Research Article

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Soil and water conservation measures for sustainable coconut production: Impact of interventions under Farmers Participatory Action Research Programme

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Abstract

A study was conducted to analyse the experiences and impact of technological interventions related to soil and water conservation implemented in 105 coconut farmers' gardens in Kasaragod District of Kerala state during 2009 to 2011 under Farmers Participatory Action Research Programme (FPARP). Participatory assessment of soil and water conservation technologies was done using matrix scoring technique. Impact assessment showed that soil conserved in the coconut basin having half-moon bund around it varied greatly in different farms. Soil collected varied from 0.038 m^3 to 0.091 m^3 and water conserved varied from 1.2 m^3 to 9.6 m^3. Soil conserved in a trench varied from 0.35 m^3 to 0.082 m^3 and water conserved varied from 1.8 m^3 to 8.3 m^3. The average pre-intervention yield was 54 nuts per palm per year. The post intervention yield was increased to 64 nuts per palm thereby indicating an average yield increase by 19 per cent. Based on the matrix scoring, mulching coconut basins was ranked first compared to other soil and water conservation technologies. Simple and comparatively low cost soil and water conservation technologies could be replicated in a substantial number of farm holdings through the farmer participatory watershed-based decentralized development schemes of local self governments with the support of National Rural Employment Guarantee Scheme under MGNREGA thus indicating the replicability and horizontal spread of technologies demonstrated under the FPARP project. Analysis of impact of technological interventions under FPARP in farmers' field revealed the efficacy of soil and water conservation technologies for water saving/water use efficiency and yield enhancement in coconut besides enhancement in knowledge about soil and water conservation measures.

Keywords: Soil and water conservation, coconut production, impact, participatory research

Introduction

Coconut, which provides livelihood to millions of small and marginal farm families, is cultivated in different soils and agro-ecological situations. To achieve higher productivity in coconut, soil moisture availability as well as other growth conditions should be ensured throughout the year. Lack of adoption of soil and water conservation measures is one of the reasons attributed for the low productivity of coconut (Anithakumari *et al.,* 2002). Soil erosion is a severe problem in the west coast region which experience long dry spell during summer and in soils having low water holding capacity. Besides slope, other factors such as undulating topography, high rainfall, deforestation, unscientific cultivation practices *etc*. also contribute to the degradation of soil. Efforts are required to promote adoption of soil and water conservation measures to enhance productivity of coconut grown in this region. Field experiments conducted at Central Plantation Crops Research Institute (CPCRI) Research Centre, Kidu, in Karnataka state had shown that substantial improvement in coconut yield could be achieved through the adoption of various conservation measures in coconut gardens in sloppy areas in the west coast region (Dhanapal *et al.,* 2004).

Central Water Commission, under the Ministry of Water Resources, initiated Farmers Participatory Action Research Programme (FPARP) throughout the country with the slogan "More Crop and Income

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per Drop of Water" for demonstrating the technologies available on shelf to the farmers for increasing the productivity and profitability of agriculture through generating synergy among water, crop, agronomic practices, soil nutrients, crop variety and implements *etc*. Various technological interventions were carried out in selected villages in Kasaragod district under FPARP to scale up the adoption of soil and water conservation measures for sustainable coconut production in farmers' gardens. The objective of this study was to analyse the experiences and impact of technological interventions implemented under FPARP programme on soil and water conservation measures for sustainable coconut production in farmers' gardens.

Materials and methods

The study was conducted under the FPARP on 'Soil and water conservation and water harvesting in the west coast region of Kerala' sponsored by Ministry of Water Resources, Govt. of India implemented in Kasaragod district of Kerala state during April 2009 to March 2011. Technological interventions to augment ground/surface water resources and conserve soil moisture through low cost water harvesting technologies and soil and moisture conservation techniques were implemented in coconut-based farming systems in selected locations and assessed for their technical and socio-economic performance with farmers' participation as per the details furnished in Table 1.

Awareness-cum-training programmes on soil and water conservation in coconut gardens and exposure visit to experimental plots of CPCRI were organised for the benefit of participating farmers as part of the implementation of FPARP.

