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RESEARCH REPORT NO. 347

A NOTE ON THE EROSIVE POTENTIAL OF RAINFALL

by

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United States Department of Agriculture

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Introduction

The main reason for preparing this note is to suggest the trial use in the analysis of watershed sediment production records of a certain indicator for the potential ability of rainfall to cause erosion. This new function, $(\overline{VD}\text{-}20)$, involving the product of drop speed and diameter, cm^2/sec, is presumed to be directly proportional to the erosiveness of rainfall at impact with the soil. The scanty data that are available suggest this. A brief review of supporting facts and concepts is given.

The other reason is to emphasize the idea that the processes involved in soil erosion are not yet understood. Present knowledge is far from adequate to say or imply that there now exists a satisfactory, scientific understanding; notwithstanding the use in this and other articles on the subject of the words and short hand methods of the physicist and the mathematician. See page 10 for list of symbols with definitions.

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Discussion

General knowledge of the influence of rainfall qualities of the soil has existed since the time of Wollney (1). More recently Laws (2) showed that the erosion-producing potentialities of rainfall and sprays from sprinkling devices was dependent upon the sizes and speeds of the droplets at impact with the soil. He reasoned that the kinetic energy divided by the area of impact might be linearly related to the erosiveness of the spray or rainfall and to its ability to reduce the water intake rate of the soil surface.

Thirteen tests were made by the Soil Conservation Service during the winter of 1937-38 in Washington, D. C., on 1 ft. x 2 ft. soil plots with eight percent slope, using five sprinkling devices that produced sprays of differing drop size and fall velocity. See Appendix I for descriptions and data of the tests. The erosion tests and the concurrent development work on artificial rainfall devices in Washington, D. C., was under the direction of Howard L. Cook. The height of free fall of the sprays from three of the devices could be measured. The drop size distributions of all sprays were determined by the flour pan method (3). From these data and the previously determined relationships between drop size, distance of fall and fall

velocity (4) the values of various functions involving drop size and speed could be computed by summing the contributions from each of several drop size intervals, weighted in accordance with the proportion of the total volume contributed by spray drops within the interval. Laws (2) chose the E/A index (kinetic energy per unit area) to represent the erosiveness of the spray.

This is proportional to ρDV^2, the drop diameter times the square of the velocity at impact times ρ (rho) the density of the liquid. And, when the concentrations of eroded material in the runoff waters from the several tests were compared with the E/A index, there was shown to be an increase in soil concentration with increasing E/A values, but at a power of E/A apparently greater than one.

The concentration of transported soil in the runoff waters is dependent upon a number of things, including: the erosivity of the rain; the erodibility of the plot surface, and the erosiveness and transport capacity of the sheet flow across the plot surface. Perhaps it is also affected by the ratio of the rainfall rate to the runoff rate. For these reasons, corrections to the raw soil concentration data of the thirteen tests are needed prior to comparisons with indices of rainfall erosivity. Neal's (5) data were analyzed for the purpose of learning how best to make these corrections and comparisons. The analysis is shown in Figure 1.

The fact of non-uniformity in spray qualities was ignored. Laws' (2) method of making the corrections was a little different.

Thus Neal's data for short plots without rilling or other flow concentration are:

$$Ca = k_1 (k_2 S^{\frac{1}{2}} + SrL) \text{ - - - - - - - - - - - - - - - - - } (1)$$

The first term within the parentheses presumably reflects the effects of splashing. It becomes important for very short slopes, and is negligible for long slopes. The order of magnitude of k_2 was 1/3. The L has been arbitrarily added to the second term within the parentheses. This term is then proportional to the power of the sheet flow per unit area. It would have to be divided by area per unit time in order for it to be dimensionless. The coefficient, k_1, is presumed to be equal to $(i/r)FU$, the product of F, and the rainfall erosiveness, U. The reciprocal of the erodibility, $(1/F)$, may be thought of as the ability of the soil surface to resist erosion.

For a constant plot surface condition, the several indices for rain erosivity may therefore be compared with

$$FU = \frac{Ca}{(i/r)\ (k_2 S^{1/2} + SrL)} \text{ - - - - - - - - - - - - } (2)$$

Figure 2 shows the plotting of FU values from nine of the 13 erosion tests, for which drop speeds could be computed, against

$\overline{VD} = \Sigma pVD$, cm^2/sec, derived from measurements of the sprays. The product ρVD is proportional to the momentum per unit area of impact. The data are given in table 1. The equation of the straight line drawn to represent the data is

$$FU = K\ (\overline{VD}-20) \quad - \quad (3)$$

The expression $(\overline{VD}-20)$ is presumed then to be directly proportional to the ability of unit volume of the rain or spray to cause erosion of bare soil for the condition of sheet flow: i.e., $(\overline{VD}-20)$ is proportional to the soil concentration in the runoff water, other things being the same. Values of $(\overline{VD}-20)$ for natural rainfall are given in table 2. For values of natural rainfall rate greater than 0.02 inches per hour,

$$\overline{VD} = 165\ i^{0.27} \quad - - - - - - - - - - - - - - - - - - - \quad (4)$$

The principal purpose of the erosion tests was to determine the requisite drop sizes and speeds in artificial rainfall devices required to truly simulate the effects of natural rainfall. The tests were therefore a part of the design procedure that led to the development of the Type F apparatus. And, although this note was prompted by recent efforts to correlate watershed erosion with rainfall energy per unit volume, interest in rainfall simulators continues. Table 3 gives computed (or estimated) values for $(\overline{VD}-20)$ and rates of equivalent natural rainfall for several devices

that have been used. Descriptions of the sprays of the Type-F and Type-FA devices are given in Appendix II.

In an application to natural rainfall of varying intensity the ($\overline{VD}$-20) value for the whole or a part of a storm would be an average value derived by summing the values for the several intensity intervals, weighted in accordance with their relative contributions to the total volume of the rainfall considered. The use of a function like this in the analysis of watershed erosion to express the mean potential of unit volume of rainfall to increase the soil concentration in the runoff seems to involve a number of assumptions. Among these is the assumption that a watershed is composed of many small elements of area (of mean slope S and length L) over which sheet flow occurs without material rilling or flow concentrations. It seems, furthermore, that the application ignores the contribution to erosion of the deeper, concentrated flows; and also the losses of transported materials to deposits along the drainage ways. Applicability of the procedure decreases as ground cover increases.

Since for the general case, soil erosion is a complex process involving both raindrop impact and flow of the runoff waters over the land surface in an inseparable manner, an analysis of soil erosion under natural conditions must take into account the existence and the qualities of the runoff waters; perhaps

somewhat as was done in analyzing Neal's results. The equation that appears to satisfactorily align his data is essentially

$$Ca = FUSiL \quad (5)$$

Applying this to a natural event, the incremental contribution to storm soil loss per unit of watershed area is

$$rCa\ (\Delta t) = FUi\ (\Delta t)SrL.$$

Erosion occurs only while runoff from the elemental area is occurring; and the applicable storm rainfall volume and intensity values are those concurrent with runoff as sheet flow. Then the soil loss per unit area due to the storm, using the notions that $U = (\overline{VD}-20)$, $\bar{U} = \frac{\Sigma Ui\ (\Delta t)}{A}$, and that the other concepts are right,

$$\Sigma rCa(\Delta t) = FSL\Sigma rUi\ (\Delta t) \quad (6)$$

$$= FSLA\bar{U}\ f(r,i)$$

where A is the amount of storm rainfall during the runoff period and $\bar{U}$ is the weighted, mean, rainfall erosivity factor for the same period. And, if concurrent infiltration rates are small in comparison with the runoff rates of the sheet flow (or their ratio differs little from storm to storm), the concentration of the runoff should be approximately proportional to $FSL\bar{U}f(r,i)$ or

$$Ca \sim FSL\bar{U}f(r,i) \quad (7)$$

Application of these notions requires an evaluation of the factor f(i,r). The runoff rates over the elemental areas are

seldom known; but since these are somewhat related to rainfall rates, an average of the higher values of rainfall rate over some selected time period may be sufficiently related to f(r,i) to characterize a storm.

