Enhancing farm income by coconut based cropping systems involving climate resilient tuber crops

A Success story of participatory demonstrations

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Coconut, the most important of all cultivated palms, provides livelihood security to several millions of people across the world, and the capacity of coconut in providing improved nutrition, employment and income generation are well known. In India, the palm is cultivated in 18 states and 3 Union Territories and supports the livelihood of over twelve million people. It is of greater importance in the agrarian economy of the four southern states of Kerala, Tamil Nadu, Karnataka and Andhra Pradesh, which account for 90% of the coconut cultivation in India. Coconut cultivation in the country is mainly in the hands of small and marginal farmers with more than 90% of the coconut holdings being less than 0.40 ha size. The area, production and productivity of coconut in India and Kerala are given in Table 1.

Table 1. Area, production and productivity of coconut in Kerala and India (Source: GOI, 2017-18)

S.No.	State/ Country	Area ('000 ha)	% to all India	Production ('000 MT)	% to all India	Productivity (Kg/ ha)
1	Kerala	807.13	38.50	5829	35.52	7828
2	India	2097.00	100.00	16413	100.00	7222

Though, Kerala occupies the largest area (38.50%) under coconut, majority of the coconut holdings are small, which neither provides gainful employment opportunities to the family throughout the year nor generate sufficient income to meet the family requirement. The coconut farmers are also

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exposed to economic risks and uncertainties due to high degree of price fluctuations. The domestic price of coconut in India has also been showing a declining trend. The phyllotaxy and the unique plant architecture of the coconut tree offer ample scope for utilizing the greater portion (75%) of the unutilized area between the trees for intercropping with annuals and perennials.

Tropical tuber crops such as cassava, elephant foot yam and greater yam are ethnic starchy vegetables with good production potential, cooking quality and taste besides medicinal and nutritive values. Hence these are important as traditional food in the diets of the people of Kerala. It is estimated that tuber crops provide about 6% of the dietary energy, apart from being good sources of β-carotene, antioxidants, dietary fibre and minerals. They have higher biological efficiency, can tolerate drought and shade, withstand flood and salinity to some extent, are adapted to marginal environments, low input situations and adverse soil and climatic conditions. Hence these crops are known as 'climate resilient' or 'future crops'.

Cultivation of these tropical tuber crops in the interspaces of coconut palms will enhance farmers' income and enable employment opportunities and the compatibility/flexibility of tuber crops in coconut gardens have been documented by ICAR-CTCRI. Experiments on cropping systems conducted over the years revealed that tuber crops were able to provide an average additional yield of 10-12 tonne ha-1, additional profit of Rs. 1 to 1.25 lakh ha-1 and employment generation of 150-200 man days ha-1 making the system economical and sustainable (Suja and Nedunchezhiyan, 2018).

ICAR Institutes, State Agricultural and Horticultural Universities under All India Coordinated Research Project on Tuber Crops (AICRP TC) and other research and extension organizations have been working on tuber crops based cropping systems for generation and dissemination of technologies for enhancing the production and farm income from unit area with minimum resources. ICAR-Central Tuber Crops Research Institute, the premier research institute solely dedicated to tropical tuber crops in the world, has been pioneering systematically in the research and field experiments cum demonstrations on cropping systems for popularizing the technologies among farmers and other stakeholders.

Several studies reported that coconut based cropping system involving tuber crops is effective for increasing the production per unit area and maximizing the economic returns through better utilization of natural resources. In order to follow this cropping system, farmers need to be convinced about the socio- economic and technical feasibility in their local conditions. Due to various constraints, many coconut growers are not able to adopt the cropping system to the desired level. Establishing participatory demonstration plots in farmer's gardens will encourage many others to follow cropping system for the improvement of their livelihood. Coconut is one of the major crops in Thiruvananthapuram

Table 2. Planting system for tuber crops intercropped in coconut gardens

Main crop	Intercrops/ Variety	Time of planting	Method of planting, spacing and plant population per ha	Duration (months)
Coconut (West Coast Tall)	Cassava (Sree Pavithra: 35-45 t/ha; 27 % starch and K efficient variety)	May-June, 2018	Mounds, 90x90 cm (9000 plants)	8-10
	Greater yam (Sree Keerthi: 25-30t/ha; 22% starch and tolerant to anthracnose disease)	May-June, 2018	Pits, 90x90cm (9000 plants)	8-9

