Efficacy of Soil and Water Conservation Measures in Coconut Plantations of West Coast Region

Abstract

A study was conducted to develop and demonstrate the efficacy of various soil and water conservation measures suitable for coconut gardens of the western ghat region. Runoff and soil loss from cropping systems adopting different soil and water conservation measures were estimated. Out of various measures for soil and water conservation tried, contour trench (4 m length X 0.5 m width X 0.5 m depth) filled with coconut husk with two lines of pineapple in the interspaces of coconut proved to be the best treatment for soil and moisture conservation in laterite soil having a slope of 14 to 16 per cent. It was also observed that CO-3 grass grown as intercrop in coconut garden not only conserved soil and water but also produced fodder @ 100 tonnes/ha/year in eight harvest. Coconut yield increased nearly three times after imposing the treatments mainly because of treatment and management effect.

Introduction

Majority of the western ghat range belongs to steep and rugged mass of hills with elevation varying from 100 m to 2700 m. The Western Ghats is fragile but endowed with potentially rich natural resources conducive to develop a sustainable agricultural growth.

High intensity of rainfall coupled with undulating topography and prevailing land use pattern are causing severe soil erosion and land degradation in the area. This leads to washing away the topsoil and nutrients which in turn leads to loss of land productivity. Even after getting a high rainfall of 3700 mm many parts experience severe scarcity of water during summer months. This happens mainly because a major portion of the rainfall is received during a short period of four months, June-September. Most of the rainwater is lost as surface runoff due to undulating topography. These factors coupled with low water holding capacity of the lateritic soil prevailing in this region results in moisture stress after the withdrawal of monsoon.

Some of the unique features of coconut palm, in comparison with other trees and annual crops, necessitate the maintenance of optimum soil moisture throughout the year as the coconut produces nuts all round the year.

The coconut palm flowers throughout the year, irrespective of seasons. On an average, a palm produces one frond, with an inflorescence in its axis, every month and 12-15 inflorescences are produced in a year. It takes 44 months for an inflorescence bud to grow and develop to produce mature nuts. Since a palm produces an inflorescence every month, its crown will have inflorescences at different stages of development throughout the year. Hence soil moisture availability, as well as other growth conditions should be congenial throughout the year for high productivity in coconut.

Most of the coconut growing soils in the west coast, being low in water holding capacity, aggravates the deleterious effects of dry spell. The drought affects the initiation and growth of fronds and inflorescences, affects female flower development and results in abortion of spadices, button shedding, drooping of leaves and bunches, poor endosperm development, reduction in size of nuts, etc (Coomans, 1975). Initiation and differentiation of vegetative and reproductive primordial are very sensitive to moisture stress. Drooping of leaves, breaking of petioles, shedding of buttons and immature nut fall are the common symptoms of drought injury (Rethinam, 1991).

Materials and Methods

Inorder to find out location specific and cost effective soil and water conservation measures involving vegetative and/or engineering measures which will help in checking soil erosion and conserving moisture for sustained productivity a field experiment was conducted at CPCRI, Seed farm, Kidu, in Karnataka state.

There were seven treatments with different soil and water conservation measures as given below,

Treatment details

T_1 - Half moon terrace with pineapple border

T_2 - Catch pit with pineapple border

T_3 - Trench filled with coconut husk with two lines of pineapple border

T_4 - Drip irrigation daily @ 66% of E_0 for coconut with grass in the interspaces

T_5 - Cover crop with vegetables

T_6 - Absolute control (No conservation practice)

T_7 - Farmers practice of providing hose irrigation with 600 mm once in seven days, for coconut and grass in the interspaces.

Contour survey of the area with one metre vertical interval was conducted prior to the study. Based on the survey, map trial plots were prepared. Experimental plots were separated from each other using GI sheets to prevent the surface runoff entering from the adjacent plot. At the bottom of each plot a multi slot devisor, with 11 slots, was provided to collect the runoff water. The water overflowing from the multi slot devisor was collected in a PVC drum to quantify the total runoff water. Sediment load in the runoff water was determined by collecting water samples. The collected water was also analyzed to determine the nutrient content (NPK) in the runoff water. Observations were taken for vegetative growth of the companion crops used in the study. Yield of all crops grown under this experiment was recorded. Results obtained from the experimental plots was compared with that of a control plot where no conservation measure was used.

