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Assessment of Soil and Water Conservation Measures in Cardamom

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ABSTRACT: *Experiment was conducted with six soil and water conservations treatments* viz. *i).Control without conservation measures, ii) CST (2 m × 0.45 m × 0.30 m) in alternate rows, iii) CST+ Pine apple, iv) CST + French bean, v) CST + Ginger, vi) Ginger alone, with four replication at Indian Institute of Spices Research, Cardamom Research Centre, Appangala during 2000-2004. Growth and yield parameters between the treatments was found to be non significant. Average runoff and soil loss for the years 2002, 2003, 2004 revealed that the soil loss ranged from 2219.74 kg per hectare to 495.56 kg per hectare with a minimum runoff (31.82 mm) and soil loss (495.56 kg/ha) in CST with pine apple treatment. Amount of soil loss was more during 2002 due to less canopy cover. Small quantity of nutrients was removed through runoff water. Addition of vegetative barrier like pine apple, French bean and ginger leads to better soil cover and additional income.*

Keywords**:** *Cardamom, Elettaria cardamomum, run off, soil and water conservation, soil loss, vegetative barrier*

INTRODUCTION

Small cardamom is an important plantation crop cultivated in the Western Ghats of Kerala, Karnataka and Tamil Nadu. In India, total area estimated under the crop is about 72,000 hectare and with a production of 12,500 MT. The cultivation of cardamom is confined to evergreen forests and the forest environment at an altitude above 900 MSL. It is a shade loving plant, requiring equitably distributed rainfall through-out the year for better growth and development. Being shallow rooted, delicate and sensitive plant, even slight change in the eco-environmental condition can result in a wide fluctuation in the growth and yield of crop. Though cardamom tracts receive heavy rainfall (1500-4500 mm), the availability of soil moisture during summer months is a limiting factor due to undulating topography of the plantations and 75 per cent of rainfall is received in three months (June, July and August) (Rajendra Hegde and Korikanthimath, 1996). In low to medium rainfall areas (1200 to 2000 mm), trench system of planting *i.e.*, planting cardamom in 1.5' × 1.5' dimension trenches by filling with farmyard manure, jungle soil and top soil was found to conserve more soil moisture and supplement the plants even during dry spells (Korikanthimath, 1987). In area having slope of more than 7 percent, of all along the contour, bench terracing of about 5-6 feet width has to be created for taking up cardamom planting.

The clearing of shade trees before taking up planting, subsequent shade regulation and mulching between the rows across the slope to prevents run off losses of rain water and serves as effective soil and moisture conservation (Korikanthimath, 1989). The effect of perennial vegetation in controlling erosion in forest ecosystems depends on a number of factors such as canopy cover, ground vegetation, litter effects, root effects and changes in the physical properties of the soil (Wiersum, 1985). The present study was also aimed to evaluate different soil and water conservation measures in cardamom for efficient utilization of rainwater, check soil erosion and quantification of runoff and soil loss in different treatments.