SSNM technology in cassava

Table 3. Demonstrations in cassava and greater yam in Thiruvananthapuram district		
S.No.	Name & address of the coconut grower	Technology
1	Mr. Thulasidas R., Susheeldhara, Ponvila, Ayira P.O. Chenkal Panchayat, Thiruvananthapuram	SSNM in cassava
2	Mr. Narayanan Nair R., Souparnika, Ambadi Nagar, Russelpuram P.O., Thiruvananthapuram	SSNM in cassava
3	Mr. Krishnan Nair V., Kalivilakathu veedu, Poozhanadu P.O. Ottsekharamangalam , Thiruvananthapuram	SSNM in cassava
4	Mr. Sasidharan Nair, Saranya Bhavan, Valicode, Ottasekharamangalam Panchayat,Thiruvananthapuram	SSNM in greater yam
5	Mr. Elizebeth Thankachan, TC5/785/2, Salom, Mannamoola, Peroorkada, Thiruvananthapuram	SSNM in greater yam
6	Mr. Thulasidas R., Susheeldhara, Ponvila, Ayira P.O. Chenkal Panchayat, Thiruvananthapuram	Organic farming in cassava
7	Mr. Narayanan Nair R., Souparnika, Ambadi Nagar, Russelpuram P.O., Thiruvananthapuram	Organic farming in cassava
8	Mr. Swami Mokshavratananda, Sree Ramakrishna Ashramam, Malamukal, Nettayam, Thiruvananthapuram	Organic farming in cassava
9	Mr. Sreekandan Nair K., Kachani, Karakulam, Thiruvananthapuram	Organic farming in greater yam
10	Mr. Sujith D., Punnamen mele Puthenveedu, Mullilavinmodode, Aruvikkara P.O.,Thiruvananthapuram	Organic farming in greater yam


Organic farming in cassava

district with an area, production and productivity of 68110 ha, 562 million nuts and 8251 nuts /ha, respectively (GoK, 2020). Keeping this in view, ten demonstration plots on Coconut based cropping system involving tuber crops vis-à-vis soil health management' sponsored by Coconut Development Board, Ministry of Agriculture and Farmers' Welfare, Kochi were established in Thiruvananthapuram district for enhancing productivity and profitability of farming per unit area.

Selection of coconut growers

Farmers who had interest in taking up intercrops were selected with the support of officials of CDB/ Krishi Bhavans/KVKs after following the principles of participatory demonstration. Socio–economic background, available resources, farming details, farming practices, knowledge on cropping system, yield details, constraints in farming etc. were collected in detail with the active participation of the farmers. Ten coconut gardens with minimum area of 50 cents each aged more than 20 years were selected for establishing demonstration plots on SSNM and organic farming with cassava and greater yam as intercrops in the cropping system (Table 2). Planting materials of tuber crops were supplied and expenditures for planting and critical inputs were provided through funding from CDB, Kochi. Soil samples were collected prior to the start of the demonstrations for analyzing the nutrient status and chemical properties. Demonstrations were carried out based on the soil nutrient status and as per the standardized technologies.

Capacity building and providing resources

Farmers were supplied with quality planting materials of improved varieties/selections of tuber crops for planting in coconut gardens as per the recommendations. Ten demonstrations were established as per the technological specifications. Farmers' were trained on latest technologies with respect to coconut and tuber crops. Frequent farm

Table 5. Economics of coconut + tuber crops cropping system vis-a vis soil health management						
Technology	Coconut yield (Nuts/ha)	Tuber yield (t/ ha)	Gross Income (Rs.)	Gross Cost (Rs.)	Net Income (Rs.)	BC Ratio
Economics of coconut + cassava cropping system : SSNM Vs POP Vs FP						
SSNM	16625	31.50	733310	235000	498310	3.12
POP	14875	26.48	625330	280000	345330	2.23
FP	14000	20.93	516680	260000	256680	1.99
Economics of coconut + cassava cropping system : OF Vs POP Vs FP						
OF	15400	24.08	587380	236050	351330	2.49
POP	14175	16.10	431490	280000	151490	1.54
FP	13650	17.40	462513	260000	202513	1.78
Economics of coconut + greater yam cropping system: SSNM Vs POP Vs FP						
SSNM	15750	4.00	297325	215000	82325	1.38
POP	14175	4.74	307650	240000	67650	1.28
FP	13475	3.39	253575	230000	23575	1.10
Economics of coconut + greater yam cropping system: OF Vs POP Vs FP						
OF	15050	3.65	278075	225000	53075	1.24
POP	13825	3.34	255325	240000	15325	1.06
FP	12950	3.60	255500	230000	25500	1.11

advisory visits were carried out by the scientists to monitor the growth and yield performance of coconut and intercrops. The list of beneficiaries is given in Table 3.

