Agric. Res. J. Kerala, 1983, 21 (1) 9—16

INFLUENCE OF CONSERVATION PRACTICES ON RUN OFF AND SOIL LOSS UNDER TAPIOCA IN HILL SLOPES*

K. Viswambharan and V. K. Sasidhar

College of Horticulture, Vellanikkara-680 654, Trichur

About 50 per cent of the cultivation in Kerala is done on slopes which in most parts of the world would be considered unsuitable for cultivation. The situation is still agravated by the cultivation of tapioca in the hill slopes by heaping the loose soil into small mounds or long ridges made along the slopes. The land between the ridges or mounds is left bare without any kind of cover and this encourages run off and soil loss.

Tapioca is an eight to ten month crop and is planted during the periods of abundant rainfall either during June-July or September-October in Kerala. The initial growth rate of the crop is comparatively slow and it generally takes $2\frac{1}{2}$ to 3 months to develop full canopy. The heavy rainfall coupled with faulty methods of cultivation results in severe soil loss from the cultivated area during the early part of the crop growth.

Intercropping as a method of reducing soil loss was suggested by Bhola *et al*. (1975) and groundnut was used as an intercrop by Lekshminarayana and Reddy (1972). Thus it was felt reasonable to test the feasibility of intercropping with groundnut and planting on ridges taken across the slope to reduce soil and water losses during the early part of the crop growth.

Materials and Methods

A field experiment was conducted in the Instructional Farm attached to the College of Horticulture, Vellanikkara during September, 1979 to May, 1980 to study the effect of various conservation practices on run off and soil loss under tapioca planted in hill slopes. The experiment was laid out in randomised block design with five treatments and four replications on a 15.32% slope. The treatments consisted of four cultivation methods and one uncultivated bare fallow as the control plot. The treatments were as follows:

T_1 Tapioca alone in monuds
T_2 Tapioca in mounds with groundnut as intercrop
T_3 Tapioca alone in ridges across the slope
T_4 Tapioca in ridges across the slope with groundnut as intercrop
T_5 Uncultivated bare fallow (control)

The experiment was conducted in uniform field run off plots having a length of 24,3 m and width of 2.7 m. The run off from each plot was collected directly into water proof polythene lined earthen tanks having a length of 2.7 m, width of 1 m and depth of 1.3 m. After each rain the run off collected in the tanks was recorded. In order to determine soil loss, the run off water was stirred thoroughly and a sample of 500 ml was quickly taken for sediment calculation. Gravimetric method was followed to measure the sediment present. Only rainfall of 12.5mm

* Part of M. Sc. (Ag.) thesis submitted to the Kerala Agricultural University, 1980

Table 1

Surface run off as affected by different treatment and dates of rainfall (10^{-3} mm)

Dates of observation	26-9-79	29-9-79	11-10-79	15-10-79	27-10-79	28-10-79	30-10-79	7-11-79	13-11-79
Treatments	1	2	3	4	5	6	7	8	9
T_1	380.0	3747.5	7037.5	2965.0	1760.0	1870.0	2120,0	4612.5	1727.5
	(2,575)	(3.534)	(3.847)	(3.451)	(3.245)	(3.271)	(3.321)	(3.658)	(3.233)
T_2	332.5	5302,5	5937.5	2170.0	965.0	525.0	380.0	1122.5	295.0
	(2.495)	(3.701)	(3.768)	(3.327)	(2.978)	(2.710)	(2.577)	(3.043)	(1.515)
T_3	245.0	972.5	1682.5	852.5	1140.0	142.5	410.0	790.0	250.0
	(2.374)	(2.982)	(3.219)	(2,882)	(3.053)	(2.067)	(2.606)	(2.897)	(2.018)
T_4	197.5	900.0	1060.0	462.5	562.5	47.5	280.0	260.0	10.0
	(2.243)	(2.947)	(2.947)	(2,640)	(2.702)	(1.520)	(2.444)	(2.404)	(1.000)
T_5	352,5	6875.0	9405.0	4865.0	4260.0	4060.0	3552.5	7912.5	2902.5
	(2.502)	(3.544)	(3.972)	(3.686)	(3.628)	(3.605)	(3.546)	(3.888)	(3.461)
SEm ±	(0.076)	(0.167)	(0.085)	(0.082)	(0.056)	(0.110)	(0.040)	(0.047)	(0.318)
C.D. (0.05)	NS	(0.514)	(0.263)	(0.252)	(0.172)	(0.339)	(0.124)	(0.144)	(0.980)