Table 1. Soil and water conservation measures implemented in farmers' gardens under FPARP

Sl. No.	Soil and water conservation measures	No. of farmers' plots
1.	Mulching coconut basins with leaves, coir pith etc.	84
2.	Coconut husk burial in the interspaces of coconut garden	68
3.	Half-moon bund around coconut basin reinforced with pineapple	92
4.	Trench filled with coconut husk	58
5.	Catch pits with pineapple border	46
6.	Cover crops as green manure and to reduce soil erosion	40

Locale of the study

The FPARP was implemented in 20 selected locations spread over the four development blocks *viz*., Nileswar, Kanhangad, Kasaragod and Manjeshwar in Kasaragod district of Kerala state. The project area comes under 'Agro climatic Zone No. 12 West Coast Plains and Ghat region'. The project area in Kasaragod district receives an annual average rainfall of 3500 mm. However, 78 per cent of this is received during the brief period from June to August. North East monsoon is very weak in the district, which provide only 15 per cent of the total rainfall and summer showers contribute only about seven per cent of the total rainfall received. Hence, there is a long dry spell, which adversely affects the agricultural production in the district. About three-fourth of the total geographical area of Kasaragod district is undulating with 10-35 per cent slope.

Respondents of the study

The study was conducted among 105 coconut farmers under the FPARP with the objective to augment ground/surface water resources and conserve soil moisture through low cost water harvesting technologies and in situ soil and moisture conservation techniques in perennial based farming systems. The technologies were put into use in farmers' gardens in selected locations and assessed for their technical and socio-economic performance with farmers' participation.

Variables

a) Profile characteristics of participating farmers such as age, educational status, occupation, farm size, social participation, status of irrigation and knowledge about soil and water conservation technologies were measured using appropriate tools.

b) Impact of technological interventions under FPARP was assessed in terms of the following:

   i) Efficacy of soil and water conservation measures *viz*., half-moon bund around coconut basin reinforced with pineapple, catch pit with pineapple border and trench filled with coconut husk taken up in the

coconut gardens was studied by monitoring the soil and water conserved in ten selected gardens for two years. Size of the catch pit and trench were 1.5 m x 0.5 m x 0.5 m and 4 m x 0.5 m x 0.5 m respectively. Half moon bund formed at the downstream within the coconut basin had an average radius of 1.6 m.

ii) Improvement in yield of coconut due to the implementation of various interventions related to soil and water conservation. Observations on coconut yield were recorded before and after implementation of interventions in 60 gardens in 13 locations. Yield estimation was done following the method suggested by Mathew *et al.* (1991).

iii) Improvement in the knowledge of farmers on various aspects of soil and water conservation, and

iv) Impact on horizontal spread of technologies and other perceived benefits of interventions.

c. Participatory assessment of soil and water conservation technologies was done using matrix scoring technique.

Data collection

Soil and water conserved in the conservation structures were physically measured at 10 selected locations. The measurement was done for two structures per plot and for a total of 10 plots. Water was collected by lining the structures with silpaulin. Soil was collected every year in the month of December *i.e.* at the end of rainy season.

Participatory tools like transect walk and matrix scoring were employed to analyse the field level situation related to soil and water conservation in coconut gardens before and after implementing the technological interventions under FPARP, and for the participatory assessment of soil and water conservation technologies. Data on profile characteristics including knowledge level of farmers on soil and water conservation technologies were collected from 105 respondents using an interview schedule. Data on horizontal spread of technologies were collected from the secondary sources of information like offices of Local Self Government. Details on various other benefits of interventions were documented based on the perception of farmers as recorded during the focused group discussions conducted as part of the participatory assessment of interventions.

Results and discussion

Profile characteristics of farmers

The distribution of farmers according to age indicated that more than 50 per cent of the farmers are above 50 years of age and about one third of the farmers belong to the age group of 35-50 years. A vast majority (98%) of the farmers were literate, which indicated a favourable environment for organising educational programmes on water conservation and water harvesting among the farmers. Sixty eight per cent of the farmers depended on farming alone as the occupation. However, nearly one third of the farmers were engaged in other supplementary activities apart from farming to earn income for their livelihood. Forty one per cent of the farmers possessed less than one ha of farm holding, as is the general trend observed in Kerala state. Fragmentation of holdings is a constraint in effectively utilising available farm technologies for enhancing agricultural production. Hence, it is imperative that group approaches have to be promoted for organising extension programmes on water conservation and water harvesting among the farmers.