The problem then would be to determine the best time period over which to find an average rate. This time period would depend somewhat upon the mean slope and length of the elementary runoff areas and upon the surface configurations and the extent of cover. This is concluded because runoff rate for a given rainfall pattern is dependent upon depth of surface detention which is affected by these things. But this is now getting away from the subject of rainfall qualities.

The ability of rainfall or spray from irrigation equipment to reduce the water intake rate of the soil surface is also a function of the drop size and speed; but apparently a different function than the one that is proportional to the rain erosivity. In a few tests that Laws and Stoltenberg of the SCS made at Auburn, Alabama, in the 1940's, the logarithm of the intake rate, other things being equal, was proportional to (-kV); or symbolically,

$$\log f = -kV \psi(t) \quad \text{- - - - - - - - - - - - - - - - - - (8)}$$

or

$$f = k^{-V} \phi(t) \quad \text{- - - - - - - - - - - - - - - - - - - (9)}$$

Actually, knowledge is not yet adequate to have great confidence in any of the stated functions of drop size and speed that purport to describe the influence of rain or spray impact on erosion or infiltration. Energy per unit volume, which is proportional to ρV^2, is no exception, even though the correlation of the product of this with storm amount and rain intensity with small plot erosion, demonstrated by Wischmeier (16) and Smith is impressive.

The present use of the Function ($\overline{VD}$-20) as an indicator of the erosivity of rainfall should be made with the knowledge that it is still an expedient and presumptive procedure. Although the existing experimental data point to its applicability and preferability among the proposed indices, these data are too limited for conclusiveness. The test procedures required to obtain confirmation or disproval appear to be quite straightforward.

The indicated procedures are the application of sprays of differing intensity, drop size, and speed at impact to standardized soil plots of differing slope and length. Consideration should be given in such tests to the use of larger plots than those for the Washington tests in order to reduce the relative value of border effects. There is also need to consider procedural or analysis methods tending to assure more nearly equal plot erodibilities at the time of making comparisons of the results.

LIST OF SYMBOLS

A	=	The amount of storm rainfall during the time of runoff
Ca	=	Concentration of soil in the runoff water, tons/acre-inch
D	=	The diameter of spray drop, cm
f	=	Infiltration rate
F	=	A number that is descriptive of the erodibility of the soil surface
i	=	Rainfall rate, inches/hour
L	=	Length of the soil surface area, or distance of overland flow, feet
ρ	=	(rho) density of the liquid
r	=	Runoff rate, inches/hour
S	=	Slope of the soil surface
t	=	Time
Δt	=	Small increment of time
U	=	A number that is descriptive of the erosiveness of rainfall or sprinkler spray at impact with the soil surface
V	=	The speed of the spray drops at the instant of impact with the soil surface, cm/sec
$\overline{VD}$	=	ΣpVD = the summation of the products of drop speed and diameter for each of the several size groups, weighted in accordance with the proportion, p, that the weight of the drops in a size group bears to the total weight of the spray. cm^2/sec
U	=	The weighted mean value of U during a runoff period

TABLE 1.--Washington, D. C., erosion tests (1937 - 1938)

Prevailing values at the attainment of 2 inches of runoff

Test No.	Concentration tons/ac-in	Rainfall in/hr	Runoff rate in/hr	i/r (3) (4)	Infiltration, f in/hr	W**	FU	$\overline{VD}$ cm^2/sec
1	2	3	4	5	6	7	8	9
1*	0.10	2.66	2.05	1.30	0.61	0.422	0.18	37
3	0.11	3.85	2.84	1.36	1.01	0.548	0.15	32
4	1.27	3.46	3.01	1.15	0.45	0.576	1.92	219
5	0.55	5.05	4.16	1.21	0.89	0.760	0.60	75
6	0.40	3.07	2.30	1.34	0.77	0.462	0.64	--
7	0.40	4.18	3.60	1.16	0.58	0.670	0.51	64
8	0.40	3.28	2.30	1.43	0.98	0.462	0.61	89
9	0.33	3.23	2.62	1.23	0.61	0.513	0.52	89
10	0.63	3.20	2.62	1.22	0.58	0.513	1.01	134
11a	0.57	4.40	3.75	1.17	0.65	0.694	0.70	--
12	0.25	3.17	2.57	1.23	0.60	0.565	0.37	--
13	1.77	5.41	5.12	1.06	0.29	0.913	1.83	225

*Values for test (1) are extrapolated beyond an accumulated runoff of 0.85 inches.

W** = $(S^{\frac{1}{2}}/3) + SrL$

TABLE 2.--Values of $(\overline{VD}-20)$, cm^2/sec, for Natural Rainfall

Intensity, in/hr	Intensity, inches/hr									
	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	0	27	37	44	50	53	57	60	64	66
0.1	69	71	73	75	77	79	80	82	84	85
0.2	87	88	89	91	92	93	95	96	97	98
0.3	99	100	101	102	103	104	105	106	107	108
0.4	109	110	111	111	112	113	114	115	115	116
0.5	117	118	119	119	120	120	121	122	122	123
0.6	124	124	125	126	126	127	127	128	129	129
0.7	130	131	131	132	132	133	133	134	134	135
0.8	135	136	136	137	137	138	138	139	139	140
0.9	140	141	141	142	142	143	143	144	144	145

	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	145	149	153	157	161	164	167	171	173	176
2	179	182	185	187	189	191	194	196	198	200
3	202	204	206	208	210	211	213	215	217	218
4	220	222	223	225	226	228	229	231	232	233
5	235	236	238	239	240	241	243	244	245	246
6	248	249	250	251	252	254	255	256	257	258
7	259	260	261	262	263	264	265	266	267	268
8	269	270	271	272	273	274	275	276	277	278
9	279	280	280	281	282	283	284	285	286	286

VD is the product of raindrop speed and diameter.

TABLE 3.--Estimates of spray erosivity of artificial rainfall devices

Device	Nozzle	$(\overline{VD}\text{-}20)$ cm^2/sec	Equivalent Rainfall Rate ins/hr	References
Type C[(a)] Dripolator or Stalactometer	yarn strands	200	2.90	(6) (7)
Type D[(b)]	Grimmell 1.5	75	0.13	(8)
Colorado	Flaring Rose	80	0.16	(9)
Type E[(c)]	Young's Smiling Cat	80	0.16	(10) (11)
Type F[(c)]	Young's F nozzle	177	1.85	(9) (12) (13)
Type FA	Young's F nozzle	190	2.50	(13)
Meyer-McCune	SSC 80100 Veejet	126	0.64	(14) (15)

(a) Fall velocity depends upon height of drip frame. Table values are for 55 inches fall distance.

(b) Developed by F. W. Blaisdell.

(c) Developed by V. D. Young.

