

Coconut based farming system for livelihood and nutritional security

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1. Introduction

Coconut is a traditional plantation crop of India and assumes the status of a high value commercial crop and Kerala ranks first in area (53.76%) followed by Tamil Nadu, Karnataka and Andhra Pradesh. In our country, 98% of the coconut holdings are less than 2.0 ha in size out of which more than 90% are less than 1.0 ha. these small holdings are mainly committed to a mono crop of coconut, which normally occupies the land for about a century. Most of these holdings neither provide gainful employment opportunities for the family labour throughout the year nor generate sufficient income to meet the family requirement. In the present condition where coconut growers are more exposed to economic risks and uncertainties owing to the high degree of price fluctuations, need of the hour is to emphasize the importance of crop diversification in coconut gardens.

Coconut gardens offer excellent opportunities to exploit the inter-space potential for maximizing returns per unit area. In humid tropics, cropping/farming system aims at crop diversification and intensive cropping in the inter space available in coconut to increase the per palm productivity as well as productivity of unit holding in a system approach wherein the available farm resources like soil and water/rainfall resource, farm labour, agricultural inputs (seeds, fertilizers, agro-chemicals) etc. are utilized to produce both nuts, food and non-food agricultural products from the farm, in a business or profitable way. Under such a cropping/farming system, all the management practices and component production systems should be able to maintain high productivity, profitability and sustainability of the existing coconut palms to maximize economic yield of the farm. Sustainability is the main objective of farming system, where production process is optimized through efficient utilization of the inputs in safeguarding the environment.

2. Scope of coconut based cropping/ farming system

Studies have revealed that planting method and growth habit of sole coconut palms at the recommended spacing of 7.5 m x 7.5 m make use of only 22.3% of land area effectively while the average air space utilization by the canopy is about 30% and solar radiation interception is 4550%. However, the effective root zone of the adult palm is confined laterally within a radius of 2 m around the base of the palm and over 95% of roots are found



Fig. 1. Cocoa under coconut as a understory crop



Fig. 2. Oranmental crops under coconut as intercrop



Fig.3. Coconut based high density multiple cropping system



Fig.4. Banana as inter crop

in the top 0-120 cm of which 18.9 % and, 63 % of roots are confined to top 0-30 cm and 31-90 cm depth, respectively. Making use of the underutilized soil space and solar radiation in pure stands, a variety of crops having different stature, canopy shape and size and rooting habit can be inter planted to form compatible combinations.

3. Relevance of Coconut Based Cropping/Farming Systems (CBCFS)

The practice of CBCFS can provide:

- Food security through food sufficiency
- Nutritional foods rich in vitamins and minerals (nutrients) through inclusion of vegetables, fruit crops, tuber crops, spice crops etc.
- Employment generation from farm diversification
- Ecological stability (environmental protection) by way of crop diversity and effective recycling of farm wastes).

3.1. Social benefits: Social benefits are the food and nutritional functions of fresh nuts of coconut and coconut products, and crops produced under Coconut Based Cropping/Farming System (CBCFS) which include; cereals (as source of carbohydrates, protein, fats and oils); root crops (as source of carbohydrates and minerals); legumes (as source of protein and vegetable fats and oils); fruit crops (as rich source of vitamins and minerals, and carbohydrates); leafy and fruit vegetables (as rich source of vitamins, minerals and dietary fibres); spice crops (food flavouring, and vitamins and minerals); coffee and cocoa (beverage and stimulants) and natural fibre crops (clothing materials and paper and packaging); wood and timber (housing materials, pulp and paper).

3.2. Ecological benefits: Ecological conditions of the long-term mono cropping land compared to the CBCFS lands indicated the favourable and stable intensive and sustainable agricultural production under latter. Ground covering through cover cropping minimizes the direct impact of rainfall and the separation of soil aggregates under a coconut environment, which can

control soil erosion by 70-90%, compared to bare soil or un-cropped condition. The micro climate in coconut garden allows other crops or plants to grow favourably between spaces of palms. The presence of undergrowth vegetation in coconut plantations minimizes soil and water loss through surface runoff. An adequate ground cover can also increase rainwater infiltration and storage, eventually increasing water supply of the entire area, and reducing the runoff and soil loss.

Thus, totals of CBCS environmental value will be (Soil conservation+ Farm diversification +Nutrient recycling+ Fuel energy). Generally, the value of the coconut based agro-ecosystem is based on the direct use as food, raw materials and fuel, but the services rendered by the ecosystem should also be covered.

4. Coconut based cropping/ farming systems

In order to enhance productivity per unit land area, we have to make maximum use of limited resources without affecting the ecological balance in any manner. The ideal approach for small farmers towards this would be to increase the cropping intensity, which can be achieved through two ways, the first being the time concept where instead of taking only one crop, more crops per year are cultivated and harvested and the second being space concept, where all the available space in between the main crop is used for cultivation of various crops.