MATERIALS AND METHODS

Experiment was conducted with six treatments *viz*

1. Control with out conservation measures,
2. Contour staggered trenches (CST) (2m × 45cm × 30 cm) in alternate rows,

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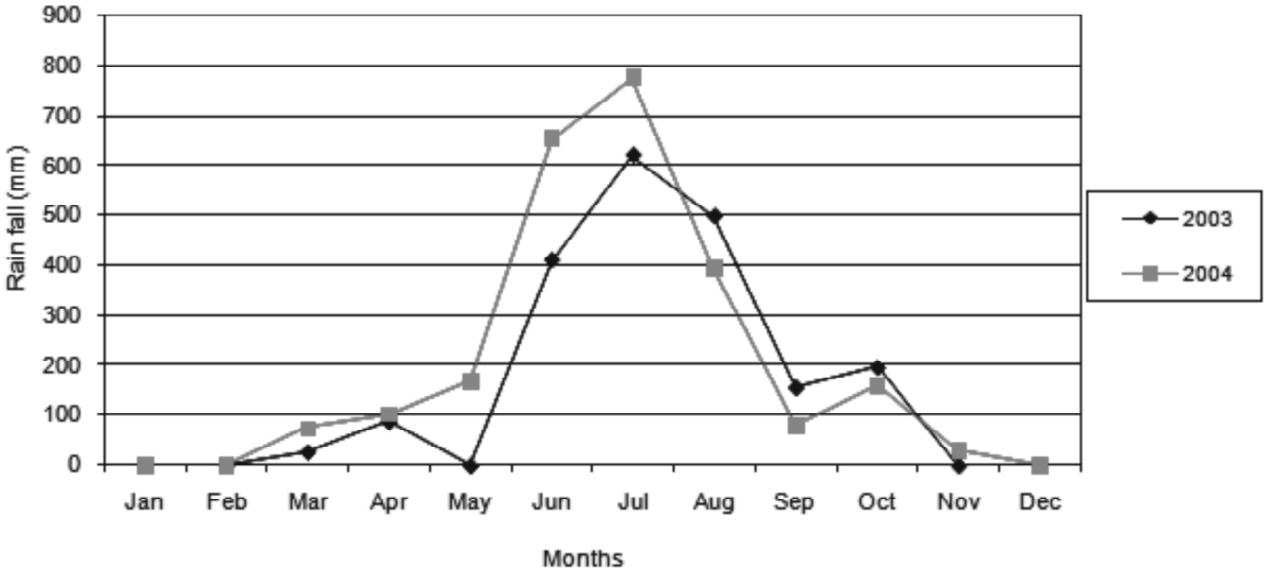

Figure 1: Mean monthly rainfall (mm) recorded at Cardamom Research Centre, Appangala during experimental period.

3. CST + Pine apple,
4. CST + French bean,
5. CST + Ginger,
6. Ginger alone, with four replication.

The plot size was 12 m × 10 m where cardamom was planted at 2 m × 2 m spacing, having a population of 30 (cardamom). Experiment was laid out during October 2000 and the treatments were imposed during May 2001. Growth and yield parameters of main crop and component crops were recorded. Recommended package of practices were followed for establishment of crop. Soil samples were collected from all the experimental plots at two depths 0-15 cm and 15-30 cm and were analysed for physio-chemical properties using standard analytical procedures (Jackson, 1973). Moisture depletion pattern and amount of soil deposited in CST's was also recorded. Amount of runoff and soil loss was recorded on every rainy day with multislot devisors. The nutrient content of runoff soil and water was also determined.

RESULTS AND DISCUSSION

Rainfall

Total mean monthly rainfall (mm) recorded at the meteorology station of the centre was 1999 mm and 2441 mm and number of rainy days were 100 and 119 during 2003 and 2004, respectively. Rainfall is distributed over a period of eight months with a peak in June, July and August months (Fig. 1). Panicle

Table 1
Soil nutrient status in different treatments during 2002

		Chemical contents (kg/ha)					
Treatments	*Depth*	*pH*	*N*	*P*	*K*	*Ca*	*Mg*
Control	D1*	4.86	415.8	18.04	210.5	1165.0	303.6
	D2	5.03	377.6	7.62	144.5	1216.5	219.64
CST	D1	4.95	372.8	22.95	164.5	2240.0	343.2
	D2	4.92	406.4	11.82	142.2	1055.0	236.0
CST +PA	D1	4.84	374.2	24.08	102.66	1989.3	185.26
	D2	4.74	388.0	24.70	152.66	1346.0	190.72
CST+ FB	D1	4.78	433.2	19.30	158.50	2237.0	259.34
	D2	5.08	360.2	7.28	104.0	1486.6	170.4
CST+ ginger	D1	5.19	460.8	35.18	243.5	2072.4	328.94
	D2	5.93	374.2	16.9	205.0	1288.0	259.5
Ginger alone	D1	5.15	339.6	5.3	153.5	1552.0	242.24
	D2	5.17	405.4	6.6	123.0	1346.0	193.9

*1 = 0-15 cm depth; D2 = 15-30 cm depth

Table 2
Influence of soil and water conservation treatments in cardamom on soil nutrient status (2003) (kg/ha).