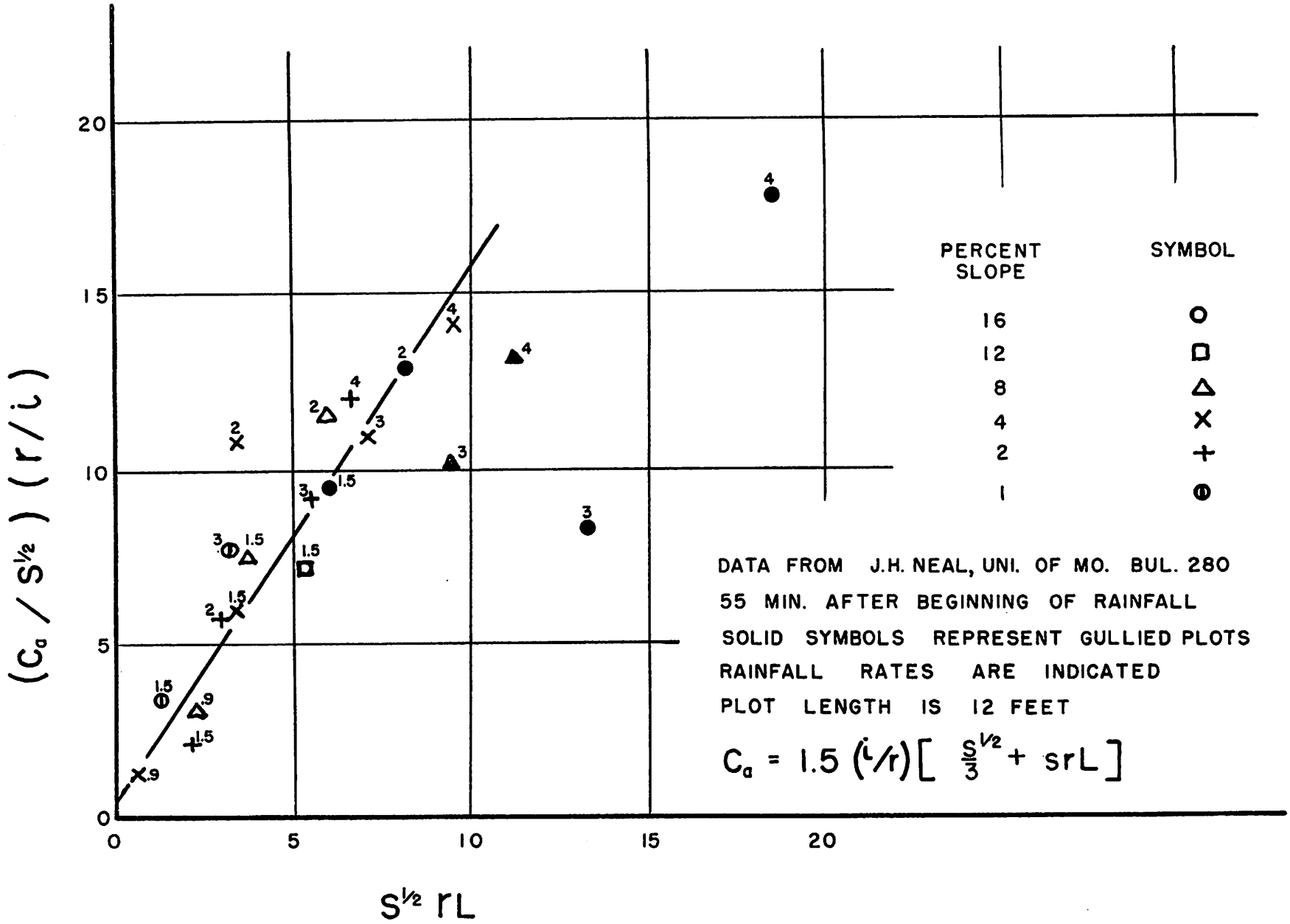
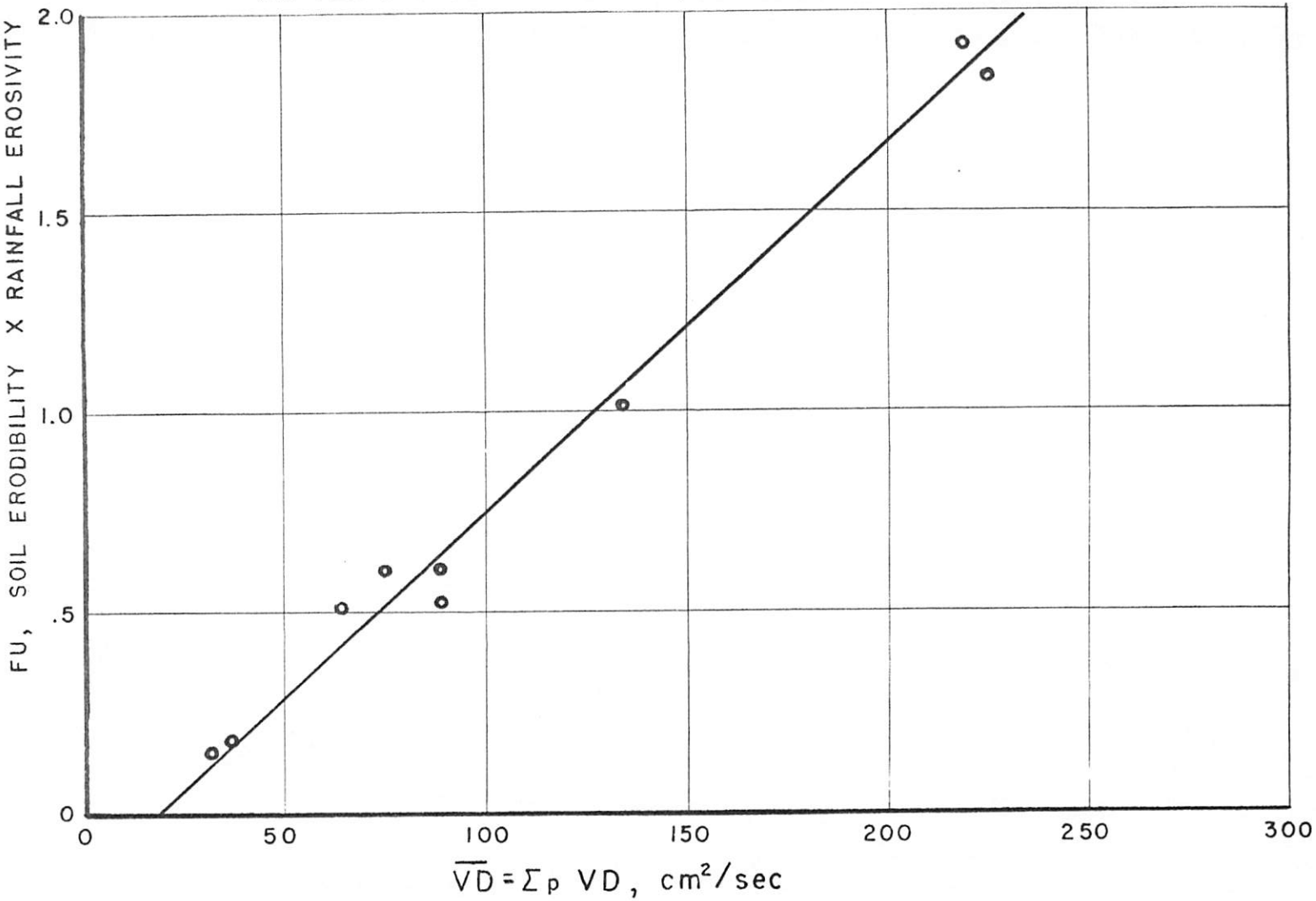


FIGURE 1 – THE EFFECTS OF RAINFALL RATE, SLOPE AND GULLYING ON EROSION

FIGURE 2 - COMPARISON OF COMPUTED RAINFALL EROSIVITY, U
WITH THE SUMMATION, $\overline{VD}$, PRODUCT OF DROP SIZE AND SPEED.
(AFTER 2 INCHES OF RUNOFF, WASHINGTON D.C. EROSION TESTS)



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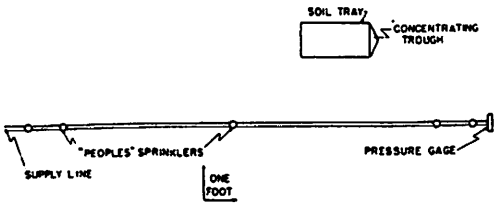
APPENDIX I

EROSION TEST NO. 1

RAIN SIMULATOR: Peoples Sprinklers operating at 12 pounds pressure, 1.9 meters above the soil surface. These nozzles were intended for lawn sprinklers. Operating under a pressure of 12 pounds per square inch, they gave a spray of fine drops fairly uniformly distributed over a circular area 12 feet in diameter.