Results and Discussions

In situ soil water conservation and reduction in surface evaporation are the common methods to alleviate moisture stress under rain fed conditions. Soil and water conservation measures in rain fed situation include contour bunding, opening of staggered trenches/pits across the slopes, husk burial, cover cropping, mulching, conservation tillage, contour planting, contour cultivation, terraces, etc. Mulching the surface with materials like coconut husk, coir pith, dry leaves, crop residues, etc are recommended practices to reduce surface evaporation.

Effect of bio-engineering measure on coconut yield

Impact of various bio-engineering measures on coconut yield and the percentage increase over the pre-treatment yield is given in *Fig.1*

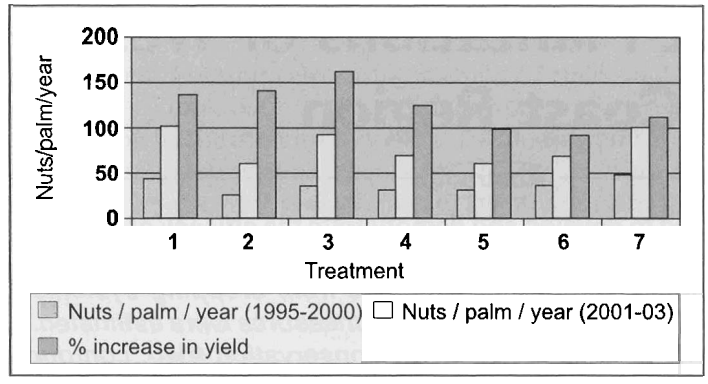

Fig. 1. Coconut yield and percentage increase over pre-treatment period

Highest increase in coconut yield (162 per cent) was observed in T_3 where the annual nut yield was increased from 35 nuts/palm to 93 nuts/palm which may be due to the combined effect of treatment and then management practices.

Contour planting on sloping land, combined with contour tillage, ridging or bunding of the soil not only prevents the water from rushing down the slope but also can collect all runoff water between bunds or ridges. With the runoff water, soil particles moved by the water are also collected in the trenches. Such trenches or pits thus have a double function of erosion control and water conservation. They can be filled or partly filled with coconut husks or coir dust, which will contribute to the improvement of soil fertility. Coir dust has the ability to absorb and retain ten times its weight of water (Liyanage, M. de S. 1988). In gravelly soils, he observed a 20 per cent increase in the number of nuts and a 15 per cent increase in copra yield as a result of burying coir dust. Das *et al.* (1991) reported a 50 per cent yield increase after incorporating coconut husks as a mulch to the basin of coconut palms. The effect of the husk lasted for 6 years. Even though the lowest increase in nut yield (92 per cent) was observed in control plot where no conservation measure was taken up the nut yield increased from 36 to 69 nuts/palm after imposing this treatment. In the treatment T_4 and T_7 the increment in yield percent was mainly due to irrigation effect which was 124 and 111 per cent respectively.

Any attempt to grow two or more crops together, and particularly to grow one beneath the shading canopy of the other, requires some understanding of the environmental factors involved, and the degree of competition likely. Important factors affecting the growth of forage species under coconuts are the available soil moisture and nutrients, the amount of light, and the degree of competition between the forage species and coconuts. Humphreys (1991) stresses that the yield of plantation crops may be positively or negatively affected by the pasture system, depending on the nature of the interference which develops and the net effect on the crop environment.

Yield of component crops

Yield of component crops viz. Banana, Pineapple and Grass grown in various treatment plots is given in *Table.1*.

The effect of drip irrigation on yield of banana was high. This was obvious from the higher banana yield of 2.29 tonnes/ha for the year 2002 –03 obtained from treatment T_4. Yield obtained from the control plot was the lowest, 0.93 tonnes/ha.