Technological interventions

Customized fertilizers based on SSNM: Technologies for SSNM in cassava and greater yam which could enhance the yield by 24% over farmers' fertilizer practice, besides maintaining soil quality. Customized fertilizers consisting of macro and micronutrients based on soil test values are used for managing the nutrient requirements in tuber crops to attain specific yield goals.

Organic farming package: Organic farming technologies of tropical tuber crops at ICAR-CTCRI, indicated that organic farming resulted in 10-20% higher yield, 20-40% profit, besides improvement in tuber quality and soil health. Organic production technologies developed for cassava and greater yam were used. Organic farming technology consisting of organically produced planting materials, organic manures, green manuring, bio-fertilizers, bio-control agents, biopesticides etc. are used for managing the nutrient requirements of tuber crops.

Layout and implementation: The layout and plot preparation were done during May- June 2018 strictly under the guidance and supervision of scientists of ICAR-CTCRI and team members of the project. In those demonstrations designated for validating SSNM, the field was laid out into three, SSNM technology (T1), present POP recommendation (T2) and Farmers practice (T3). Likewise, in demonstrations identified for validating organic farming, the field was laid out into three, Organic Farming technology (T1), present POP recommendation (T2) and Farmers practice (T3). This methodology was followed for cassava

SSNM technology in greater yam

and greater yam. The critical inputs were weighed and applied as per the technical programme. The chemical properties and nutrient status of the soil viz., soil pH, organic carbon, primary, secondary and micronutrients in ten coconut gardens were analyzed before and after the demonstrations to maintain the soil fertility.

Economics of cropping systems vis-a-vis soil health management in coconut + tuber crops systems

On-station proven sustainable nutrient management technologies viz., site specific nutrient management and organic farming technologies were separately demonstrated and validated (in comparison with POP and farmer's practice) in cassava and greater yam under intercropping in 10 coconut gardens of Thiruvananthapuram district and the findings are given below.

Pre-assessment of the coconut gardens before introducing the cropping system and sustainable nutrient management technologies were done in selected ten gardens of Thiruvananthapuram district and the results are given in Table 4. An average yield of 83 nuts per palm was obtained by the farmers during 2017-18, which resulted in net income of Rs. 17250 per year from one ha area with a B:C ratio of 1.13.

Table 4. Economics of coconut cultivation before the intervention (One ha)

Coconut (Nuts/ Palm)	Coconut yield (Nuts/ha)	Gross Income (Rs.)	Gross Cost (Rs.)	Net Income (Rs.)	BC Ratio
83	14525	145250	128000	17250	1.13

The results of the economics of coconut + tuber crops cropping system vis-a vis soil health management viz., SSNM and organic farming technologies are given in Table 5.

The coconut + cassava cropping system experiment on SSNM technology conducted in Thiruvananthapuram district during 2018-19 revealed that (Table 5) the maximum tuber yield was obtained from SSNM treated plot with 31.5 t/ha followed by POP (26.48 t/ha) and farmers' practices (20.93 t/ha). Similar trend was observed with regard to coconut yield. The net income of Rs. 4.98 lakhs per ha was obtained in SSNM plot followed by POP (Rs. 3.45 lakhs) and Farmers' practices (Rs. 2.56 lakhs). With regard to benefit: cost ratio SSNM plot had the maximum value with 3.12 followed by POP (2.23) and farmers practices (1.99).

Organic farming in greater yam

The coconut + cassava cropping system experiment on organic farming technology conducted in Thiruvananthapuram district during 2018-19 revealed that the maximum tuber yield was obtained from organic farming treated plot with 24.08 t/ha followed by farmers practice (17.4 t/ha) and POP (16.1 t/ha). Coconut yield was maximum in organic farming plot followed by POP and farmers' practices. The net income of Rs. 3.51 lakhs per ha was obtained in organic farming plot followed by farmers' practices (Rs. 2.02 lakhs) and POP (Rs. 1.51 lakhs) and similar trend was observed with regard to benefit: cost ratio viz., organic farming (2.49), farmers practices (1.78) and POP (1.54).