The profile characteristics indicated that the farmers have higher level of social participation. Majority of the farmers are members in social organizations like self-help groups, farmers' clubs and co-operative societies. Besides, all are members of the *Gramasabha*, which is a very important grass root level organization under the decentralised planning and implementation of development initiatives of Grama Panchayats. The favourable trait of higher level of social participation of the farmers can be effectively exploited for formulating participatory initiatives for water conservation and water harvesting appropriate to the local situations.

Fifty nine per cent of the farmers do not irrigate their crops. The predominance of rainfed agricultural holdings indicated the importance of implementing soil and water conservation and water harvesting activities for sustainable agricultural

Table 2. Impact of soil and water conservation measures under FPARP

Year	Structure	Soil conserved (m^3)			Water conserved (m^3)		
		Lowest	Highest	Average	Lowest	Highest	Average
First Year							
	Half moon bund	0.038	0.091	0.046	1.2	9.6	2.2
	Catch pit	0.011	0.032	0.020	0.3	3.2	0.7
	Trench	0.035	0.082	0.048	1.8	8.3	2.5
Second Year							
	Half moon bund	0.012	0.041	0.018	1.3	8.8	2.4
	Catch pit	0.003	0.012	0.005	0.3	3.8	0.7
	Trench	0.015	0.043	0.021	1.6	8.6	2.3

production. Basin irrigation was the most common method of irrigation adopted by the farmers having irrigation facilities.

Impact of soil and water conservation measures

Efficacy of soil and water conservation measures taken up in the coconut gardens was studied by monitoring the soil and water conserved in ten selected gardens for two years (Table 1). This was then extrapolated to the entire project area to get the impact of these interventions. Soil conserved in the half moon bund during the first rainy season varied greatly from 0.038 m^3 to 0.091 m^3. However, the average amount of soil collected was only 0.046 m^3. Similarly, water conserved by the structure also varied from 1.2 m^3 to 9.6 m^3 with average value of 2.2 m^3. Same trend was observed in the case of catch pit and trench also. The large variation observed in the amount of conserved soil and water was mainly because of the variation in the size of the bund, size of catchment area, upstream slope and vegetative cover. Though recommended spacing of coconut was 7.5 m x 7.5 m, farmers seldom practice it. In majority of the cases, the spacing was much less than the recommended one and in a few cases, this was higher. Due to this variation in coconut spacing, the catchment area of each structure also varied. This was the major reason for the large variation in the volume of soil and water collected in the structures. Another reason is the variation in slope of the land. Size of the coconut basin gets reduced when slope increased. Vegetation in the interspaces also affected the soil and water collected in the structures. There were few cases where length of

Table 3. Impact of soil and water conservation technologies on coconut yield

Location	No. of holdings	Pre-intervention yield	Post-intervention yield	Improvement in yield (%)
Birikkulam	4	47	56	19.3
Cheripady	18	52	61	18.2
Kolleramgode	5	51	62	22.0
Raveneswaram	8	57	67	17.0
Bela	7	54	65	20.5
Iriyani	2	61	74	20.9
Kadambar	4	49	60	22.2
Madikai	3	53	62	17.7
Paramba	4	64	75	16.5
Pannikunnu	2	49	58	19.0
Vallikadavu	1	66	77	16.0
Mundakkaai	1	51	61	20.0
Nekraje	1	44	54	21.8
	60	54	64	19

the trench had to be reduced from 4 m, the recommended length, due to specific reasons. This also affected the amount of conserved soil and water. The findings of this study reconfirm results of previous studies which concluded that adoption of soil and water conservation measures, especially, bio-engineering measures resulted in reduction in soil loss and runoff (Sudhishri and Dass 2012). The higher amount of soil got collected in the structures in first year was due to the disturbances happened to the top soil during construction and poor vegetative cover. However, there was not much reduction in the amount of water collected in the structures even during the second year.