Coconut based cropping/farming systems have received priority in India in recent years and accordingly, research programmes on coconut based cropping systems were initiated during the thirties at the Coconut Research Stations at Kasaragod, Pilicode and Nileshwar and were intensified in the seventies with the establishment of Central Plantation Crops Research Institute at Kasaragod and All India Coordinated Research Project (AICRP) on Palms with centers in different coconut growing states. A number of coconut based cropping systems involving annuals, biennials, perennials and combinations of both annuals and perennials have been developed to



Fig.5. Pineapple under coconut



Fig.6. Grass under coconut

suit the farmers' needs, availability of resources like labour, rainfall, irrigation facilities, finance etc., soil characteristics and market demand. The crops found suitable for cultivation as subsidiary crops in coconut gardens include tuber crops, rhizome spices, cereals, pulses, oilseeds, fruit crops, vegetables, and medicinal and aromatic plants among the annuals and beverage crops and spices among the perennials. The research effort of ICAR-CPCRI has resulted in the development of technologies for coconut based intercropping, multi-storied, high density multi-species cropping systems and these are being widely adopted by the farmers. The high density multi-species cropping system and coconut-based mixed farming system, involving annuals/biennials/perennials grown in different tiers by exploiting soil and air space more efficiently and integrating with poultry and animal husbandry, help to maximize profits and can even buffer the price crash of the main crop. The crops selected for a cropping system should be compatible with the main crop and it should have local demand.

4.1. Coconut based High Density Multispecies Cropping Systems (HDMSCS): The HDMSCS is the growing of number of compatible crops in a unit area to meet the diverse needs of a farmer and 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. HDMSCS models consist of a large number of crop species that include annuals, biennials and perennials with very high plant density. The crop selected will have large, medium and small canopy architecture and are planted in a systematic manner to exploit space both in the vertical and horizontal dimensions. The disturbance to soil is to be kept to the minimum (only slash weeding is done) and all the biomass (other than the economic part) produced is also to be recycled within the system. Cash, food and fodder crops are generally included in the cropping system. The annual crops are removed as the canopy size of perennial crops increases.

4.2. Productivity and Economics of HDMSCS: The productivity of land increases in the high density multispecies cropping system due to crop diversification and intensification. HDMSCS at ICAR CPCRI, Kasaragod with coconut + black pepper + nutmeg + banana + pineapple + annual crops like ginger, turmeric has resulted in higher system productivity and income. The coconut yield realized during 2014-15 under different nutrient management system was 177 to 188 nuts/palm/year compared to the pre-experimental yield (2005-07) of 142 to 152 nuts/palm/year. The economics of the system for the year 2014-15 indicated higher net return in applying fully organic with recycling biomass (vermicompost)+biofertiliser+green manuring+vermiwash+husk burial+mulching) (Rs. 3.55 lakhs/ha/year) followed by other nutrient management treatments (Rs. 3.30 lakhs/ha/year). The results of the studies on HDMSCS conducted during 2008 to 2015 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. The coconut based cropping systems under integrated nutrient management evaluated at different AICRP Centres also showed higher productivity and income than mono crop of coconut. At Aliyamagar (Tamil Nadu) Centre, the cropping system of coconut + cocoa + banana + pineapple with integrated nutrient management of 75% of recommended NPK coupled with organic recycling with vermicompost recorded higher net income of Rs. 3.77 lakhs/ha followed by fully organic treatment (Rs. 3.46 lakhs/ha), whereas, mono crop of coconut recorded the lowest net income (Rs. 1.24 lakhs/ha). At Arsikere (Karnataka) Centre, the cropping system of coconut + cocoa + lime + drumstick recorded higher net returns under fully organic nutrient management (Rs.2.95 lakhs/ha) followed by 50% of recommended NPK + organic recycling with vermicompost + vermiwash application + biofertilizer application and in situ green manuring (Rs. 2.84 lakhs/ha), whereas, mono crop recorded the lowest net income (Rs. 1.10 lakhs/ha). At Ambajipeta



Fig.7. Dairy unit associated with coconut

(Andhra Pradesh) also, the HDMSCS with cocoa+ banana+vegetables+ pineapple resulted in realizing higher income (Rs. 2.75 lakhs/ha), whereas, mono crop recorded only Rs.1.25 lakhs/ha indicating the financial advantage of HDMSCS over mono cropping coconut.

4.3. Coconut based Integrated Farming System (CBIFS): The sustainability and profitability of coconut based integrated farming system comprising coconut, black pepper trailed on the coconut trunk, banana in the border of the plots, fodder grass (Hybrid Bajra Napier Co 3) in the interspaces of coconut, dairy unit (seven cows of Holstein Friesian and one Jersey cross breed), poultry (100 broiler birds/batch), Japanese quails (100 layers) and aquaculture (1000 finger lings) are assessed in a coconut stand of 40 years old maintained in the soil type of sandy loam of ICAR-CPCRI, Kasaragod. The coconut palms maintained under CBIFS receiving integrated nutrient management practices i.e., organic recycling and 50% of the recommended chemical fertilizer recorded higher coconut yield (140 nuts/palm) which was comparable with other nutrient management practices and also higher than coconut mono cropping (114 nuts/palm). The integrated farming system improved the soil fertility, physical properties of soil viz., bulk density, water holding capacity and hydraulic conductivity which are required for sustainability of the system. Hybrid Bajra Napier CO 3 and Co 4 as intercrop in coconut resulted in average yield of 117 t and 114 t green fodder /ha/year, respectively. Such a coconut based farming system resulted in the net returns of Rs 5.18 lakhs /ha during the year 2014-15, which indicates the profitability of the system.