Mass of average drop: mg	Diam. of average drop mm	Percent of total mass:
5.35	2.17	1.1
2.16	1.61	10.2
0.784	1.15	30.4
0.300	0.83	27.3
0.124	0.620	21.8
.0454	0.444	7.7
.0228	0.353	1.2
.00734	0.244	0.3

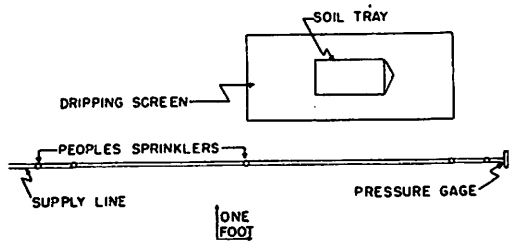
SOIL MOISTURE: 3.07%. HEIGHT OF FALL OF DROPS: 2.4 to 3.2 meters. RAIN INTENSITY: 3.85 in./hr.

RUN-OFF DATA

Time beaker was: Inserted: min.:sec.	Removed: min.:sec.	Mass of sample: grams	Mass of soil: grams	Concentration: percent	Accumulated run-off: inches	Remarks
0:0	15:0[a]	114[b]	.226[c]	---[f]	.00[f]	Run-off began at 15 min.
15:0	20:0	400[d]	.537	.149	.08	
20:0	24:0	403[d]	.987	.265	.15	a) This time known only to within 15 sec. of true value
24:0	27:0	403	1.122	.296	.24	
27:0	29:0	272	.947	.370	.29	b) Trickle from conc. trough but apparently no run-off from plot.
29:0	31:0	253	.695	.294	.34	
31:0	33:0	262	.609	.248	.40	c) This soil must have come from splashes into the conc. trough.
					.44	
35:0	37:0	284	.531	.198	.50	d) A little slopping occurred during change of beakers.
					.56	
39:0	41:0	272[e]	.602	.235	.61	e) Not sure of the order in which these samples were taken
					.67	
43:0	45:0	272[e]	.327	.128	.72	f) In computing these two columns a correction was made for 7.6 ml water falling on the conc. trough per minute, as measured by first sample.
					.78	
47:0	49:0	321[e]	.476	.156	.85	

EROSION TEST NO. 2

RAIN SIMULATOR: C-apparatus or "Dripolator" employing Peoples Sprinklers operating under 12 pounds pressure 15 inches above dripping screens which were 55 inches above the soil surface. The dripping screens were constructed of corrugated wire cloth covered with muslin thru which specially treated woolen yarn was threaded; they acted as converters, transforming the fine spray that fell on their upper surface into large drops that dripped from the strands of yarn. In this test the dripping screens were supported by a rigid frame.



Mass of average drop: mg	Diam. of average drop: mm	Percent of total mass:
77.0	5.29	5.3
63.2	5.04	8.6
50.3	4.60	20.7
42.2	4.33	57.7
27.2	3.73	4.2
1.13	1.29	3.5

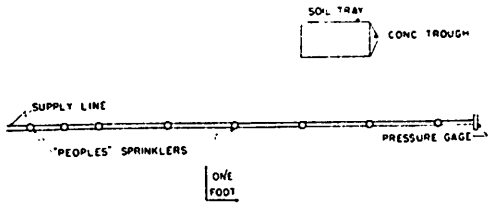
SOIL MOISTURE: Not measured. INTENSITY: 2.68 in./hr. HEIGHT OF FALL OF DROPS: 1.4 meters

RUN-OFF DATA

Time beaker was: Inserted: min.:sec.	Removed: min.:sec.	Mass of sample: grams	Mass of soil: grams	Concentration: percent	Accumulated run-off: inches	Remarks
0:0	12:00	277	7.15	2.56	.06	The drops fell in the same spots and quickly dug deep holes in the soil. Attempts to scatter the drops by jiggling the frame supporting the dripping screens and by playing a fan on the falling drops, were of no avail.
12:00	15:30	284	4.60	1.62	.12	
15:30	18:30	302	4.50	1.49	.18	
18:30	21:00	267	3.66	1.37	.24	
21:00	24:00	354	4.80	1.36	.31	
24:00	27:30	345	6.76	1.96	.38	
27:30	29:30	360	6.21	1.73	.46	
29:30	32:00	377	5.22	1.39	.53	
32:00	34:00	261	3.33	1.28	.59	
34:00	36:00	313	3.65	1.17	.66	
36:00	38:00	304	3.38	1.11	.72	
38:00	40:00	314	3.73	1.19	.78	
40:00	42:00	243	3.47	1.43	.84	
42:00	44:00	331	6.55	1.98	.90	
44:00	45:45	355	8.18	2.31	.98	
45:45	47:30	357	7.48	2.10	1.05	

EROSION TEST NO. 3

RAIN SIMULATOR: Peoples Sprinklers operating at 12 pounds pressure 15 inches above the soil surface. These nozzles were intended for lawn sprinklers. Operating at a pressure of 12 pounds per square inch, they gave a spray of fine drops fairly uniformly distributed over a circular area 12 feet in diameter.



Mass of average drop: mg	Diam. of average drop: mm	Percent of total mass:
5.35	2.17	1.1
2.16	1.61	10.2
.784	1.15	30.4
.300	.83	27.3
.124	.620	21.8
.0454	.444	7.7
.0228	.353	1.2
.000734	.244	.3

SOIL MOISTURE: 3.65%. INTENSITY: 3.85 in./hr. HEIGHT OF FALL OF DROPS: 1.0 to 1.8 meters

RUN-OFF DATA

Time beaker was: Inserted: min.:sec.	Removed: min.:sec.	Mass of sample: grams	Mass of soil: grams	Concentration: percent	Accumulated run-off: inches
0:0	3:30	21[a]		---[b]	.00[b]
3:30	7:00	345	.529	.164	.07
7:00	9:30	326	.446	.144	.13
9:30	12:00	328	.676	.216	.20
12:00	14:00	282	.616	.228	.26
14:00	16:15	325	.746	.240	.32
16:15	18:00	265	.573	.226	.38
18:00	20:00	322	.691	.224	.44
20:00	22:00	344	.600	.181	.51
					.66
26:00	27:45	335	.555	.171	.73
					.94
33:00	34:30	309	.458	.153	1.01
					1.20
39:00	40:30	323	.406	.129	1.27
					1.56
47:00	48:15	286	.317	.114	1.62
					2.04
57:15	58:45	327	.316	.099	2.10
65:00	66:00[c]	251	.265	.108	

Remarks

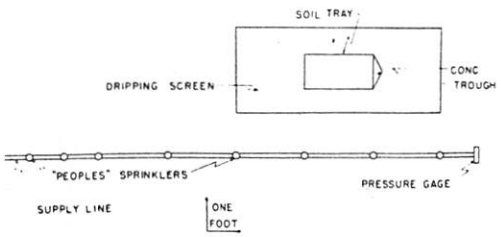
Run-off began at 3½ minutes

a) Sample indicates the amount of rain falling on conc. trough
b) These two columns computed after correcting for 6 ml falling on conc. trough per minute
c) Soil tray was covered at about 66 minutes

Intensity test began at 70 min., ended at 80 min.

EROSION TEST NO. 4

RAIN SIMULATOR: C-apparatus or "Dripolator" employing Peoples Sprinklers operating under 12 pounds pressure 15 inches above dripping screens which were 55 inches above the soil surface. The dripping screens were constructed of corrugated wire cloth covered with muslin thru which specially treated woolen yarn was threaded; they acted as converters, transforming the fine spray that fell on their upper surface into large drops that dripped from the strands of yarn. In this test the dripping screens were supported on a swinging frame.



