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Soil Erosion by Surface Run-off.

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Introduction. In the black soil areas of the Ceded Districts conditions are generally favourable for heavy losses of soil and water by surface run-off after rains. Sheet erosion has been responsible for a steady deterioration in the depth and fertility of the soil. The main factors contributing to this are (1) the heavy type of soil—which does not allow the rain water to be absorbed as fast as it is received, (2) the undulating nature of the land and (3) the great intensity of the rainfall. About half the annual rainfall of the tract is received within a limited period of four to six weeks between September and October. Unless proper preventive measures are adopted, most of the rainfall received in heavy instalments is lost as surface run-off carrying with it large quantities of the rich surface soil. A knowledge of the exact amount of soil and water lost by run-off is essential for an understanding of the magnitude of the problem.

Experimental. During the last three years data on the amount of soil and water lost by surface run-off have been collected in plots specially constructed for the purpose.

Two plots 66′ × 8½′ (area 1·25 cents) with a gradient of 1 in 80 were selected. On three sides each plot was enclosed by galvanised iron sheets and the run-off was collected into masonry cisterns towards which the plots slope. The amounts of water and silt collected as run-off were measured after each rain. Samples of run-off waters were analysed for total salts, lime and nitric nitrogen. Nitric nitrogen determined in samples of rainwater served as a correction for the values obtained for samples of run-off. The silts collected in the different seasons were analysed separately. During 1937—38 both the plots were kept under the same treatment viz. hand hoeing by the blade harrow given before the rainy season. The results of the first season served as duplicates.

The effect of Scooping. The effect of scooping the land on the control of the erosion was studied during 1933—39 and 1939—40. In one of the run-off plots, scoops were formed before the rainy season and the amounts of water and silt collected in the run-off tanks after each rain were studied. The results obtained for the last three seasons are summarised below in Table I. It will be seen from the figures that in the control plot 44 and 48 per cent. of the rainfall was lost as run-off during 1937-38 and 1938-39 respectively. During 1939 the run-off tanks overflowed on two occasions and the results given in the table are exclusive of the data on those two days. The silt washed off in the control plot is considerable as it amounted to 6·6, 9·9 and 7·4 tons per acre respectively for the rainfall of 9·2″, 15·7″ and 8·4″ for the three years under study. For every inch of water lost, the amount of silt carried off was 1·65, 1·31 and 2·69 tons per acre in the control plot for the three years under study. Under the same conditions of gradient and size of plot, 4·3 tons of soil per acre was lost from a clean fallow at the Dry Farming Station, Sholapur, during 1935-36.

TABLE I. Run-off results—Hagari Experimental Station.

	1937—38 Average of two control plots.	1938—39		1939-40 *	
		Control.	Scooped.	Control.	Scooped.
1. Number of days when there was run-off.	11	13	10	16	10
2. Total rainfall on days when there was run-off in either of the plots.	9·16"	15·66"	15·66"	8·36"	8·36"
3. Rainwater lost.	4·00"	7·52"	3·29"	2·73"	1·34"
4. Rainwater lost—expressed as per cent of rainfall received.	43·67	48·01	21·01	32·66	16·03
5. Silt washed off in tons per acre.	6·58	9·86	3·60	7·35	2·44
6 Silt washed off in tons per inch of rainwater lost.	1·65	1·31	1·09	2·69	1·82
7. Total salts lost in pounds per acre.	100·60	132·86	95·79	65·00	41·72
8. Lime (CaO) lost in pounds per acre.	2·45	20·07	16·79	5·46	2·62
9. Nitric nitrogen lost in pounds per acre.	0·11	0·59	0·29	0·19	0·09

* Excluding 2 days when the tanks overflowed—Rainfall being 3·82" and 2·61" within 24 hours on 10—8—39 and 25—10—39 respectively.

Intense storms received during a short spell contribute most to the run-off. The pockets into which one of the run-off plots was thrown by scooping, effectively decreased the run-off of water to less than half the value of the control plot, while the silt washed off was only about one-third.

Analysis of silt collected in 1937-38 clearly showed that the soil washed off the land is richer than the original soil both from the physical and chemical point of view as shown in the tables below:—

TABLE II Mechanical analysis of silt collected in 1937-38.

Heads of analysis.	Silt.	Soil 0—1 foot depth. East Block.
Clay (per cent)	56·8	44·9
Silt ,,	26·9	17·1
Fine sand ,,	8·5	15·7
Coarse sand ,,	1·4	17·5

TABLE III. Chemical analysis of silt collected in 1937–38

Heads of analysis.	Silt.	Soil 0—1 foot depth. East Block.
Loss on ignition	7·14	3·12
Insoluble matter	63·95	75·49
Iron and alumina ($Fe_2O_3 + Al_2O_3$)	20·95	13·19
Lime (CaO)	3·83	3·45
Magnesia (MgO)	1·52	0·92
Potash (K_2O)	1·28	0·29
Phosphoric acid (P_2O_5)	0·041	0·05
Nitrogen (N)	0·043	0·02

The mechanical analysis shows that the silt washed off consists of 83·7 per cent. of the fine fractions, clay and silt, while the original soil contains only 62 per cent. The nitrogen content of the silt was 0·043 per cent. while that of the soil was 0·024 per cent. Potash was about four times as much as was contained in the soil. Similarly the 'loss on ignition' is higher for the silt than for the soil. During the course of the washes, the coarser particles settle down and the finer richer material is washed off. The results of the analysis for the silt collected during 1938—39 are in general agreement with the above data. (Data on the run-off for the first two years were published in an article entitled 'Soil and Water Losses by Run-off' in the *Madras Agricultural Journal* Vol. XXVII, pp. 244—246, 1939).