4.4. Role of Coconut Based Cropping/Farming System in Root (wilt) affected garden: Root (wilt) of coconut is a debilitating disease and there is no effective prophylactic or curative measure for this disease as it is caused by phytoplasma. Those palms, affected by the disease, often, are seen superimposed with leaf rot disease also, and if left unattended, the disease will advance and cause drastic reduction in nut yield. The net return from the disease affected area is comparatively low due to the poor yield of coconut and also due to the additional expenditure to be incurred on plant

protection operations to combat the leaf rot disease. In such a situation, where the income from the main crop is declining, the agronomic strategy has to be oriented to evolve a suitable inter/mixed/multi-storied cropping programme, which will ensure a reasonable income to the farmer from the land. Various studies conducted on CBCS or CBFS through HDMSCS in root(wilt) disease affected areas have clearly indicated the beneficial role in improving total productivity of the land (by way of enhancing coconut yield, additional yield from inter/mixed crops, thereby ensuring nutritional security), as well as providing additional employment opportunities to the farm family. The crops included, besides coconut were banana, pineapple, black pepper, elephant foot yam and vegetables. The contribution from various inter/mixed crops varied from 30 % to 50% in different years indicating that fall in price of main crop (coconut) could be compensated to a great extent by other crops in the system. The biomass available in the field could be effectively recycled to meet the nutritional requirement of the system, though partially, which will also improve physico-chemical and biological properties of soil paving way for improving the production efficiency of the system. Recent studies in the root(wilt)disease affected coconut gardens have proved the potential of intercropping flower crops such as *Heliconia stricta* Iris and sequential cropping of *Tagetes* (seven months) followed by *Gomphrena* (five months) (both being short duration crops) in improving the yield of coconut palms as well as increasing the economic returns.

4.5. Productivity and Economics of the System in Littoral Sandy Soil:

The littoral sandy soil constitute a major portion in the coconut growing regions. Fodder grass (Hybrid Bajra Napier, Co3- 92 t/ha/year), vegetable crops (cowpea-6 t/ha, ridge gourd-9 t/ha, snake gourd- 8t/ha), pumpkin-10.12 t/ha and ash gourd-(9.2 t/ha), tuber crops (elephant foot yam- 20t/ha) and fruit crops (banana and pineapple-15t/ha) could be successfully grown as intercrops in coconut gardens under coastal sandy soil by adopting appropriate soil moisture conservation measures viz., opening of trenches/ pit depending upon the crops chosen and incorporation of one layer of coconut husk in the bottom of this trench/pit with its



Fig.9. Tuber crops under coconut



Fig.9. Vegetable under coconut

concave surface facing planting zone and this husk layer is covered with organic manure which is covered by soil. The yield of coconut could be increased from initial level of 40 nuts/palm to 120 nuts/palm under coconut + vegetable intercropping system followed by coconut + pineapple (107 nuts/palm), coconut + fodder grass(102 nuts/palm) and mono cropping (98 nuts/palm) during 2014-15. The economic advantage of the system under coastal sandy soil is that all the cropping systems had realized higher net returns as compared to mono crop. The net returns ranged from Rs. 0.46 lakh/ha/year in case of coconut mono crop to Rs. 1.13 constitute a major portion in the coconut growing regions. Fodder grass(Hybrid Bajra Napier ,Co3- 92 t/ha/year), vegetable crops (cowpea-6 t/ha, ridge gourd-9 t/ha, snake gourd-

8t/ha), pumpkin-10.12 t/ha and ash gourd-(9.2 t/ha), tuber crops (elephant foot yam- 20t/ha) and fruit crops (banana and pineapple-15t/ha)) could be successfully grown as intercrops in coconut gardens under coastal sandy soil by adopting appropriate soil moisture conservation measures viz., opening of trenches/ pit depending upon the crops chosen and incorporation of one layer of coconut husk in the bottom of this trench/ pit with its concave surface facing planting zone and this husk layer is covered with organic manure which is covered by soil and planting taken. The yield of coconut could be increased from initial level of 40 nuts/palm to 120 nuts/palm under coconut + vegetable intercropping system followed by coconut + pineapple (107 nuts/palm), coconut + fodder grass (102 nuts/palm) and mono cropping (98 nuts/palm) during 2014-15. The economic advantage of the system under coastal sandy soil is that all the cropping systems realized higher net returns as compared to mono crop. The net returns ranged from Rs. 0.46 lakh/ha/year in case of coconut mono crop to Rs. 1.13 lakhs/ha/ year in case of coconut + pineapple intercropping system. ■

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