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Assimilating socio-economic perspective in designing crop sector technology interventions: A farmer participatory study on coconut sector in Kerala

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Abstract

The economic viability of coconut farming in the state has witnessed a steady decline due to a complex interplay of several socio-economic, environmental and institutional factors. But the crop sustains the livelihood of a significant share of the population in the state. Equitable growth in agricultural sector of the state cannot be attained unless the fortunes of coconut farming sector are revived. A critical understanding of the production environment is very important in crafting appropriate strategies for the sector. This study is based on a detailed analysis of socio-economic profile of 180 coconut farmers in Kerala across five major agro-ecological units, collected using pre-tested structured questionnaire. The study draws on trends in relevant socio-economic trends to examine the reasons for the vicious cycle of low investment-low profits -low productivity. The study identified structural agrarian changes like low dependence on farm income, High share of non-farm income, high cost and non-availability of skilled labour, *etc.,* as contributing factors to the extant situation. Based on the socio-economic profile of the coconut farmer and technical studies, soil nutrient management centric strategy was identified as the key element in reorienting coconut farming. The intervention strategy was designed as an alternative approach for reviving the economic viability of coconut farming. The initial results on farmer perception on impact of technology intervention, with direct and indirect links to several biological and socio-economic limiting factors, indicate significant improvement across several parameters influencing crop productivity. Assimilating the lessons from the operation of the intervention strategy, the study also outlines a roadmap for multiple institutional involvements for scaling up this strategy across the state.

Keywords: Coconut sector, Kerala technology interventions

Introduction

A crucial element linking the generation of new technology to increased farm productivity is the diffusion and actual adoption of the technology (Feder and Slade, 1985). In developing countries, this linking was often mediated through public institutions and policy. In India, planned and public-funded programmes for generation and dissemination of technology in specific crop sectors have a long history dating back to the 19th century. The technology intervention programmes in oilseeds, maize, pulses, and cotton are examples of such crop-specific sectoral interventions. The choice of technology intervention strategy was often determined by availability of technology rather than any conscious effort to understand the socio-economic context of technology dissemination. The rates of technology dissemination and adoption can remain at robust levels and translate to productivity gains only when the technology and the dissemination mechanism are in tune with the socio-economic context of the use and adoption of these technologies. Though technology dissemination and adoption yielded substantial returns on investment during the green revolution period (Pingali, 2012), the rate of productivity gains has tapered off in the later years.

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The generation of new technology is not a sufficient condition for ensuring increased farm productivity (Feder and Slade, 1985). The technology should also have acceptance among the target population and suit the socio-economic profile of the client to aid its dissemination and adoption. The failure to consider the socio-economic context of technology dissemination effort can lead to systemic failure in achieving objectives of developmental programmes in the crop sector.

This postulate can be examined from the perspective of the sectoral narrative of coconut production in Kerala, where it is the major plantation crop (0.79 million ha) and has the largest share in the Gross Cropped Area of the state (38.7 per cent) during 2016-17. The impact of dissonance between technology choice and socio-economic context should be more pronounced in the plantation crop economy, where formal and informal institutional arrangements are more explicit in production and marketing. There were concerns about the declining economic viability of coconut farming in Kerala since the turn of this century (GoK, 2003; CACP, 2003). The studies on the coconut sector of the state projected a host of reasons for the declining viability of coconut farming including global market integration (Lathika and Kumar, 2009), liberalized trade policies (KSPB, 2004), declining and unstable prices (Varma, 2004) , intra-regional competition and labour shortages (Sportel and Veron, 2016). Low productivity and high cost of production are often cited as the major factor behind the low level of economic profits from coconut farming. Though enhanced technology adoption can address the issue, a deeper understanding the socio-economic context of technology dissemination is needed to deploy effective strategies for enhancing technology uptake, reduce cost of production and create a viable business proposition for coconut farming in the state, especially among the smallholder producers. The urgent need to address lack of economic incentive in the coconut production sector hinges on the significance of the sector in terms of its potential for employment generation and securing the livelihood of small and marginal farmers.