Impact of soil and water conservation measures on coconut yield

There was substantial improvement in yield of coconut due to the implementation of various interventions related to soil and water conservation as revealed by the impact assessment done in 60 holdings in 13 locations of project implementation (Table 3). The average pre-intervention yield was 54 nuts per palm per year. The post intervention yield increased to 64 nuts per palm thereby indicating an average yield increase by 19 per cent.

Earlier studies had also revealed that yield of coconut could be enhanced substantially by adopting soil and moisture conservation practices like half-moon bund around coconut basin with pineapple border, trench filled with coconut husk, and catch pits with pineapple border (Dhanapal *et al.,* 2004).

Knowledge gains on soil and water conservation measures

There was substantial improvement in the knowledge of farmers on various aspects of soil and water conservation and water harvesting due to the interventions carried out under FPARP (Table 4). Pre-intervention knowledge score was highest for mulching coconut basins with leaves, coir pith *etc*. (86%) and lowest for catch pits with pineapple border (8%). Similarly, post- intervention knowledge score was highest (94%) for the mulching coconut basins with coconut leaves, coir pith etc and lowest (65%) for half-moon bund around coconut basin reinforced with pineapple. Maximum gain in knowledge (85%) was for catch pits with pineapple border followed by cover crops as green manure and to reduce soil erosion (77%) and half-moon bund around coconut basin reinforced with pineapple (61%).

Knowledge gains by farmers on soil and water conservation measures indicate the effectiveness of awareness-cum-training programmes on soil and water conservation in coconut gardens and exposure visit to experimental plots of CPCRI organised as part of the implementation of FPARP.

Participatory ranking of soil and water conservation technologies implemented

Based on the perceived attributes *viz*., cost of inputs, labour requirement, availability of inputs, easiness to adopt, suitability to existing farming systems, requirement of maintenance and visibility of the impact various technological interventions on soil and water conservation implemented under the project were assessed by the farmers (Table 5). Based on the matrix scoring, mulching coconut basins with leaves, coir pith *etc*. was ranked first compared to other soil and water conservation technologies. Half moon bund was ranked second based on the total score.

Mulching is comparatively a low cost soil and water conservation technology which use locally

Table 4. Knowledge gain on soil and water conservation measures

Sl. No.	Type of soil and water conservation measure	Pre-intervention knowledge score (%)	Post-intervention knowledge score (%)
1.	Mulching coconut basins with coconut leaves, coir pith etc.	86	94
2.	Coconut husk burial in the interspaces of coconut/arecanut garden	26	72
3.	Half-moon bund around coconut basin reinforced with pineapple	16	65
4.	Trench filled with coconut husk	17	70
5.	Catch pits with pineapple border	08	85
6.	Cover crops as green manure and to reduce soil erosion	09	87

Table 5. Participatory ranking of soil and water conservation technologies

Attribute	Matrix score (Range 0-10) for SWC measures					
	Half-moon bund	Coconut husk burial	Trench filled with coconut husk	Mulching	Cover crops	Catch pits
Cost	7	6.5	6.0	9	8.5	8
Labour	6	5.0	4.5	8	7.0	6
Availability of input	6	6.0	6.0	8	8.0	6
Easy to adopt	8	6.0	6.0	9	8.0	7
Suitability to existing farm system	9	8.0	8.0	9	5.0	8
Requirement of maintenance	7	8.0	8.0	6	5.0	7
Visibility of impact	7	6.0	6.0	7	7.0	6
Total	50	45.5	44.5	56	48.5	48

available material, require less labour and easy to adopt and hence scored high on the participatory ranking. Half moon bund was a suitable soil and water conservation in the coconut gardens in the sloppy terrain and hence scored high on the attribute on suitability to the existing farm system.

Impact on horizontal spread of technologies

Under the FPARP project, technologies for water conservation and water harvesting are demonstrated in farmland with coconut-based perennial farming systems, which is the most predominant cropping system in the agroclimatic situation prevailing in the west coast region. These technologies could be replicated in a substantial number of farm holdings in the west coast region having coconut based cropping systems with agroclimatic situation similar to the project area. The replicability of technologies becomes all the more easier since the technologies are simple and comparatively of low cost. Further, the labour component which accounts a major cost of technologies, required for implementing technological interventions in individual private holdings can be made available through National Rural Employment Guarantee Scheme wherever plan for watershed based development has been prepared by local self-governments thereby reducing the burden of farmers and enhancing the scope for replication. Three grama panchayats in the FPARP project area *viz*., Madikkai, Kodom-Belur, Panathady and Kanhangad Block Panchayat have already implemented some of technologies demonstrated under FPARP like half-moon bund around coconut basin, catch pit *etc*. through MGNREGA programme on a wider scale (Table 6).