Mass of average drop: mg	Diam. of average drop: mm	Percent of total mass:
77.0	5.29	5.3
63.2	5.04	8.6
50.3	4.60	20.7
42.2	4.33	57.7
27.2	3.73	4.2
1.13	1.29	3.5

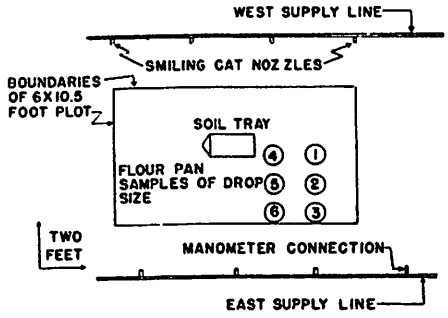
SOIL MOISTURE: 4.78% INTENSITY: 3.37 ins./hr. HEIGHT OF FALL OF DROPS: 1.4 meters

RUN-OFF DATA

Time beaker was: Inserted: min.:sec.	Removed: min.:sec.	Mass of sample: grams	Mass of soil: grams	Concentration: percent	Accumulated run-off: inches	Remarks
0:0	4:15	274	7.01	2.56	.06	Run-off began at 3 min. 15 sec.
4:15	7:15	339	5.76	1.70	.13	
7:15	9:00	371	5.77	1.56	.20	
9:00	10:15	257	3.58	1.40	.26	No rain fell on concentrating trough
10:15	11:30	256	3.51	1.37	.31	
11:30	12:45	257	3.63	1.41	.37	
12:45	14:00	261	3.46	1.32	.42	
14:00	15:15	272	3.66	1.35	.48	
15:15	16:30	269	3.58	1.33	.53	
16:30	17:45	280	3.80	1.36	.59	
17:45	19:15	326	4.11	1.26	.66	
19:15	20:45	325	4.12	1.27	.72	
20:45	22:00	284	3.32	1.18	.78	
22:00	23:28	312	3.63	1.16	.85	
23:28	24:45	298	3.49	1.17	.91	
24:45	26:15	334	4.04	1.21	.98	
26:15	27:30	283	3.28	1.16	1.04	
27:30	28:47	288	3.21	1.12	1.08	
28:47	30:15	328	3.81	1.16	1.17	
30:15	31:45	334	3.54	1.06	1.25	
31:45	33:15	331	3.47	1.05	1.31	
33:15	34:45	333	3.78	1.14	1.38	
34:45	36:15	331	3.39	1.02	1.45	
36:15	38:45	579	6.33	1.09	1.57	
38:45	41:00	529	5.78	1.09	1.68	
41:00	43:00	510	5.95	1.17	1.79	
43:00	45:15	542	6.12	1.13	1.90	
45:15	47:30	550	5.94	1.08	2.02	
47:30	49:45	570	5.84	1.02	2.14	
49:45	52:00	570	6.12	1.08	2.26	
52:00	54:30	604	6.38	1.06	2.39	
54:30	56:45	543	5.83	1.08	2.50	
56:45	59:00	541	5.80	1.07	2.62	Soil tray covered and intensity test begun at 64 min., ended at 74 min.
59:00	61:15	554	6.36	1.15	2.73	
61:15	63:15	524	6.08	1.16	2.84	

EROSION TEST NO. 5

RAIN SIMULATOR: E-apparatus operating under 3 pounds pressure, 6 feet above the soil surface. This apparatus was developed for field use and consisted in two supply lines running parallel with the plot along which Smiling Cat nozzles are staggered at intervals of 3½ feet as shown in the attached diagram. The so-called "Smiling Cat" nozzles were developed by V. D. Young as a modification of the Skinner Catfish nozzle.



Mass of average drop: mg	Diam. of average drop: mm	Percent of total mass:
12.7	2.90	2.1
5.09	2.14	23.6
2.06	1.59	42.4
.804	1.16	23.6
.280	0.815	6.6
.123	0.62	1.7

HEIGHT OF FALL OF DROPS: 2.0 to 2.3 meters

SOIL MOISTURE: 4.08% (top soil)
1.11% (sub soil)

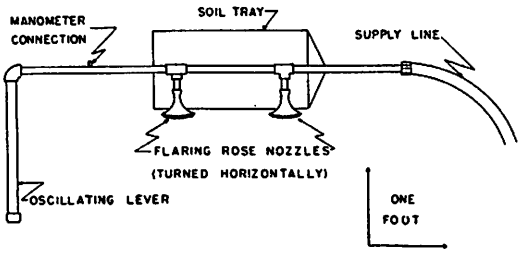
INTENSITY: 5.22 in./hr. (with splash walls)
4.89 in./hr. (without splash walls)

RUN-OFF DATA

Time beaker was: Inserted: min.:sec.	Removed: min.:sec.	Mass of sample: grams	Mass of soil: grams	Concentration: percent	Accumulated run-off: inches	Remarks
0:0	1:37	56	0.54	.969	.01	Run-off began at 1 min. 37 sec.
1:37	3:15	359	4.12	1.148	.09	
3:15	4:15	295	3.25	1.101	.15	
4:15	5:30	376	4.03	1.071	.23	Part of run-off lost
5:30	6:30	347	3.56	1.031	.30	
6:30	7:30	328	2.80	.854	.37	Water collected in s.w. corner of plot
7:30	8:30	353	2.95	.835	.44	
8:30	9:30	342	2.54	.744	.51	
9:30	10:30	330	2.23	.676	.58	
10:30	11:30	352	2.20	.625	.66	
11:30	12:30	356	2.06	.579	.73	
12:30	13:30	363	2.00	.551	.81	
13:30	14:30	350	1.76	.504	.88	
14:30	16:00	540			1.00	
16:00	17:00	369	1.79	.485	1.07	
17:00	18:30	547			1.19	
18:30	19:30	373	1.64	.439	1.27	
19:30	21:00	549			1.38	
21:00	22:00	316	1.53	.484	1.45	
22:00	23:30	543	2.07	.382	1.57	
23:30	24:30	366	1.36	.372	1.64	
24:30	26:00	557	2.06	.370	1.76	
26:00	27:00	358	1.28	.358	1.84	
27:00	28:30	554	1.99	.360	1.95	
28:30	29:30	368	1.27	.345	2.03	Splash walls removed at 29 min. 30 sec.
29:30	31:00	499	2.59	.519	2.13	
31:00	32:15	388	1.82	.469	2.22	
32:15	33:45	503			2.32	
33:45	34:45	322	1.52	.472	2.39	
34:45	36:15	486			2.50	
36:15	37:15	336	1.60	.476	2.57	
37:15	38:45	480			2.68	
38:45	39:45	314	1.39	.443	2.74	
39:45	41:30	581			2.86	
41:30	43:15	563			2.98	
43:15	45:15	617	2.79	.452	3.11	
45:15	47:00	565			3.23	
47:00	47:45	247	1.10	.447	3.28	
47:45	49:30	564			3.40	
49:30	50:15	242	1.12	.464	3.45	
50:15	53:15	991			3.66	
53:15	54:03	251	1.06	.423	3.72	
54:03	55:45	557			3.83	
55:45	56:15	170	0.75	.440	3.87	
56:15	58:00	579			3.99	Soil tray covered and first intensity test begun at 61 min., ended at 71 min.
58:00	58:30	170	0.76	.443	4.03	
58:30		860			4.20	

EROSION TEST NO. 6

RAIN SIMULATOR: Colorado "Rain Maker" operating at 1.3 pounds pressure 7 feet above the soil surface. This apparatus was developed and used in the field and consists of a supply line running down the center of the plot on which are mounted Flaring Rose nozzles at intervals of 16 3/4 inches. The supply line is mounted so that it can be rotated. In performing this test the spray was made to sweep from outside to outside of two boundaries placed 6 feet apart 44 to 56 times a minute.



Mass of average drop: mg	Diam. of average drop: mm	Percent of total mass:
12.5	2.89	1.7
5.10	2.14	19.3
2.08	1.59	47.3
0.926	1.21	30.9
0.334	0.87	0.5
0.112	0.60	0.3

HEIGHT OF FALL OF DROPS: 2.1 meters. (The effective height of free fall is somewhat greater since the drops possessed an initial downward velocity on leaving the nozzle.)

INTENSITY: 3.03 in./hr. first test
2.85 in./hr. second test
3.32 in./hr. third test
3.07 in./hr. average

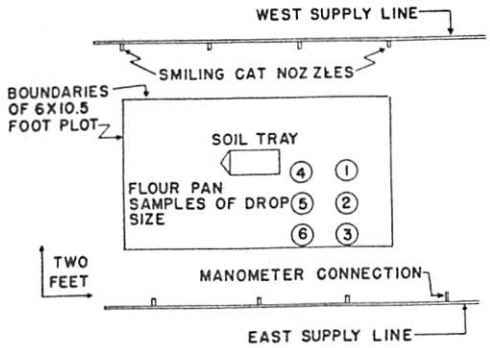
SOIL MOISTURE: Not measured.