Pineapple was grown only in three treatments, i.e., T_1 T_2 and T_3. Among these treatments, the treatment T3-

Table.1 Component crops yield in coconut based cropping system

Treatments		Banana-tonnes/ha		Pineapple-tonnes/ha		Grass-tonnes/ha	
		01-02	02-03	01-02	02-03	01-02	02-03
T_1	Half moon type with pineapple border	0.7	1.14	14.82	16.71	-	-
T_2	Catch pit with pineapple border	1.35	1.28	16.85	20.80	-	-
T_3	Trench filled with coconut husk with 2 lines of pineapple border	1.12	1.49	17.2	21.36	-	-
T_4	Drip irrigation daily @ 66% of Eo for coconut with grass in the interspace	1.52	2.29	-	-	100	89.3
T_5	Cover crop with vegetables	0.95	1.22	-	-		
T_6	Absolute control	0.57	0.93	-	-		
T_7	Irrigation as per farmers practice with grass in the interspaces.	0.96	1.46	-	-	102	91.59

Trench filled with coconut husk with two lines of pineapple border, gave higher yield (17.2 tons/ha) compared to other treatments.

Regarding the grass yield from two different treatments there was not much difference in yield (89.3 and 91.5 tonnes/ha) and on an average 90 tonnes/ha could be realized by growing grass as inter crop in coconut garden with irrigation.

Yield, root volume and land coverage of vegetables

The treatment T_5, cover crop with vegetables, was taken up to establish the ability of vegetative cover of the vegetables to prevent the soil loss and to get an additional income from the vegetables grown. Various vegetables tried were pumpkins, ash guard and cucumber. Yield, root volume and land coverage of the vegetables tried is given in *Fig.2, Fig.3 and Fig.4*, respectively. Among these vegetables pumpkin had good coverage of land and maximum yield. Yield of pumpkin was followed by ash guard (80 kg) and then cucumber (35 kg). The same trend was observed in the case of root volume and land coverage.

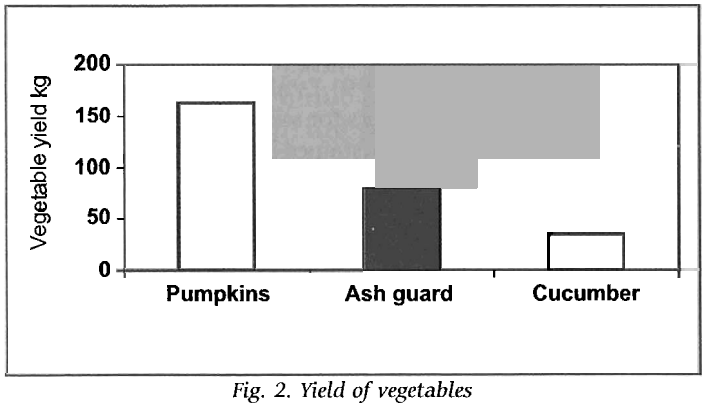

Fig. 2. Yield of vegetables

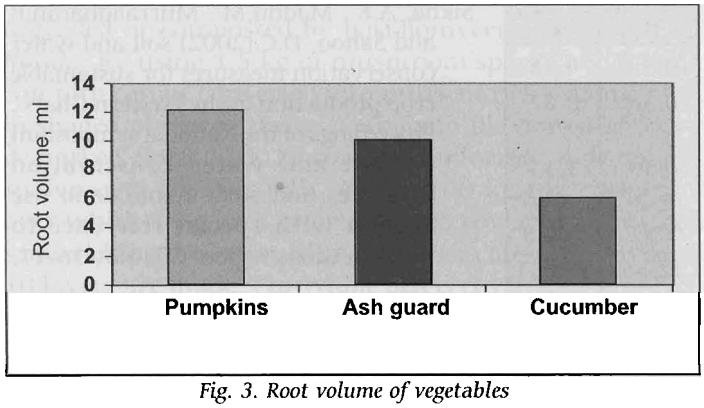

Fig. 3. Root volume of vegetables

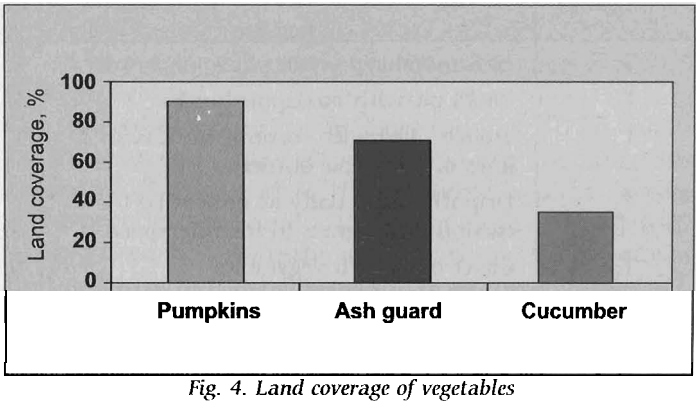

Fig. 4. Land coverage of vegetables

Run off and soil loss

Effect of various treatments on runoff and soil loss was given in *Table.2*.