Other benefits of technological interventions

Other benefits of technological interventions implemented under FPARP as perceived by farmers include the following:

i) Enhanced number of days of irrigation during summer months on an average by 15-30 days

ii) Enhanced water availability during summer months for domestic use, both for household use and animal husbandry

iii) Pineapple planted as conservation measure provided additional income. On an average 1-1.5 kg per fruit per pine apple plant could be harvested.

iv) Enhanced green fodder availability in the

Table 6. Interventions included under NREGS/Watershed programmes

Local self- government	Half moon bund		Catch pit	
	Number	No. of holdings	Number	No. of holdings
Kanhangad block panchayat	45,000	350	12,300	260
Madikkai grama panchayat	62,982	625	75,397	1,500
Kodom-Belur grama panchayat	2,85,000	1,400	26,000	550
Panathady grama panchayat	84,500	850	18,400	340

coconut holdings having integrated farming system.

v) Greener leaves and reduced drooping of leaves of coconut palms indicating improved crop health due to soil and water conservation measures.

Social benefits of implementing the project interventions as perceived by the farmers include the following;

i) Enhanced awareness on natural resource management for sustainable farming through awareness-cum-training programmes, exposure visit programmes and impact through Farmer to Farmer Extension

ii) Employment generation for non-participating families under MGNREGA

iii) Facilitated coordination among different agencies for natural resource management activities

iv) Enhanced level of participation of farmers in implementation of soil and water conservation and water harvesting interventions through participatory situation analysis, identification of problems, selection of appropriate technologies, implementation of interventions and assessment of impact

Technological interventions for each of the holdings under FPARP were selected based on the participatory assessment of the situation prevailing in the farms and choices of the farmers and hence the level of participation of farmers in the implementation of interventions was enhanced. This is in conformity with the findings of earlier studies which conclude that targeting at priorities and preferences of local farmers will serve as effective doorways to their willing and committed participation in conservation undertakings (Kessler, 2006).

Conclusion

Tangible and intangible benefits accrued by the farmers revealed that the desirable impact of technological interventions under FPARP was very much convincing. Analysis of impact of technological interventions under FPARP in farmers' field revealed the efficacy of soil and water conservation technologies for water saving/water use efficiency, yield enhancement in crops and enhancing cropping intensity. The activities under FPARP also led to enhancement in knowledge about soil and water conservation measures and level of participation of farmers in implementing soil and water conservation interventions. Based on the matrix scoring conducted as part of participatory assessment of interventions by the farmers mulching coconut basins with leaves, coir pith *etc*. was ranked first compared to other soil and water conservation technologies. The interventions also revealed the potential for scaling up these technologies in farm holdings in the west coast region having coconut based cropping systems with agroclimatic situation similar to the project area.

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References

Anithakumari, P., Thamban, C. and Arulraj, S. 2002. Constraint analysis in coconut cultivation. *Indian Coconut Journal* **33**(9): 6-8.

Dhanapal, R., Mathew, A.C. and Palaniswami, C. 2004. Efficacy of soil and water conservation in coconut plantation of west coast region. *Indian Coconut Journal* **35**(9): 3-6.

Kessler, C.A. 2006. Decisive key-factors influencing farm households' soil and water conservation investments. *Applied Geography* **26**(1): 40-60.

Mathew, J., Vijayakumar, K., Nambiar, P.T.N. and Amarnath, C.H. 1991. Forecast of annual coconut yield based on biometrical characters. *CORD* **7**: 24-34.

Sudhishri, S. and Dass, A. 2012. Study on the impact and adoption of soil and water conservation technologies in Eastern Ghats of India. *Journal of Agricultural Engineering* **49**(1): 51-59.