The socio-economic features of the coconut production system of Kerala having a bearing on the declining profitability and its influence on the choice of technology for mitigating the situation are discussed after the introductory section. This paper presents the results from a large scale farmer participatory experiment and demonstration and deployment of a nutrient management centric production technology, developed after assimilating extant socio-economic status of coconut farmers. The strategy aimed at reviving the coconut production through enhancing its economic viability while accounting for the socio-economic context of the production system. After detailing the methodology adopted for the study, the results from the analysis of techno-economic data are presented in the following section. The rationale for intervention strategy designed for coconut farming in the state is elaborated before presenting the initial results from the trial. In the concluding section, the study proposes a model for intervention in the coconut sector based on the field demonstration results and involving institutional and primary producer stakeholders.

Material and methods

The socio-economic profile of the coconut farmer in the state needs to be defined to understand the context of technology intervention. To develop a profile of the coconut farmer, data from 180 coconut farmers from 5 agro-ecological units were collected through a structured, pre-tested questionnaire during 2014-15. The National Bureau of Soil Survey and Land Use Planning (ICAR), Regional Centre, Bangalore has demarcated the State into 23 Agro-ecological Units, each with distinct soil and climatic features. (Nair *et al.*, 2011). The five agro-ecological units were purposively selected to represent a diversity of the soil profiles in predominantly coconut based cropping systems of the state. The selected agro-ecological units were AEU 1-Southern coastal plain, AEU 3-Onattukara sandy plain, AEU 9-South central laterites, AEU 10-North central laterites and AEU 11-Northern laterites. Considering the extent of area under coconut, two locations in Northern laterites were selected. In other AEU's, one location was selected. Thus 30 farmers each from 6 districts under five agro-ecological units were selected. After constructing a comprehensive techno-economic profile of the coconut farmer in the state, the constraints in technology adoption in coconut farming were explored using Garrets ranking technique. Based on the synthesis of the information collected, a technology intervention strategy was designed considering the techno-economic profile, identified constraints and secondary information on soil profile.

Soil amendments and fertilizer components in technology intervention: based on soil tests conducted at the selected sites, the soil nutrient management strategy was formulated. The soil amendments and fertilizers were provided to individual farmers in (specific combinations according to the compatibility of the chemicals and time/sequence of application) high-density polythene bags. The details of the packets and the timing of their application are provided in Table 1. Packets were customized for application for one palm. The combinations are worked out based on compatibility of fertilizers on mixing, for excluding the possibility of interaction of nutrients and convenience in application with least labour.

The intervention strategy was imposed on a sub-set of 60 coconut farmers randomly selected from the initial sample with a restriction that the farmer should have at least 40 palms under management. The full manifestation of the impact of the technology intervention strategy in crops like coconut palms with long lifecycles typically takes more than three years. The initial visible impacts, which by themselves are indicative in nature, itself takes more than a year to be perceptible to the farmer. Here, we undertook a perception study of the farmers about the beneficial impacts of the technology intervention across farmer distinguishable parameters after a time-lapse of two years from the start of technology intervention; *viz.,* during 2017-18. The farmer perception of each distinguishable beneficial parameter was recorded across four descriptive categories ordered from best preferred to the least preferred result (Substantial improvement (score 4), good improvement (score 3), marginal change (score 2), no change (score 1) and decline (score 0)). The results are tabulated to gauge the initial impact of the technology intervention on crop productivity and health.