RUN-OFF DATA

Time beaker was: Inserted: min.:sec.	Removed: min.:sec.	Mass of sample: grams	Mass of soil: grams	Concentration: percent	Accumulated run-off: inches	Remarks
0:0	3:30	44	.34	.773	.01	Run-off began at 3 min. 30 sec.
3:30	7:30	301	2.77	.920	.07	
7:30	10:30	340	2.67	.785	.14	Plot wetted in transverse streaks
10:30	13:15	397	2.97	.748	.23	
13:15	15:45	362	2.45	.676	.30	
15:45	17:45	283	1.64	.580	.36	
17:45	19:45	349	2.16	.619	.44	
19:45	22:45	518	2.96	.572	.55	
22:45	24:45	337	1.75	.519	.62	
24:45	27:45	510	2.47	.484	.72	
27:45	29:45	325	1.35	.415	.79	
29:45	32:45	562	2.41	.429	.91	
32:45	34:45	344	1.36	.395	.98	
34:45	37:45	497	1.76	.354	1.09	
37:45	39:45	366	1.44	.394	1.17	
39:45	42:45	592	2.18	.368	1.29	
42:45	44:45	363	1.23	.339	1.37	
44:45	47:45	543	1.82	.336	1.48	
47:45	49:45	356	1.26	.354	1.56	
49:45	52:45	443	1.47	.332	1.65	
52:45	54:45	205	.81	.395	1.70	
54:45	57:45	422	1.50	.356	1.78	Plot covered at 62 min. 35 sec. and third intensity test begun
57:45		305	.91	.298	1.85	

EROSION TEST NO. 7

RAIN SIMULATOR: E-apparatus operating under 4 pounds pressure, 6 feet above the soil surface. This apparatus was developed for field use and consisted in two supply lines running parallel with the plot along which Smiling Cat nozzles are staggered at intervals of 3½ feet as shown in the attached diagram. The so-called "Smiling Cat" nozzles were developed by V. D. Young as a modification of the Skinner Catfish nozzle.



Mass of average drop: mg	Diam. of average drop: mm	Percent of total mass:
15.0	3.07	0.3
9.75	2.66	0.7
4.87	2.11	15.2
1.95	1.56	34.2
0.768	1.09	33.3
0.296	0.830	11.3
0.128	0.628	5.0

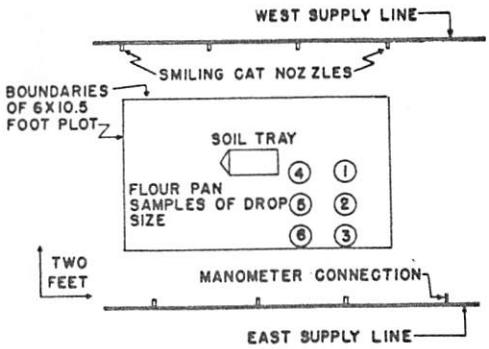
SOIL MOISTURE: 3.99% **INTENSITY:** 4.18 in./hr. **HEIGHT OF FALL OF DROPS:** 2.3 to 2.5 meters

RUN-OFF DATA

Time beaker was: Inserted: min.:sec.	Removed: min.:sec.	Mass of sample: grams	Mass of soil: grams	Concentration: percent	Accumulated run-off: inches	Remarks
0:0	2:00	27	.27	1.01	.01	Run-off began at 2 minutes
2:00	4:45	548	7.00	1.28	.12	
4:45	6:45	498	5.92	1.19	.22	After being prepared, the soil
6:45	9:45	776			.39	remained in the tray over night
9:45	11:45	551	3.89	.706	.50	before the test was begun.
11:45	14:45	824			.68	
14:45	16:45	572	2.84	.497	.80	
16:45	18:45	545			.91	
18:45	20:15	427	1.86	.436	1.00	
20:15	22:15	548			1.12	
22:15	23:45	406	1.64	.403	1.20	
23:45	25:45	554			1.32	
25:45	27:15	422	1.59	.376	1.41	
27:15	29:15	557			1.52	
29:15	30:45	425	1.51	.356	1.61	
30:45	32:45	562			1.73	
32:45	34:15	422	1.45	.345	1.82	
34:15	36:45	710			1.97	
36:45	38:15	425	1.43	.336	2.06	
38:15	40:45	719			2.21	
40:45	42:15	426	1.44	.338	2.30	
42:15	44:45	712			2.45	
44:45	46:15	429	1.43	.333	2.54	
46:15	48:45	721			2.70	
48:45	50:15	438	1.42	.325	2.79	
50:15	52:45	712			2.94	
52:45	54:15	442	1.47	.332	3.03	
54:15	56:45	735			3.19	
56:45	58:15	438	1.40	.320	3.28	
58:15	60:45	716			3:43	
60:45	62:15	434	1.38	.317	3.52	Soil tray covered and intensity
62:15		254			3.58	test begun at 63 minutes

EROSION TEST NO. 8

RAIN SIMULATOR: E-apparatus operating under 3 pounds pressure, 9 feet above the soil surface. This apparatus was developed for field use and consisted in two supply lines running parallel with the plot along which Smiling Cat nozzles are staggered at intervals of 3½ feet as shown in the attached diagram. The so-called "Smiling Cat" nozzles were developed by V. D. Young as a modification of the Skinner Catfish nozzle.



Mass of average drop: mg	Diam. of average drop: mm	Percent of total mass:
13.2	2.94	5.8
5.50	2.20	29.8
2.18	1.62	39.0
0.801	1.16	17.8
0.294	0.829	6.0
0.137	0.641	1.7

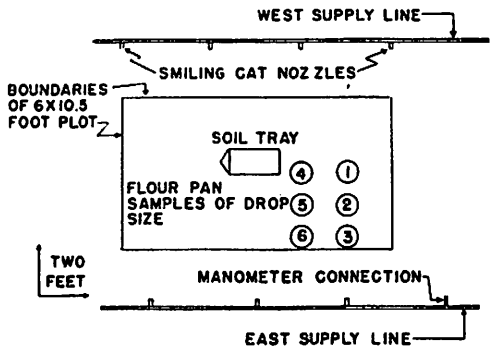
SOIL MOISTURE: 3.62% INTENSITY: 3.28 in./hr. HEIGHT OF FALL OF DROPS: 3.0 to 3.2 meters

RUN-OFF DATA

Time beaker was: Inserted: min.:sec.	Removed: min.:sec.	Mass of sample: grams	Mass of soil: grams	Concentration: percent	Accumulated run-off: inches	Remarks
0:0	3:30	25	.227	.091	.00	Run-off began at 3 min. 30 sec.
3:30	5:30	216	1.937	.896	.05	
5:30	7:30	296	2.597	.877	.11	Soil allowed to stand 4 hours
7:30	9:30	322	2.870	.891	.18	before beginning test
9:30	12:30	517			.29	
12:30	15:30	538	3.776	.702	.40	
15:30	19:30	729			.56	
19:30	22:00	470	2.473	.526	.65	
22:00	26:00	772			.82	
26:00	28:30	490	1.881	.384	.92	Noticed crevice in soil along
28:30	32:30	806			1.09	side wall
32:30	35:00	517	1.813	.351	1.20	
35:00	39:00	761			1.36	
39:00	41:30	465	1.429	.307	1.46	
41:30	45:30	768			1.62	
45:30	48:30	580	1.806	.311	1.74	
48:30	52:30	717			1.89	
52:30	55:30	529	1.407	.266	2.01	
55:30	59:30	748			2.17	
59:30	62:00	468	.933	.199	2.27	
62:00	66:15	824			2.44	Soil tray covered and intensity
66:15	68:45	490	.916	.187	2.54	test begun, at 76 min., ended
68:45	72:45	780			2.71	at 86 min.
72:45	75:15	499	.860	.172	2.82	Soil surface noted to be 1/4 in.
75:15		181			2.85	below crest of conc. trough

EROSION TEST NO. 9

RAIN SIMULATOR: E-apparatus operating under 3 pounds pressure, 9 feet above the soil surface. This apparatus was developed for field use and consisted in two supply lines running parallel with the plot along which Smiling Cat nozzles are staggered at intervals of 3½ feet as shown in the attached diagram. The so-called "Smiling Cat" nozzles were developed by V. D. Young as a modification of the Skinner Catfish nozzle.