	pH		*Phosphorus*		*Nitrogen*		*Potassium*		*Calcium*		*Magnesium*	
Treatments	*D1**	*D2*	*D1*	*D2*	*D1*	*D2*	*D1*	*D2*	*D1*	*D2*	*D1*	*D1*
Control	5.13	5.39	22.31	18.99	322.48	341.7	583.5	559.7	3223	2944	860.35	839.32
CST (2m × 45 cm × 30 cm)	5.808	6.01	23.60	20.14	282.77	209.0	546.0	585.5	2680	2950.50	781.35	826.88
CST + Pine apple	5.513	5.78	23.41	20.28	225.54	242.2	462.0	672.5	2900	3173.50	806.37	799.50
CST + French bean	5.735	5.53	26.20	19.59	184.16	218.5	681.5	541.5	3017	2628.5	888.77	774.55
CST + Ginger	5.823	6.28	22.77	20.02	271.52	206.7	612.0	564.5	3033	3167.5	728.5	866.40
Ginger alone	5.84	5.23	21.99	18.62	266.47	244.5	491.0	523.0	3138	3174.0	672.6	812.40
CD @ 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

*D1 = 0-15 cm depth; D2 = 15-30 cm depth

initiation, flowering and setting is staggered in cardamom and it depends on the rainfall distribution for normal fruit setting. Initiation of new panicles and suckers commences from December and continued up to May. This critical phase coincides with long dry spell during December to April.

Soil Moisture Content

Soil moisture was low up to April in all the treatments. From May to August soil moisture content was relatively higher. In July it ranged from 17.53 to 23.08 percent (Fig 2.). In September soil moisture content was reduced and in October increased due to rains and in November it reduced. Similar trend in soil moisture depletion pattern was observed during 2002 and 2003 cropping season. Compared to control the depletion was lower in CST, CST + pine apple/French bean covers. These shrubby covers softened the mechanical impact of the rain drops on the soil surface, diminishing the superficial