Results and discussion

Coconut crop in Kerala

Kerala has the largest area under coconut in the country. But the state is ranked third in terms of production due to poor productivity of coconut palms. The productivity of the crop in the state is 7535 nuts per hectare compared to Tamil Nadu and Andhra Pradesh where the productivity is 14,873 nuts per hectare and 13,808 nuts per hectare respectively in 2014-15. As the crop with the largest share in net cropped area and the primary cash crop of the state, a rise in incomes of farmers in the state is critically dependent on the rise of incomes from coconut, primary cash crop in terms of area under

Table 1. Fertilizer and soil amendments package

Packet No.	Content of each packet	No. of packets	Time of application
1.	Urea 250 g	2	One each of packets numbered 1 to 3 should be applied in April/May after receipt of enough rainfall to moisten the soil. The remaining 1-3 numbered packets are applied Oct-Nov.
2.	Factamphos 500 g MOP- 1kg	2	
3.	Sodium Chloride - 1kg	2	
4.	Lime - 1 kg Dolomite - 1 kg Gypsum -2 kg	1	15 days after application of packets 1-3 in April/May
5.	$MgSO_4$- 500 g Borax- 50 g Zinc Sulphate - 50 g Mo salt - 5 g	2	One packet 10 days after lime in April/May. One packet 10 days after Urea and other fertilizers (packets numbered 1 to 3) in Oct/Nov.

cultivation (KSPB, 2017). The fortunes of the coconut farmers have a direct bearing on livelihood security and equitable growth in the state. The economic viability of coconut farming in the state has witnessed a steady decline due to a complex interplay of several socio-economic, environmental and institutional factors. Mirroring this decline in profitability, the area under the crop has also shown a declining trend.

The share of the state in the area under coconut which stood at 66.3 per cent during 1965-66 declined to 40.5 per cent by 2013-14. A much sharper decline was witnessed in case of coconut production where the state's share declined from 65.4 per cent to 29 per cent during the same period. The existence of a large number of senile and unproductive palms and growing of coconuts in unsuitable areas and lower investment due to inadequate incentives are the major reasons attributed to the low productivity of coconut compared to other states or countries (KSPB, 2015).Though the coconut economy in the state has witnessed several policy prescriptions, institutional interventions, and developmental schemes, they have failed to create and sustain significant changes. We suggest that the failure to assimilate the agrarian changes and techno-socio-economic context of coconut farming in sectoral intervention strategies led to the lack of traction for these interventions.

Who is a coconut farmer in Kerala?

Coconut production in the state needs to be understood in the context of general agricultural trends prevailing in the state. Kerala agriculture is characterized by marginal and fragmented land holdings with an average farm size of 0.22 ha. Along with this, the high wage rates and lower number of agricultural labour households in the State have put further severe pressure on farm wages and viability of farming in general (KSPB, 2015). Other confounding factors like low share of population dependent on agriculture as sole source of income (16 per cent) and low fertilizer consumption per unit area (121 kg NPK per ha of net sown area) can also be identified from the National Sample Survey Office (NSSO) study. This general agrarian situation forms the backdrop of coconut farming in Kerala.

A clear understanding of the profile of a coconut farmer is important for developing efficient intervention strategies. In our sample 80.6 per cent of the coconut farming households had landholdings less than one hectare with just 6.7 per cent having holding size of more than 2 hectares. This imposes severe restrictions on mechanization and reaping economies of scale in technology adoption. The composition of the sources of household income among the coconut farming holdings is instructive (Table 2). Nearly 80 per cent of the coconut farming households had alternate sources of income. Though the share of income from these alternate sources was not estimated, the availability of alternate sources indicates the possibility of considering coconut farming enterprise as a source of additional income and not as the primary income source. Reduced production effort can also result from this income structure.

Table 2. Source of household income among coconut farming households (n=180)

Occupation	No. of farmers	Per cent
Farming alone	38	21.1
Farming and agricultural labour	5	2.7
Farming and government employment	12	6.7
Farming and private employment	16	8.9
Farming and own business	18	10.0
Farming and any other source#	91	50.6
Total	**180**	**100**

Other sources include foreign remittance, pension, rental income or more than one source of the other categories *etc.*

Table 3. Status of adoption of technology in coconut farming

Item	No. of farmers	Per cent
Optimum palm density	59	32.8
Pest management technology	30	16.7
Disease management technology	33	18.3
Recommended fertilizer application	11	6.1
Summer irrigation	29	16.1

The status of the adoption of technology in coconut farming is presented in Table 3. The low adoption rate of pest and disease management technologies indicate low interest in crop health management with less than 20 per cent of the farmers opting for technology adoption related to pest and disease management. The low propensity of the farmers to incur additional expenditure on crop protection technologies could be due to poor profitability of coconut farming in the state.