Table 1 (continued)

Dates of observation	16-11-79	19-11-79	21-11-79	23-11-79	28-11-79	7-4-80	17-4-80	26-4-80	20-5-80
Treatments	10	11	12	13	14	15	16	17	18
T_1	6810.0	2210.0	3932.5	7117.5	30702.5	6532.5	395.0	15575.0	937.5
	(3.829)	(3.317)	(3.583)	(3.844)	(4.487)	(3 814)	(2.593)	(4.190)	(2.948)
T_2	3747.5	687.5	925.0	1862.5	13055.0	5390.0	347.5	10690.0	587.5
	(3.548)	(2.670)	(2.935)	(3.262)	(4.110)	(3.731)	(2.513)	(4.029)	(2.708)
T_3	1832.5	287.5	997.5	1150.0	8375,0	2685.0	150.0	4722.5	130.0
	(3.262)	(1.866)	(2.996)	(3.046)	(3.881)	(3.429)	(2.036)	(3.626)	(2.109)
T_4	1865.0	297,5	997.5	1050.0	4260.0	2502.5	202.5	2407.5	172.5
	(3.267)	(1.880)	(2,993)	(3.011)	(3.606)	(3.398)	(2.271)	(3.344)	(2.191)
T_5	15350.0	12370.0	7847.5	12502.5	48190.0	7810.0	3525.0	36512.5	4525.0
	(4.185)	(4.096)	(3.893)	(4.084)	(4.683)	(3.891)	(3.544)	(4 562)	(3.652)
SEm ±	(0.40)	(0.269)	(0.045)	(0.530)	(0.058)	(0.018)	(0.113)	(0.063)	(0.092)
C.D. (0.05)	(0.123)	(0.828)	(0 139)	(0.164)	(0.177)	(0.056)	(0.349)	(0.196)	(0.282)

Figures in brackets are means of logarithms

Table **2**

Soil loss as affected by different treatments and dates of rainfall (kg/ha)

Dates of observation	26–9–79	29-9-79	11-10-79	15-10-79	27–10–79	28-10-79	30–10–79	7–11–79	13–11–79
Treatments	1	2	3	4	5	6	7	8	9
T_1	100.38	352.45	572.43	677.23	207.63	94.28	277.18	1799.75	92.43
	(1.966)	(2.531)	(2.750)	(2.777)	(2.314)	(1.961)	(2.406)	(3.079)	(1.923)
T_2	44.28	27503	393.18	323.88	118.40	87.23	54.45	218.50	58.98
	(1.603)	(2.417)	(2.574)	(2.509)	(2.054)	(1.917)	(1.717)	(2.333)	(1.730)
T_3	59.79	113.95	261.05	238.98	131.75	110.78	48.15	222.28	62,25
	(1.607)	(2,049)	(2.410)	(2.163)	(2.115)	(2.025)	(1.665)	(2.286)	(1.791)
T_4	60.13	80.83	191.48	200.43	102.40	84.98	60.75	205.90	50.85
	(1.708)	(1.893)	(2.268)	(2.286)	(2.009)	(1.907)	(1.745)	(2.304)	(1.680)
T_5	109.53	1215.65	1482.93	871.40	733.50	319,05	699.33	4987.85	403.03
	(2.037)	(3.054)	(3.138)	(2.910)	(2.777)	(2.399)	(2.790)	(3.676)	(2.559)
SEm±	(0.155)	(0,078)	(0.051)	(0,063)	(0.083)	(0.080)	(0.096)	(0.096)	(0.059)
C.D. (0,05)	NS	(0.240)	(0.153)	(0.195)	(0.256)	(0.247)	(0,297)	(0.297)	(0.183)

Table 2 (continued)

