) | Net returns (₹/ha) | Yield (kg/ha) | Net returns (₹/ha) | Yield (kg/ha) | Net returns (₹/ha) | Yield (kg/ha) | Net returns (₹/ha) | Yield (kg/ha) | Net returns (₹/ha) |
| 75 % of RDF + 25 % organic | 9000 | 125573 | 20160 | 277280 | 18408 | 387454 | 21120 | 556744 | 14690 | 641540 |
| 50 % of RDF + 50 % organic | 9710 | 134039 | 21960 | 350690 | 18089 | 276788 | 24728 | 719356 | 13965 | 551335 |
| 100 % organic | 9490 | 139816 | 21060 | 337698 | 18196 | 265192 | 23320 | 611723 | 13705 | 529265 |
| Monocrop RDF | 9270 | 85510 | 18900 | 96300 | 18231 | 98705 | 19888 | 85716 | 13430 | 201527 |

RDF= Recommended doses of fertilizers

system. The biomass produced in the cropping system can be recycled through vermicomposting. Improvement in soil fertility of coconut garden, enhanced nutrient uptake by coconut palms and increase in earthworm and microbial population can be achieved through intercropping in coconut gardens.

**Coconut + medicinal plants**

The studies on intercropping of medicinal and aromatic plants in coconut garden conducted at different parts of India during 2006 to 2011 under All India Coordinated Research Project on Palms have indicated the suitability of lemon grass, garden rue, tulsi (*Ocimum sanctum*), kalmegh (*Andrographis paniculata*), arrow root and makoi (*Solanum nigrum*) for Karnataka; *Alpinia galangal*, patchouli, lemongrass, *Aloe vera* and tulsi for Tamil Nadu, patchouli, palmarosa, mango ginger and citronella for Andhra Pradesh; shatavari *(Asparagus racemosus*), adulsa (*Adhatoda vasica*), arrow root, lemon grass and citronella for Maharashtra; stevia, mango ginger, sarpaganda and patchouli for Chhattisgarh; sarpaganda, ashwaganda and arrow root for west Bengal; and sarpaganda, pipali (*Piper longum*), vedailota (*Paederia foetida*), citronella and patchouli for Assam. The yield of coconut was improved with the intercropping of medicinal and aromatic crops. Soil nutrient status and uptake of nutrients by coconut were improved with intercropping of medicinal and aromatic plants in coconut garden.

**Flower crops:** Flower crops can also be grown as intercrops in coconut gardens. Shade tolerant flower crops having good market are to be selected for intercropping in coconut garden. The flower crops suitable for intercropping in coconut vary with agro-climatic condition. The studies conducted at different Centres of All India Coorinated Research Project on Palms indicated the better performance of Chrysanthemum (*Dendranthema grandiflora*), Marigold (*Tagetes erecta*) and Gomphrena (*Gompherena globosa*) in coastal Tamil Nadu, Crossandra, Chrysanthemum, China aster and Marigold in semi arid Karnataka (Basavaraju *et al.,* 2018), Gerbera, Gladiolus, Tube rose and Marigold in Assam and Gerbera, Gladiolus, Tube rose, Marigold and Heliconia in West Bengal.

The dried biomass obtained from coconut in the form of leaves and spathe and fresh/dry biomass of annual/ biennial intercrops after their harvest and fresh biomass from pruning of perennial intercrops can be used for vermicomposting. The vermicompost so produced can be applied to coconut and intercrops. The vermiwash can also be collected during the process of vermicomposting and applied to coconut and intercrops. The quantity of biomass and vermicompost production in the cropping system varies with the crop components and the agro-climatic situation.

## CONCLUSION

The palm- tree-crop system produces adequate returns from land and labour within the constraints of unpredictable climatic conditions and limited inputs. Income obtained per unit area of this system will be much more than from a corresponding area of pure plantation crop. It is a economically viable, environmentally sustainable and ensures rural prosperity in the coconut growing communities. Thus, coconut farmers can increase their income by four times with the adoption of a integrated farming system. However, the traditional practice of growing coconut without good agricultural practices leads to exploitation of the soil resources. In addition to the economic benefits, the systems ensure food and nutritional security coupled with sustainability and environmental services.

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