The constraints in technology adoption need to be understood in the design of strategies aimed at the revival of the coconut farming sector in the state. The ranked constraints for technology adoption in coconut farming are presented in Table 4. The top two constraints being the non-availability and the high cost of labour is indicative of the need for developing low labour input crop management package for coconut farming in Kerala. Along with the low price and market instability, the incidence of the high share of non-farm income is reflected by the higher rank (Rank 4) obtained by the subsidiary nature of coconut farming activity.

The information gained from the analysis of the socio-economic and technology profile of the coconut farmer was juxtaposed with relevant secondary data to design the technology intervention strategy.

Choice, design, and components of technology intervention strategy

Designing a technology intervention strategy requires information on diverse parameters like the extant status of technology adoption, perceived production constraints and information on key technical parameters influencing production and productivity. On close examination of the factors leading to the economic unviability of the crop, it can be seen that the extant socio-economic context of the coconut production sector plays an important role. The predominance of smallholdings, high cost of labour, high share of non-farm income, *etc*. has contributed to escalating the cost of production without commensurate increase in productivity and returns from coconut cultivation. Kerala had the least percentage share of agricultural households (27.3 per cent) among its rural households.

Non-agricultural income was the major source of income for 61 per cent of the agricultural households in rural Kerala (NSSO, 2015), reducing the dependence on fortunes from farming and

Table 4. Ranking of constraints for technology adoption in coconut farming

Constraint	Mean Score	Rank
Non availability of labour	66.6	1
High cost of labour inputs	61.8	2
Low price of output/ market fluctuation	61.2	3
Coconut farming is subsidiary activity/not main income source	56.2	4
High cost of chemical fertilizers and plant protection inputs	54.2	5
Small size of holding	53.8	6
Lack of subsidy and incentives	49.7	7
Non availability of extension services	48.7	8
Absentee land ownership	39.5	9
Lack of confidence in technology	36.6	10

resulting in a high proportion of unmanaged coconut plantations. The sharp rise in input costs including labour cost, which accounted for as high as 56 per cent in the case of coconut (Vishandass *et al.,* 2013) and non-availability of technology solutions suited for the stakeholder profile have further contributed to the existence of a vicious cycle of economic decline in profitability of coconut farming. A schematic representation of these major mutually reinforcing elements is presented in Figure 1.

In this context, the major technical barrier identified was related to soil health and fertility status. Several studies on soil nutrient status in major soil coconut growing tracts in Kerala has reported soil nutrient profile as a production constraint for coconut farming (CPCRI, 2007; Kavitha and Sujatha, 2015; Malhotra, *et al.,* 2017; Basavaraju and Hanumanthappa, 2010; Mini *et al.*, 2015). Coconut is highly exhaustive palm and it is difficult to meet the demand of plants through fertilizers alone. Hence, to reduce the cost of inorganic fertilizers and to sustain yields, locally available organic resources and bio-fertilizers are recommended. The use of these organics in combination with appropriate ratio of fertilizers may be beneficial in increasing the crop yield and maintaining soil health (Baloch *et al*., 2014).

The results from the multi-institutional project on 'Soil Based Plant Nutrient Management Plan for Agro-Ecosystems of Kerala" funded by Kerala State Planning Board also indicate several fertility constraints like imbalance in major nutrients, micronutrient deficiency low adoption of soil nutrient management practices across coconut growing agro-ecological regions of the state (GoK, 2013).