Dates of observation	16–11-79	19–11-79	21–11–79	23–11-79	28–11-79	7-4-80	17-4-80	26-4-80	20–5–80
Treatments	10	11	12	13	14	15	16	17	18
T_1	1786.18	279.73	1126.23	3266.33	12889.40	195.75	75.00	8453.65	1908.05
	(3.091)	(2.246)	(2.900)	(3.437)	(4.077)	(2.281)	(1.851)	(3.845)	(3.117)
T_2	114.50	59.35	80.50	102.28	713.90	105.93	63.40	3873.63	223.35
	(2.054)	(1.733)	(1.877)	(2.000)	(2.834)	(2.010)	(1.799)	(3.474)	(2.342)
T_3	112.63	53.63	97.13	106.88	670.03	80.88	48.35	1500.782	31.73
	(2.031)	(1.687)	(1.967)	(2.012)	(2.813)	(1.905)	(1.627)	(3.163)	(2.312)
T_4	71,50	80.33	68.48	108.63	379.75	68.95	33.50	1120.50	215.10
	(1.853)	(1.876)	(1.798)	(2.018)	(2.547)	(1.831)	(1.516)	(3.033)	(2.330)
T_5	3249.45	794.20	1730.60	3759.70	19174.60	557.10	201.50	34413.58	2701.65
	(3.498)	(2895)	(3.183)	(3.486)	(4.266)	(2.743)	(2.301)	(4.536)	(3,403)
SEm±	(0.097)	(0,093)	(0,078)	(0.068)	(0.033)	(0.042)	(0.091)	(0.102)	(0,109)
C.D.(0.05	(0.300)	(0287)	(0.240)	(0,209)	(0.102)	(0.129)	(0.281)	(0.315)	(0.336

Figures in brackets are means of logarithms.

Table 3

Run off and soil loss as affected by different treatments before and after harvest of intercrop

Treatments	Run off (mm)*			% of total rainfall	Soil loss (kg/ha)**		
	Before harvesting intercrop	After harvesting intercrop	Total		Before harvesting intercrop	After harvesting intercrop	Total
T_1	76.99	23.44	100.43	14,68	23521.6	10632,5	34154.1
	(4.885)	(4.370)	(5.001)		(4.323)	(3.950)	(4.484)
T,	37,31	17.02	54.32	7.94	2644.5	4266.3	6910.8
	(4.570)	(4.230)	(4.735)		(3.418)	(3.545)	(3.801)
T,	19.13	7.69	26.82	3.92	2289.2	1861.9	4151.1
	(4.275)	(3.866)	(4.419)		(3.348)	(3.259)	(3.609)
T,	12.25	5.29	17.54	2.56	1746.4	1438.1	3184.5
	(4.082)	(3.714)	(4.238)		(3.235)	(3.146)	(3.494)
T.	140.65	52.37	193.02	28.22	39530.8	37873.3	77404.1
	(5.148)	(4.719)	(5.286)		(4.578)	(4.577)	(4.882)
C.D. (0.05)	(0.075)	(0.110)	(0 079)	0.840	(0.127)	(0.274)	(0.157)
SEm±	(0.024)	(0.036)	(0.026)	0 273	(0.041)	(0.089)	(0.051)

* Figures in brackets are mean logarithms of run off in 10^{-3} mm values

** Figures in brackets are mean logarithms of soil loss in kg/ha

or more was taken for the study as erosion was negligible under lower rains. Only those rainfall characters which can be taken directly from a recording rainguage chart were considered. For this purpose, an automatic recording rain guage was installed at the centre of the experimental area and the chart observations were checked with a 122 mm ordinary rain guage.

All the cultural operations were done as per the Package of Practices Recommendations of Kerala Agricultural University (Anon., 1978). Tapioca and groundnut were planted in appropriate plots with a spacing of 90 cm x 90 cm and 15 cm x 15 cm. respectively. In plots with ridges, groundnut was planted on both sides of ridges and in mounds it was planted around the mounds. The population and spacing were kept constant in both the cases.

Results and Discussion

The total rainfall occurred during the period of study was 684.05 mm distributed over 53 different rainfalls out of which 18 rains recorded 12.5 mm and above. The total kinetic energy of these rainfalls was 12358.04 metre tonnes/ha and the total erosion index value (EI_{30}) was 475.59 metric units.

Run off

The run off observed in different treatments under different rainfalls studied is shown in Table 1. During all the rains, maximum run off was observed under uncultivated bare fallow plots which was significantly higher over all the other treatments. This can be attributed to the direct impact of falling rain drops which puddle the soil surface and prevent infiltration, thus promoting more run off. Amongthe various cultivation methods maximum run off was observed in T_1 (tapioca alone on mounds). This can be attributed to the low coverage of land and low interception of run off between the mounds. Similarly the minimum run off observed in T_4 (tapioca on ridges across slope with groundnut as intercrop) can be attributed to the high coverage coupled with high interception of run off between ridges.