Methods Adopted to Control Erosion. Among the chief methods adopted to control erosion and conserve the rain water may be mentioned (i) bunding the land at regular intervals, (ii) bunding combined with deep ploughing periodically and (iii) scooping the land. The beneficial effect of scooping in checking erosion was shown above. The relative efficiency of the different cultural methods in checking erosion and increasing the powers of absorption of the soil may be seen from a study of the moisture condition of the differently treated plots before and after periods of intense rainfall. The following are a few typical figures for soil moisture which illustrate the effect of cultural treatments on the absorption of rain-water, when it is received in heavy instalment.

TABLE IV. Moisture contents of differently treated soils.

Treatment.	Moisture per cent. in the layer 0—3 feet			Rainfall absorbed in inches.
	on 16th August 1938.	on 31st August 1938.	Difference.	
		Rainfall between the dates :		6·15"
Control	18·1	22·1	4·0	1·9
Bunded	19·0	24·1	5·1	2·5
Ploughed in March '38 and bunded	17·2	25·1	7·9	3·8
		on 1st Septr. 1938.		
Control	15·3	21·2	5·9	2·83
Bunded	15·4	24·8	9·4	4·51
Scooped with basin lister and bunded	16·6	26·8	10·2	4·90
Scooped with *Danthies* and bunded	15·7	26·4	10·7	5·14

The treatments are most effective in checking erosion, during the first spell of heavy rains and in years of poor rainfall. In years of very good rainfall, however, the effect of the treatments is not so conspicuous in the conservation of rainwater as there is a tendency for the different plots to attain the maximum field capacity ; but there is the lasting benefit of saving the soil, which is, otherwise, washed off in large quantities as shown in the earlier part of this note.

EXTRACTS

Fertilizer Placement.

With recognition of the fact that absorption of nutrient substances by plants from the soil was a matter of competition or antagonism between the plants and soil, much attention has been paid to fertilizer placement with the object of giving the maximum advantage to the plant. The subject has been fully investigated in the United States where the superiority of localised applications of fertlisers for crops planted in hills and rows is now widely recognised. One of the main technical problems is the design of an efficient distributor which will sow seed and fertilizer in one operation without damaging the seed. Most writers agree that the fertilizers should be placed in bands near, but not too near, and at the side of, rather than directly above or below, the seed or plant. **Placement in bands under, above, or mixed with the soil around the seed usually delays emergence of the crop and reduces yield.** This is due to the greater tendency of fertilizer salts to move vertically rather than laterally in the soil. Lateral bands allow the seed to develop without coming in contact with salts at a stage in its growth at which high concentrations would be injurious.

The optimal distance of the fertiliser band from the seed varies with the rate of application, the texture of the soil and the sensitivity of the crops. **Under average farm conditions, placement 2 inches from the seed row and 3 inches below ground is satisfactory.** W. S. Blair recommends narrow bands 3 inches from the seed and 2 inches deep in the soil for potatoes, turnips, mangolds and fodder corn. An uncontrollable factor which may cause injury to germination in placement fertilising is the moisture content of the soil. J. A. McMillan and F. Hanley have studied drilling fertilizers with the seed at Cambridge. Barley did better with a moderate dressing of fertilizer drilled down the same coulter with the seed than when an equal dressing was broadcast. Sugar beet was more sensitive than barley to high concentrations of fertilizer salts. It was safer to use separate coulters for fertilizer and seed in order to minimise risks to germination in droughty periods. A. S. Alov obtained two to three times as great an effect with row placement as with broadcasting of complete fertilizers on cereals.

The danger of damage to the seed from contact with high salt concentrations is obviously greatest with soluble fertilizers (generally nitrogeaous) and least with those (phosphatic) which are strongly absorbed by the soil. J. B. Hester describes three "systems of nutritional variations" designed to eliminate the differences in the solubility and fixation of three main nutrient elements in fertilizing tomatoes. Superphosphate may be placed immediately under the seeds and nitrogen and potash placed further away and at a later date when the plants are ready to use them ; or super-phosphate may be placed in, and the nitrogen and potash broadcast ; or complete mixtures low in nitrogen and potash may be placed in the row and side dressed with high nitrogen potash mixtures. Similarly, placement of superphosphate in contact with the seed and nitrogen and potash in side bands, is recommended for potatoes.