Assimilating these technical constraints and agrarian socio-economic realities in technology intervention strategies are integral to the successful implementation of revival strategies envisaged for the coconut farming sector. The choice set of technology and management strategy, bounded by these socio-economic conditions, aimed at reducing the opportunity cost of intervention while enhancing the ease of technology adoption and providing enabling services for accessing the technology. This strategy will ensure that the proposed technology intervention package suits the farmer profile.

The strong correlation between input management and farm income (Kahlon and Acharya, 2007), high availability of bio-mass for recycling in coconut plantation (Nampoothiri, 2001), information from the socio-economic farmer profiling and the well documented prevalence of soil-related constraints adversely affecting productivity guided the strategy orientation in focusing on an integrated nutrient management centric technology intervention strategy. The intervention specifically aimed at enhancing productivity of coconut palms by improving soil health through organic residue recycling and soil test based nutrient management. The logical framework exploring the link between the proposed strategy leveraging soil nutrient management and the extant crop practices is presented in Table 5.

Fig 1. Cycle of economic decline in coconut farming

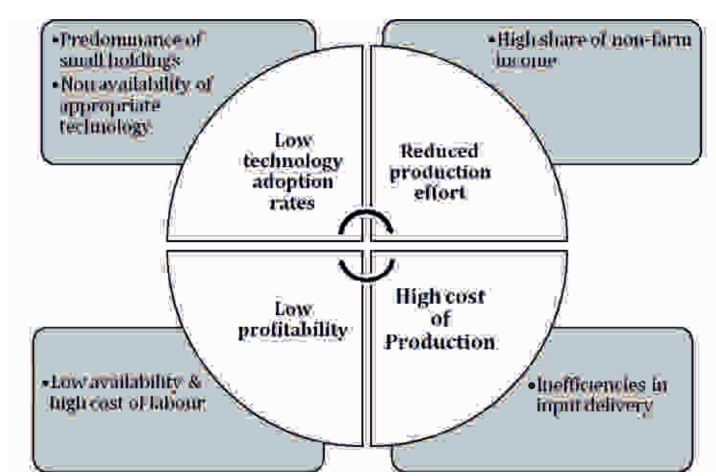

Table 5. The link between intervention design and extant crop practices

Observation/status	Outcome/impact on production environment	Intervention design feature
Not a source of primary income	Less time to devote for technology adoption and management	The intervention package is easy to adopt and can be implemented with minimum time commitment
Small size and fragmented nature of operational holding	Low possibility for mechanization	The strategy is scale neutral in application and can be bundled proportional to the holding size
Failure to adopt (low propensity) plant protection technologies	Higher relative importance of soil fertility to maintain crop vigour and health	The intervention strategy leverages soil nutrient management as a tool for enhancing crop health
High cost and non-availability of labour	Need for technologies with low labour requirement	Reduces labour use per unit area by developing alternatives for labour intensive crop management components
Inherent adverse/imbalanced soil nutrient status	Normal low input farming practices fail to give desired results	Specialized nutrient management strategy to correct imbalance and thereby address the key technical production constraint

The key elements of the technology intervention package developed were bundled together for enhancing the ease of adoption and comprehension (Eg: Premixed fertilizer combinations). Organic matter requirement was met by applying the bio-mass residue from each palm (dried fronds, coconut husk, *etc.*) at its base. Plot level customization of fertilizer inputs through farmer profiling was also done. Substantial reduction in labour use was achieved by eliminating palm basin intercultural operations related to fertilizer application. Effective handholding was ensured by leveraging local talent pool, trained and monitored by institutional stakeholders) for extension services. The total cost of the intervention was 41 per cent lower than the standard package of practice for coconut (Table 6).