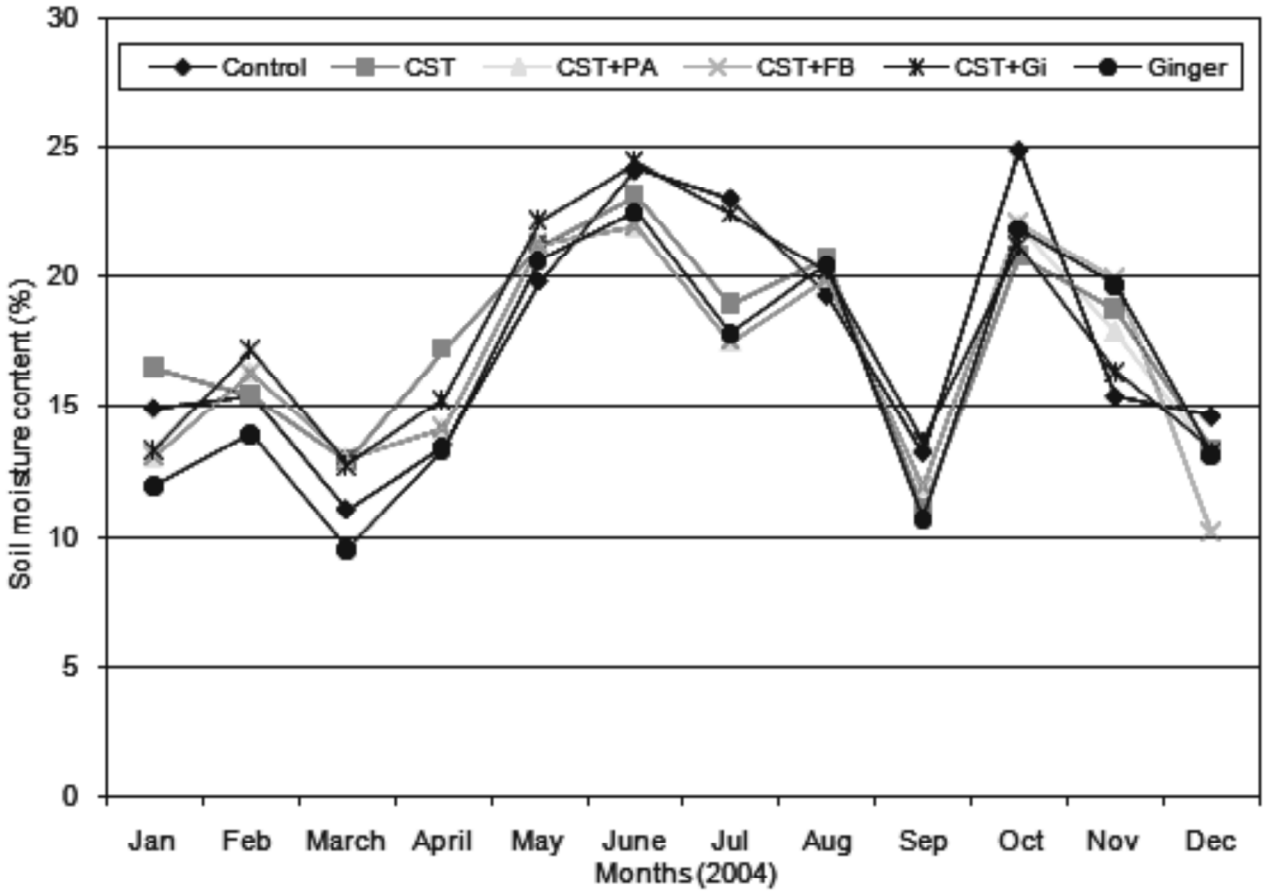

Figure 2: Soil moisture depletion pattern in different treatments (0-15cm depth).

Table 3
Run off (mm) and Soil loss (Kg/ha) under different soil and water conservation treatments in cardamom.

Treatment \ years	*2002*		*2003*		*2004*		*Average*	
	Run off	*Soil loss*	*Run off*	*Soil loss*	*Run off*	*Soil loss*	*Run off*	*Soil loss*
1. Control	55.2	3048.9	11.21	146.61	105.6	424.83	57.34	1206.78
2. CST	59.9	2268.3	3.96	124.3	43.8	148.09	35.88	846.89
3. CST+ pine apple	12.2	897.6	11.25	267.4	72.0	321.68	31.82	495.56
4. CST+ French bean	18.7	1507.7	16.21	464.3	139.8	634.62	58.24	868.87
5. CST+ ginger	24.9	2455.3	7.74	198.3	142.40	493.60	58.35	1049.06
6. Ginger alone	72.6	4721.5	19.92	943.6	216.0	994.12	102.84	2219.74
Annual rainfall (mm)	*2181*		*1999*		*2441*		*2207*	

runoff and therefore favouring the soil conservation and the infiltration rate of the rainfall water was higher in these plots, thereby retaining more moisture.

Soil Physio-chemical Properties

Bulk density was in the ranged of 1.0-1.2 mg per m^3 with a mean of 1.1 mg per m^3. The pH of the soil was acidic (4.72-6.28). Nitrogen content was high in all the treatments during 2002 as compared to 2003 (Table 1 and 2). In general nitrogen content varied from medium to high. Phosphorus content was higher during 2003 as compared to 2002. During both the years the surface soil (0-15 cm) recorded highest potassium as compared to sub-surface (15-30 cm). All the conservation measures recorded higher potassium content of the soil and was higher during 2003 as compared to 2002. The surface soil (0-15 cm) showed higher K than the sub soil (15-30 cm). Calcium and Magnesium also followed the same trend as that of potassium. Nutrient status of cardamom growing soil was medium to high.

Run Off and Soil Loss

Average of runoff and soil loss for the years 2002, 2003 and 2004 revealed that the amount of soil loss ranged from 2219.74 kg per ha to 495.56 kg per ha. Minimum run off (31.82 mm) and soil loss (495.56 kg/ha) were recorded from CST + Pine apple followed by CST and CST + ginger. The amount of soil loss was more during the year 2002 compared to 2003 due to high intensity of rainfall (Table 3 and Fig. 3 and 4). Differences in soil loss from fallow plot were primarily due to varying quantities, intensities and distribution pattern of rainfall in different years.

The amount of soil loss was more in ginger alone which might be due to more runoff and exposure of