Runoff from all the treatments was reduced considerably after the imposition of various conservation measures. However even after the reduction, the runoff occurred from T_5-cover crop with vegetables and T_6-absolute control plots was high. Higher runoff in the control plot was obviously because of the absence of any conservation measure. However, high runoff from T_5-cover crop with vegetables was attributed to the delay in establishing proper vegetative cover to the soil surface in this treatment. Lowest runoff was obtained in T_3 - trench filled with coconut husk with 2 lines of pineapple border (1.13 mm) followed by T_1-half moon type with pineapple border (5.6 mm). Dhruva Narayan (1987) measured that in western ghats at Ooty with 20 percent slopes under potato crop, the runoff under up and down cultivation was 4.0 percent (soil loss-39.3 t/ha) as against 2.1 and 1.1 percent (soil loss 1.4 & 0.4 t/ha) under potato crop with

Table.2. Treatment effect on runoff and soil loss

Treatment	Rainfall, mm		Run off, mm		Run off, %		Soil loss, t/ha	
	2002	2003	2002	2003	2002	2003	2002	2003
T_1	2882	3204	13.48	5.60	0.47	0.17	0.59	0.02
T_2	2882	3204	17.2	16.72	0.60	0.52	0.69	0.12
T_3	2882	3204	5.27	1.13	0.18	0.04	0.14	0.01
T_4	2882	3204	42.2	14.61	1.46	0.46	2.02	0.06
T_5	2882	3204	204.5	146.25	7.09	4.56	7.44	2.61
T_6	2882	3204	337.03	184.46	11.69	5.76	10.52	2.99
T_7	2882	3204	39.27	16.16	1.36	0.50	2.28	0.12

graded bund and bench terrace respectively.

Soil loss from each one of the treatment plots followed the same trend as that of the runoff. Lowest soil loss was observed in T_3 (0.01 t/ha) followed by T_1 (0.02 t/ha). Highest soil loss (2.99 t/ha) was from control plot. Treatment T_5-cover crop with vegetables also produced considerable soil loss (2.81 t/ha) since the runoff was more from this plot. Sikha (2002) reported that soil loss varied from 2.65 to 6.42 tonnes/ha for different bio-engineering measures taken up at gudalur.

Nutrient loss

Nutrients, N, P and K, carried away by the surface runoff water from various treatments are given in *Table.3*. Since the surface runoff and soil loss were more in the control plot (T_6), the nutrient loss also was more in the plot compared to the other treatments. Lowest nutrient loss was observed from T_3 - Trench filled with coconut husk with two lines of pineapple border obviously because of low runoff. However, it may be noticed that the nutrient input of treatments varied according to the component crops.

Conclusion

Runoff, soil loss and nutrient loss under different soil and water conservation treatments were determined. Among the various soil and water conservation measures tried, contour trench (4 m length X 0.5 m width X 0.5 m depth) filled with coconut husk with two lines of pineapple in the interspaces of coconut proved to be the best treatment for soil and moisture conservation in laterite soil having a slope of 14 to 16 per cent. Nutrient loss also was lowest in this treatment. The study provided location specific and cost effective soil and water conservation measures involving vegetative and/or engineering measures that would help in checking soil erosion and conserving moisture for sustained productivity.

Table.3 Nutrient loss from various treatments

Treatments		Nutrient loss (kg/ha)		
		N	P	K
T_1	Half moon type with pineapple border	3.30	0.83	4.18
T_2	Catch pit with pineapple border	2.71	0.56	3.87
T_3	Trench filled with coconut husk with 2 lines of pineapple border	1.28	0.20	1.15
T_4	Drip irrigation daily @ 66% of Eo for coconut with grass in the interspace	18.58	2.97	15.28
T_5	Cover crop with vegetables	58.41	12.66	110.61
T_6	Absolute control	104.98	22.48	166.66
T_7	Irrigation as per farmers practice with grass in the interspaces.	14.60	2.97	16.96

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