Soil loss

The soil loss observed in different treatments under different rainfalls during the period of study is given in Table 2. It can be seen that during all the rains, maximum soil loss occurred under bare fallow plots as in the case of run off. Similarly among the various cultivation methods, maximum soil loss was observed in T, (tapioca alone in mounds) and reasons have been explained earlier under run off. The factors which contribute to increased run off also increase soil loss. Minimum soil loss was observed in T_4 (tapioca on ridges across the slope with groundnut as intercrop) where the ridges coupled with groundnut intercrop reduced the soil losses. This indicates clearly that vegetation decreases soil loss as it resists the direct impact of rain drops through their canopy effects. This is in agreement with the findings of Ellison (1947) who reported that soil detachment hazard was inversely proportional to the resistance factor of surface covers and mulches in reducing run off velocity.

The data on soil and water losses before and after the harvest of intercrop are givan in Table 3. It is seen that soil and water losses were significantly lower

in the intercropped fields even after the harvest of the intercrop. This may be attributed to the high infiltration occurring in these fields as a result of the root effect of the intercrop. The effect of the intercrop in increasing granulation and porosity might have persisted even after the harvest of the intercrop. Ridges across the slope were also effective in reducing soilloss. This may be due to its effect on reducing run off as discussed earlier.

The total soil loss during the cropping season from uncultivated bare fallow was 77.4 tonnes/ha which was significantly higher than that of the other plots. Among the different cultivation techniques, maximum soil loss was registered from T_1 being 34.15 tonnes/ha which was significantly higher than that of the other treatments. In the corresponding intercropped field (T_2) the soil loss was only 6.9 tonnes/ha. Similarly in T_3 soil loss was only 4.15 tonnes/ha, the corresponding intercropped field (T_4) recorded loss of soil being only 3.18 tonnes/ha. It can be clearly seen that intercropping as well as ridges across the slope were effective in reducing soil and water losses.

Summary

A field experiment was conducted to study the effect of supporting conservation practices on run off and soil loss under tapioca planted in hill slopes. The run off and soil loss were measured under 18 different erosive rainfalls which recorded 12.5 mm or more. Maximum run off and soil losses were observed in uncultivated bare fallow plot which was significantly higher over all the other treatments. Among the cultivation techniques, groundnut intercropping as well as planting of tapioca in ridges across the slope were effective in reducing soil and water losses in tapioca.

സംഗ്രഹം

കുന്നിൻ ചെരിവുകളിൽ മരച്ചീനി കൃഷി ചെയ്യുമ്പോഴും ഉണ്ടാകുന്ന മണ്ണൊലിപ്പിനെപ്പറ്റിപഠനം നടത്തുന്നതിന് ഒരു പരീക്ഷണം 1979–80 വിളക്കാലത്ത് വെള്ളാനിക്കfa ഇൻസ്ട്രക്ഷണൽ ഫാമിൽ നടത്തുകയുണ്ടായി. വിവിധതരം കൃഷിരീതികളും നിലക്കടല ഇടവിളയും ഉപയോഗിച്ച് നടത്തിയ ഈ പരീക്ഷണത്തിൽനിന്നും മനസ്സിലായത് ചെരിവിനെതിരെ എടുക്കുന്ന വരമ്പുകളിൽ മരച്ചീനി കൃഷി ചെയ്തോ, കൂനകളിൽ കൃഷിചെയ്യുമ്പോഴും നിലക്കടല ഇടവിളയായി കൃഷിചെയ്തോ കുന്നിൻ ചെരിവുകളിൽ നിന്നും മണ്ണൊലിപ്പു തടയാൻ കഴിയും എന്നാണ് .

Acknowledgement

The authors wish to acknowledge their sincere thanks to Dr. P. C. Sivaraman Nair, Director of Research, Kerala Agricultural University for providing necessary facilities for the conduct of this experiment.

References

Anonymous, 1978. *Package of Practices Recommendations.* Directorate of Extension, Kerala Agricultural University

Bhola, S. N,, Khybri,M.L.and Rajbans Dayal,1975. Run off and soil loss studies under different cropping patterns. *J. Indian Soc. Soil Sci.* 23:298-301.

Ellison, N, D. 1947. Soil erosion studies-Part I to VII. *Agric. Engg.* 28: 145-146.

Lekshminarayana, A. and Reddy, S. G. H. 1972. Slope characterisation for crop planning in dryland red soils of Rayalaseema. *Madras agric. J.* 58: 253-256.