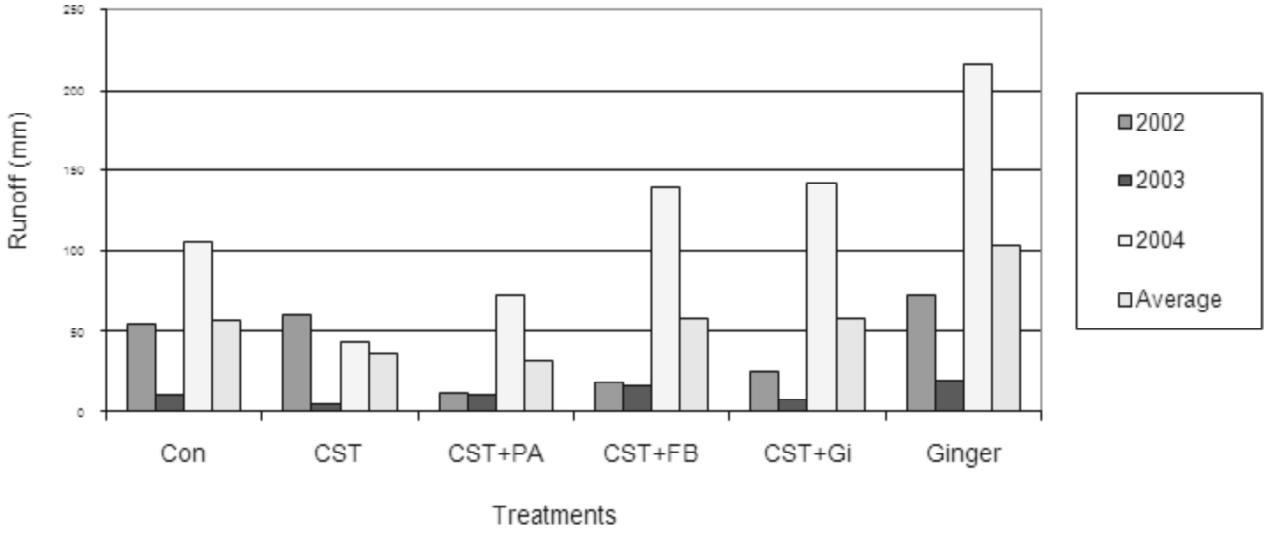

Figure 3: Runoff (mm) in different treatments.

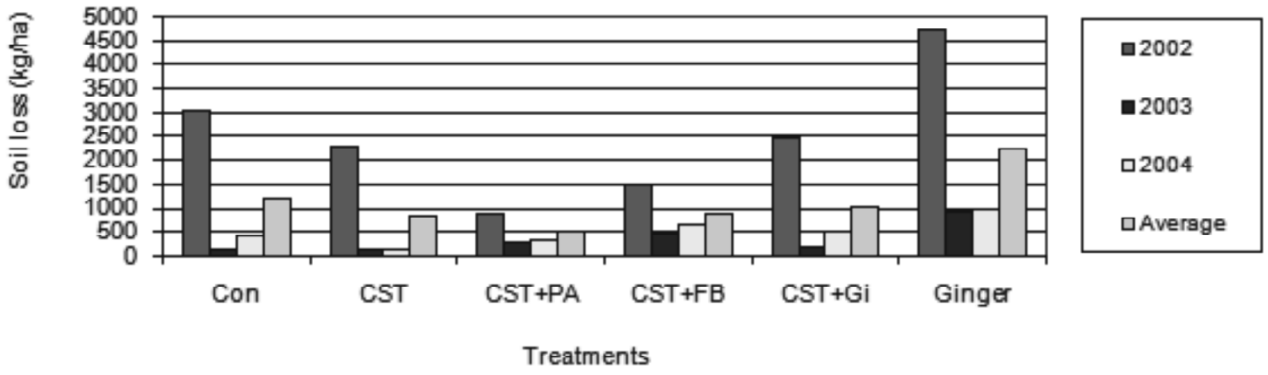

Figure 4: Soil loss (kg/ha) in different treatments in cardamom

soil. As the soil is much disturbed under ginger alone for inter cultivation operations like weeding and earthing up without any other CST and control treatments, the soil loss was found to be of higher magnitude in this treatment. The introduction of conservation measures like contour staggered trenches along with ginger also reduced the soil loss and runoff to a marked extent. Introducing the vegetative barrier like pine apple and French bean further reduced the soil loss during 2003. During 2004 CST treatment recorded the minimum runoff and soil loss followed by CST + Pine apple. The reduction in runoff and soil loss by contour terrace and pine apple/ french bean is attributable to the canopy effect of reducing rainfall erosivity and obstruction to overland flow by contour terrace as well as the barrier effect of crops.