Mass of average drop: mg	Diam. of average drop: mm	Percent of total mass:
13.2	2.94	5.8
5.50	2.20	29.8
2.18	1.62	39.0
0.801	1.16	17.8
0.294	0.829	6.0
0.137	0.641	1.7

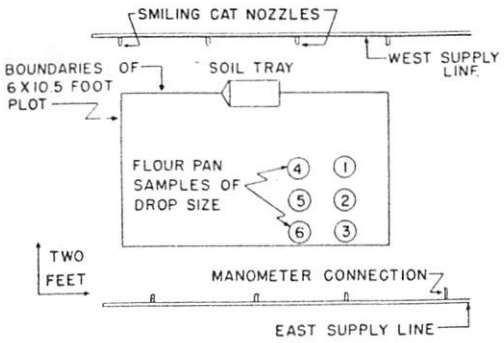
SOIL MOISTURE: 2.60% INTENSITY: 3.23 in./hr HEIGHT OF FALL OF DROPS: 3.0 to 3.2 meters

RUN-OFF DATA

Time beaker was: Inserted: min.:sec.	Removed: min.:sec.	Mass of sample: grams	Mass of soil: grams	Concentration: percent	Accumulated run-off: inches	Remarks
0:0	3:45	30	.26	.871	.01	Run-off began at 3 min. 45 sec.
3:45	6:45	337	2.36	.700	.08	
6:45	9:45	441	2.69	.610	.17	
9:45	12:45	511	3.09	.606	.28	
12:45	14:45	342	2.23	.652	.35	
14:45	16:45	363	2.22	.612	.42	
16:45	18:45	366	2.02	.552	.50	
18:45	22:45	750			.66	
22:45	24:45	388	1.58	.408	.74	
24:45	28:45	789			.91	
28:45	30:45	407	1.33	.328	.99	
30:45	34:15	696			1.14	Poor beaker changing
34:16	36:15	386	1.14	.296	1.22	
36:15	39:45	694			1.37	
39:45	41:45	404	1.15	.285	1.45	
41:45	45:15	696			1.60	
45:15	47:15	410	1.16	.284	1.69	
47:15	50:45	720			1.84	
50:45	52:45	417	1.12	.270	1.93	
52:45	56:15	715			2.08	
56:15	58:15	412	1.11	.269	2.16	
58:15	61:45	723			2.32	
61:45	63:45	416	1.14	.274	2.40	
63:45	67:15	721			2.56	No appreciable shrinkage of soil.
67:15	69:15	417	1.08	.260	2.64	Soil tray covered and intensity test begun at 72 min., ended at 82 min.
69:15		603			2.77	

EROSION TEST NO. 10

RAIN SIMULATOR: E-apparatus operating under 3 pounds pressure, 9 feet above the soil surface. This apparatus was developed for field use and consisted in two supply lines running parallel with the plot along which Smiling Cat nozzles are staggered at intervals of 3½ feet as shown in the attached diagram. The so-called "Smiling Cat" nozzles were developed by V. D. Young as a modification of the Skinner Catfish nozzle.



Mass of average drop: mg	Diam. of average drop: mm	Percent of total mass:
24.2	3.60	4.7
11.9	2.84	22.1
5.91	2.25	46.2
2.62	1.72	19.5
0.760	1.14	1.9
0.268	0.803	1.9
0.130	0.631	3.6

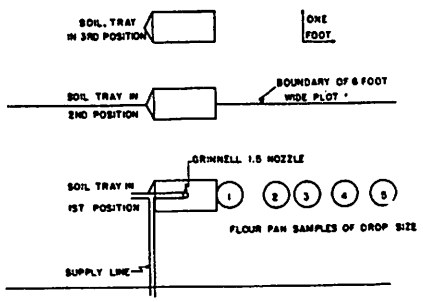
SOIL MOISTURE: 2.65% INTENSITY: 3.20 in./hr. HEIGHT OF FALL OF DROPS: 3.5 meters

RUN-OFF DATA

Time beaker was: Inserted: min.:sec.	Removed: min.:sec.	Mass of sample: grams	Mass of soil: grams	Concentration: percent	Accumulated run-off: inches	Remarks
0:0	2:45	34	.28	.827	.01	Run-off began at 2 min. 45 sec.
2:45	5:45	353	5.12	1.45	.08	
5:45	7:45	323	3.82	1.182	.15	Pitting of soil by drops appreciably greater on west side of soil tray
7:45	9:45	341	3.77	1.106	.22	
9:45	11:45	358	3.84	1.073	.30	
11:45	13:45	363	3.41	.940	.37	
13:45	15:45	371	3.12	.843	.45	
15:45	17:45	387	2.97	.768	.53	
17:45	19:45	387	2.74	.708	.61	
19:45	22:45	586			.74	
22:45	24:45	390	2.42	.622	.82	
24.45	27:45	606			.95	
27:45	29:45	400	2.34	.585	1.03	
29:45	32:45	601			1.16	
32:45	34:45	397	2.20	.555	1.24	
34:45	37:45	611			1.37	
37:45	39:45	399	2.10	.526	1.45	
39:45	42:45	603			1.58	
42:45	44:45	403	2.15	.533	1.67	
44:45	47:45	614			1.80	
47:45	49:45	419	2.28	.545	1.88	
49:45	52:45	624			2.02	
52:45	54:45	409	2.20	.540	2.10	
54:45	57:45	629			2.23	
57:45	60:45	640			2.37	
60:45	62:45	409	2.20	.538	2.46	
62:45	65:45	641			2.59	
65:45	68:45	633			2.72	
68:45	70:45	435	2.45	.563	2.82	
70:45	73:45	642			2.95	
73:45	76:45	631			3.08	
76:45	78:45	423	2.40	.567	3.13	Intensity test began at 80 min., ended at 90 min.
78:45		317			3.24	

EROSION TEST NO. 11

RAIN SIMULATOR: D-apparatus operating under 5½ pounds pressure, 6.9 feet above the soil surface. This apparatus developed by F. W. Blaisdell of this laboratory, was designed for field use. It employed a nozzle commercially available and intended for fire extinguishing systems, the Grinnell 1.5 nozzle. When pointed downward and operating under a pressure of 5½ pounds per square inch, 7 feet above the plot, the nozzle threw a spray of fair uniformity over a circular area 14 feet in diameter.



Mass of average drop: mg	Diam. of average drop: mm	Percent of total mass: Sample No. 1	2	3	4	5
83	5.4	0.0	0.0	0.0	0.0	2.5
32	4.0	0.0	0.0	0.0	0.0	5.7
24	3.6	0.0	0.0	0.0	1.5	7.8
20	3.4	0.0	0.0	0.0	1.1	4.7
15	3.1	10.0	9.9	6.2	6.5	19.0
6.5	2.3	25.2	14.1	11.7	21.4	26.7
2.4	1.7	27.5	20.6	24.7	33.0	19.0
0.84	1.2	20.4	21.3	35.3	27.7	6.4
0.30	0.8	10.0	19.5	18.5	6.0	2.7
0.057	0.5	6.9	14.6	3.6	3.8	5.4

HEIGHT OF FALL OF DROPS: 2.1 meters
(The effective height of fall is somewhat greater since the drops possessed an initial downward velocity on leaving the nozzle.)