Farmer perception of the impact of the intervention

There exists a considerable time gap (about 3 years) for a full manifestation of impact of changes in crop management practices in plantation crops like coconut. However, farmer perception of measurable indicators that influence final outcomes of production, productivity, and efficiency of coconut farming is a clear indicator of the direction and magnitude of the final impact. The perceptions of the project beneficiaries (a subset of 60 farmers) collected during 2017-18 are presented in Table 7. Farmers reporting substantial, good or marginal improvement in parameters considered favourable for enhancing crop productivity and efficiency significantly outnumbered the number of farmers reporting no impact. This held true for most of the selected parameters. In case of parameters like increase in nut size and increase in kernel thickness, the farmers reporting 'no impact' was more than the farmers reporting substantial or good impact. This could arise from the time lag for manifestation of the full impact of the intervention on these specific parameters. The project

Table 6. Cost of adopting the designed technology intervention (2014-15 prices)

Operations	Cost of palm management (per palm)	
	Existing package of practice	Technology intervention
Cultural operations	175	10
Harvest	200	200
Organic matter	75	Nil
Chemical Fertilizer	100	115
Total	550	325

Source: Cost of palm management compiled based on expert opinion

Table 7. Farmers perception of impact of technology intervention (n=60)

Parameter/Indicator variable	Substantial/Good impact	Marginal impact	No impact
Increase in yield	34.9	39.5	25.6
Reduction in cost of cultivation	34.9	37.2	27.9
Reduction in pest incidence	25.0	34.1	40.9
Reduction in disease incidence	27.3	39.5	33.2
Increased number of fronds	46.5	30.2	23.3
Increased green colour of leaves	84.1	13.6	2.3
Reduction in leaf dropping	51.6	12.9	35.5
Reduction in button shedding	47.7	36.4	15.9
Increase in size of nut	13.6	34.1	52.3
Increase in kernel thickness	27.9	32.6	39.5
Increase in number of earth worms	59.0	23.1	17.9
Increased awareness on coconut farming	84.1	9.1	6.8
Increased tolerance to water scarcity	30.2	53.5	16.3
General health of palms	79.6	15.9	4.5

intervention strategy had no direct prophylactic chemical component aimed at reduction of pest and disease incidence. Therefore, the impact on the incidence of pests and diseases is also low.

The farmer perception of measurable indicators underlines the scope of the proposed technology intervention strategy as a viable alternative in coconut farming in Kerala.

Conclusion

Taking into cognizance the encouraging initial results of the farmer participatory demonstrations, a framework for scaling up of the soil health management centric production strategy for enhancing productivity and income from coconut farming in Kerala is suggested. The framework indicates the field-oriented research requirements, extension delivery mechanism, and the proposed roles and responsibilities institutional entities involved. Action to be taken by different stakeholders is given hereunder.

CPCRI/KAU: Evolving agro-ecology unit wise technology package for soil health management for coconut and facilitate linkage among institutional entities.

Krishi Vigyan Kendras: Assessment and refinement of the technology package for soil health management, empowerment of FPOs on production and marketing of customized fertilizer inputs.

Department of Agriculture/ Krishibhavan: Facilitating FPOs, Incentivizing coconut primary producers for the adoption of the technology package, undertake technology dissemination services.

Farmer Producer Organizations of coconut growers: Production and marketing of customized fertilizer inputs, organizing community interventions for enhancing production and value addition with a focus on adoption of soil health management practices, supporting delivery of extension services.

Coconut growers: Active participation in community interventions.

The structural agrarian changes and changing socio-economic farmer profile along with shifts in priority can adversely affect crop management practices, technology adoption and profitability of farming. The case of these forces adversely affecting coconut farming in the state was examined and found to have strong linkages with the sinking profitability of coconut farming in the state leading to a vicious cycle of 'low investment-low profits-(and) low productivity". Failure to consider the underlying socio-economic realities of the farming community led to the failure of several revival schemes specifically targeting the crop. Alternate approach assimilating the socio-economic situation, farmer profile, technology suitability, and strategic intervention choice with emphasis on soil management as a key element was designed, tested and found to positively influence production, productivity, and efficiency of coconut farming enterprise. A strong institutional framework is essential for reducing transaction costs, delivery of extension services, and providing technology and marketing support while implementing the sector intervention. With a strong institutional architecture and focused approach, for scaling up the intervention, a significant impact can be made in the coconut economy of the state.

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