Amount of soil deposited in CST in different treatments was in the range of 62.71-79.08 kg/CST. Similar reduced average runoff and soil loss by 27% and 45% under contour cultivation of maize compared to cultivated fallow was observed by Narain *et al*. (6). In their study, inclusion of contour paired rows of trees in maize further reduced the runoff by 41% and soil loss by 48% and under the grass cover, average reduction in runoff and soil loss were 73% and 94% over fallow plot, in Western Himalayan conditions. Other studies conducted in humid and sub-humid regions have also reported a remarkable reduction in runoff and soil loss due to barrier effect of hedgerow intercropping on steeper slopes (Banda *et al*., 1994; Alegre and Rao, 1996; Victor Hugo *et al*. 2004). The use of plant covers on steep slopes is advisable for the recycling nutrients, and consequently for an efficient regulation of the flow of nutrients by runoff and sediments. Vegetation makes a nutrient pool available while moderating surface runoff and sediment movement, both of which are major nutrient carriers.

Nutrient Loss Through Run Off

Nutrients content in runoff water and silt were analyzed for pH, N, P, K, Ca and Mg. Nutrients loss through runoff is presented in table 4. The pH of the runoff water was found to be acidic (5.87). Nitrogen content in runoff was in the range of 1.1-15.4 kg/ha and that of phosphorus was 0.005-0.048 kg/ha. The maximum N in runoff was recorded under control. The potassium content was in the range of 0.263-1.748kg/ha, calcium in the range of 0.507-7.318 kg/ha and magnesium in the range of 0.633-3.36 kg/ha. The maximum loss of K, Ca and Mg under ginger alone might be due to the heavy runoff and soil loss recorded in this treatment.

Growth and Yield Parameters of Cardamom

The growth and yield attributes were found to be non significant between treatments. However, the total number of tillers per plant was high in CST with pine apple and CST with ginger during 2003 (Table 5). During 2004 growth and yield parameters did not reveals significant variation between treatments (Table 6). Growth and yield parameters were better in treatments with CST compared to control. CST with ginger recorded maximum yield (461.3 kg/ha) followed by CST (446.5 kg/ha) and low yield was recorded in control with out any

Table 4
Nutrient loss (kg/ha) through runoff under different soil water conservation treatments in cardamom.

Treatments	*Nutrient content*				
	N	*P*	*K*	*Ca*	*Mg*
Control	15.4	0.011	0.801	7.318	2.607
CST	10.0	0.022	1.001	3.295	2.828
CST + Pine apple	1.7	0.022	0.267	0.507	0.633
CST + French bean	5.4	0.005	0.263	2.926	0.757
CST + ginger	1.1	0.048	0.593	4.726	1.508
Ginger alone	2.2	0.014	1.748	6.754	3.360

Table 5
Influence of treatments on the growth parameters of Cardamom in 2003-2004

Treatments	*Bearing tiller /plant*		*Non-bearingtillers /plant*		*Total tillers /plant*		*No. of leaves /tiller*		*No. of panicles / plant*	*Dry yield (kg/ha)*
	2003	*2004*	*2003*	*2004*	*2003*	*2004*	*2003*	*2004*	*2004*	*2004*
Control	17.38	15.1	13.25	12.0	30.59	27.1	12.21	12.1	12.5	309.3
CST	14.81	16.5	12.37	13.8	25.2	27.8	12.77	11.9	17.5	446.5
CST+ Pine apple	16.81	12.4	15.93	11.3	33.12	23.7	12.55	12.8	15.0	343.4
CST + French bean	16.52	15.1	11.37	10.6	27.5	25.7	12.57	12.7	16.5	399.2
CST + ginger	17.31	14.4	14.25	13.6	32.8	28.1	13.12	13.4	16.6	461.3
CD@5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

conservation measures (309.3 kg/ha). CST with pine apple recorded lower yield may be due to competition between cardamom and pine apple for space and nutrients (343.4 kg/ha).

YIELD OF INTERCROPS

Ginger Yield

The yield was higher (8.09*t*/ha) in ginger alone compared to ginger yield from CST + ginger (2.44*t*/ha) during 2001-2002. Ginger beds were prepared and re-sowing of ginger was done on May 2002 for second crop. Growth of ginger was very poor due to rhizome rot incidence in second year. Mono cropping of ginger during consequent years in the same site leads to more disease incidence and it is not practiced in ginger cultivation.

French Bean Yield

French bean total yield was found to be 195 kg/ha. French bean beds were prepared and re-sowing of french bean was done during subsequent years. The yield of French bean was also reduced in subsequent sowing due to shade by more canopy coverage of cardamom.

Pine Apple Yield

Total number of 2187 fruits were harvested and recorded 1094 kg yield per hectare.

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