In the case of coconut + greater yam cropping system experiment on SSNM technology, maximum tuber yield was obtained from POP treated plot with 4.74 t/ha followed by SSNM (4 t/ha), and farmers' practices (3.39 t/ha) (Fig. 1). The yield of coconut was higher in SSNM plot followed by POP and farmers practices. The net income was higher with respect to SSNM (Rs. 82325) followed by POP (Rs.67650) and farmers practices (Rs.23575). Benefit cost ratio of 1.38 was obtained from SSNM followed by POP (1.28) and farmers' practices (1.10).

Coconut + greater yam cropping system experiment on organic farming technology revealed that maximum tuber yield was obtained from organic farming (3.65 t/ha) followed by farmers' practices (3.60 t/ha) and POP treated plot with 3.34 t/ha (Fig.3). The coconut yield was higher in organic farming plot followed by POP and farmers practices. The net income was higher with respect to organic farming (Rs. 53075) followed by farmers practices (Rs. 25500) and POP (Rs.15325). Benefit cost ratio of 1.24 was obtained from organic farming followed by farmers' practices (1.11) and POP (1.06).

Fig.1. Harvested produce of greater yam from three different treatments of SSNM technology

Fig. 2. Harvested produce of greater yam from three different treatmetns of organic farming technology

Based on the results from the Table 4, it is understood that sustainable soil health management of tuber crops based cropping systems in coconut gardens resulted in higher productivity and profitability in comparison to monocrop.

Advantages of cropping system as perceived by coconut growers

- Efficient use of farm and natural resources (land, water, sun light, labour, capital, etc.)
- Additional yield with minimum resources per unit area
- Reduction in cost of cultivation
- Improvement in soil fertility with abundant soil flora and fauna
- Less incidence of pests and diseases
- Crop residues can effectively be recycled as organic manure in the system
- Easy to adopt and suitable for different agro-climatic conditions
- High energy food for farm family and feed for farm animals
- Behave as insurance crop against risk and natural calamities
- Ensure food security, augment net income and enhance employment opportunities

Conclusion

Adoption of tuber crops based cropping systems in coconut gardens are technically feasible, economically viable and sustainable in the long run. It enhances food production, provides additional farm income and employment opportunities. It also enables better utilization of resources and safeguards the farm family from risks and natural calamities. On-farm demonstrations on customized fertilizers and organic farming technologies in tuber crops will help in increasing the productivity and profitability of coconut as well as upliftment of tuber crop growers. These trials and demonstrations will serve as model plots for other farmers to adopt improved technologies in coconut farming, which warrant the efforts from all stakeholders viz., ICAR-CTCRI, CDB, Kochi, Department of Agriculture, Krishi Vigyan Kendra, farmers, input agencies, marketing traders etc. The demonstrated technologies are given to KVKs, Department of Agriculture and other line departments for popularization and scaling up of the technologies in larger areas for doubling farmers' income on a sustainable basis. The successful tuber crops based cropping system models are to be emulated in large scale in the context of 'doubling farmers' income' and 'self reliance'.

Hindi Fortnight 2020 Valedictory Function held at CDB

Hindi fortnight valedictory function of CDB was held at Kochi on 10th March 2021. Shri. Saradindu Das, Chief Coconut Development Officer chaired the function and delivered presidential address. Shri R.Madhu, Secretary, CDB offered felicitations.

The winners of various competitions held at Headquarters in connection with Hindi Fortnight 2020 from 14th to 25th September 2020 were present during the occassion. All other officials of the Board attended the function through online. Shri. Saradindu Das, Chief Coconut Development Officer distributed prizes to the children of officers and staff of Board who have scored highest marks in Hindi in the SSLC/CBSE/ICSE 10th and 12th standard exams. Shri R. Madhu, Secretary, CDB distributed prizes to the winners of the competitions conducted for the Officers and staff of the Board. He also distributed prizes for winners of team competitions and distributed certificates to the officers and staff who participated in the Hindi incentive scheme 2019-2020.

Smt. S. Beena, Assistant Director(OL), CDB welcomed the gathering and Dr. Surya Pratyush, Junior Translation Officer proposed vote of thanks.

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Rerirement

Shri. T.K. Soman retired from the services of Coconut Development Board on 28th February 2021 on super annuation. He has served the Board for around 34 years.