SOIL MOISTURE: 2.71%

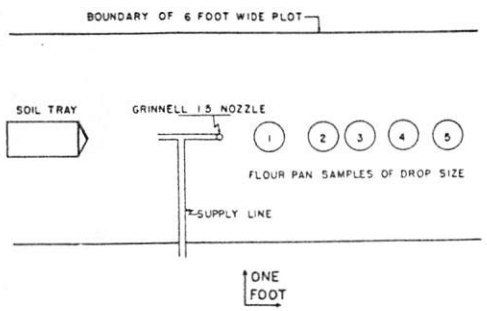
INTENSITY: 4.40 in./hr. first location
2.89 in./hr. second location
2.65 in./hr. third location

RUN-OFF DATA

Time beaker was: Inserted: min.:sec.	Removed: min.:sec.	Mass of sample: grams	Mass of soil: grams	Concentration: percent	Accumulated run-off: inches	Remarks
0:0	2:15	30	.286	.953	.01	Run-off began at 2 minutes
2:15	3:45	252	3.572	1.420	.06	
3:45	4:45	226	2.195	.971	.11	
4:45	6:15	353	3.296	.934	.18	
6:15	7:15	250	2.405	.962	.23	
7:15	10:15	779			.40	
10:15	11:15	262	2.161	.825	.45	
11:15	13:15	546			.57	
13:15	14:15	272	2.045	.752	.62	
14:15	16:15	557			.74	
16:15	17:30	350	2.276	.650	.82	
17:30	20:00	707			.96	
20:00	21:00	285	1.574	.552	1.02	
21:00	23:00	568			1.14	
23:00	24:30	433	2.342	.541	1.24	
24:30	27:00	721			1.39	
27:00	28:30	431	2.192	.508	1.48	
28:30	31:00	731			1.63	
31:00	32:30	453	2.280	.503	1.73	
32:30	35:00	879			1.91	
65:00	67:00	136	.520	.382		Soil tray covered and first intensity test made; then the soil tray was moved to second location; run-off recommences at 67 min.
67:00	69:00	291	.793	.273		
69:00	71:00	306	.766	.250		
71:00	74:00	506	1.214	.240		
74:00	78:00	725				
78:00	81:00	560	1.218	.218		
81:00	85:00	728				
85:00	88:00	541	1.200	.222		
88:00	92:00	717				
92:00	95:00	545	1.095	.201		
95:00	97:00	414				
127:00	132:00	488	1.006	.206		Soil tray covered and second intensity test made; then the soil tray was moved to third location.
132:00	135:30	523				
135:30	139:00	531	1.037	.195		
139:00	143:30	714				
143:30	146:30	465	.994	.214		
146:30	151:00	715				
151:00	154:00	488	1.101	.226		
154:00	155:00	190				

EROSION TEST NO. 12

RAIN SIMULATOR: D-apparatus operating under 5½ pounds pressure, 6.9 feet above the soil surface. This apparatus developed by F. W. Blaisdell of this laboratory, was designed for field use. It employed a nozzle commercially available and intended for fire extinguishing systems, the Grinnell 1.5 nozzle. When pointed downward and operating under a pressure of 5½ pounds per square inch, 7 feet above the plot, the nozzle threw a spray of fair uniformity over a circular area 14 feet in diameter.



Mass of average drop: mg	Diam. of average drop: mm	Percent of total mass:
16.3	3.16	7.9
6.71	2.35	12.9
2.34	1.65	22.7
0.816	1.16	28.7
0.351	0.88	19.0
0.058	0.48	8.8

Average of samples 2 and 3

HEIGHT OF FALL OF DROPS: 2.1 meters. (The effective height of fall is somewhat greater since the drops possessed an initial downward velocity on leaving the nozzle.)

SOIL MOISTURE: Not measured.

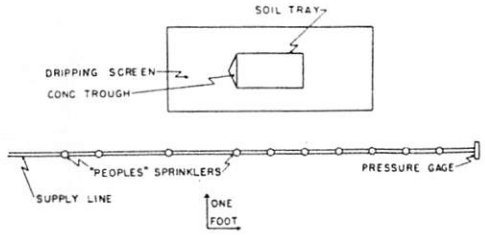
INTENSITY: 3.17 in./hr.

RUN-OFF DATA

Time beaker was: Inserted: min.:sec.	Removed: min.:sec.	Mass of sample: grams	Mass of soil: grams	Concentration: percent	Accumulated run-off: inches	Remarks
0:0	3:30	15	.088	.604	.00	Run-off began at 3 min. 15 sec.
3:30	4:30	79	.616	.784	.01	
4:30	5:30	104	.554	.535	.03	
5:30	6:30	127	.548	.433	.06	
6:30	7:30	132	.593	.450	.09	
7:30	9:30	294	1.243	.423	.15	
9:30	11:30	322	1.460	.454	.22	
11:30	13:30	329	1.364	.415	.29	
13:30	15:30	337	1.373	.408	.36	
15:30	17:30	350	1.346	.384	.43	
17:30	19:30	370	1.349	.364	.51	
19:30	21:30	358	1.226	.343	.58	
21:30	23:30	374	1.299	.347	.66	
23:30	25:30	373	1.229	.330	.74	
25:30	27:30	389	1.342	.346	.82	
27:30	29:30	389	1.277	.329	.91	
29:30	31:30	386	1.177	.305	.99	
31:30	35:30	796			1.16	
35:30	37:30	404	1.077	.265	1.24	
37:30	41:30	797			1.41	
41:30	43:30	408	.985	.241	1.50	
43:30	47:30	808			1.67	
47:30	49:30	407	.890	.219	1.75	
49:30	53:30	834			1.93	
53:30	55:30	398	.906	.228	2.01	
55:30	59:30	818			2.18	Soil tray covered and intensity test begun at 62 min., ended at 77 min.
59:30	61:30	405	.815	.201	2.27	
61:30		131			2.30	

EROSION TEST NO. 13

RAIN SIMULATOR: C-apparatus or "Dripolator" employing Peoples Sprinklers operating under 12 pounds pressure 15 inches above dripping screens which were 55 inches above the soil surface. The dripping screens were constructed of corrugated wire cloth covered with muslin thru which specially treated woolen yarn was threaded; they acted as converters, transforming the fine spray that fell on their upper surface into large drops that dripped from the strands of yarn. In this test the dripping screens were supported on a swinging frame.



Mass of average drop: mg	Diam. of average drop: mm	Percent of total mass:
121.0	6.15	2.6
95.8	5.67	7.2
93.2	5.63	1.4
77.0	5.28	4.6
63.2	4.94	7.6
50.4	4.58	19.4
42.2	4.33	50.6
27.1	3.74	3.7
1.12	1.29	3.1

SOIL MOISTURE: Not measured. INTENSITY: 5.41 in./hr. HEIGHT OF FALL OF DROPS: 1.4 meters

0:0	1:45	28	.37	1.34	.01	Run-off began at 1 min. 45 sec.
1:45	3:00	226	6.89	3.05	.05	
3:00	4:00	305	6.09	1.98	.12	
4:00	5:00	332	6.13	1.84	.18	
5:00	6:00	358	6.76	1.89	.26	
6:00	7:30	554	9.73	1.76	.37	
7:30	8:32	387	6.55	1.69	.46	
8:32	9:32	391	6.18	1.58	.54	
9:32	10:30	345	5.38	1.56	.61	
10:30	11:30	385	6.53	1.69	.69	
11:30	12:30	385	5.96	1.55	.77	
12:30	13:30	382	5.94	1.55	.85	
13:30	15:30	794			1.02	
15:30	16:30	405	5.85	1.44	1.10	
16:30	18:30	789			1.26	
18:30	19:30	394	5.50	1.40	1.35	
19:30	21:30	800			1.51	
21:30	22:30	419	6.49	1.55	1.60	
22:30	24:30	817			1.77	
24:30	25:30	403	6.18	1.53	1.86	Water pressure observed to be at 14 lbs., reduced to 12 lbs.
25:30	27:30	837			2.03	
27:30	28:30	410	6.23	1.52	2.12	
28:30	30:30	819			2.29	
30:30	31:30	407	6.49	1.59	2.37	
31:30	33:30	815			2.54	
33:30	34:30	400	6.29	1.57	2.62	
34:30	36:30	832			2.80	
36:30	37:30	404	6.88	1.67	2.88	
37:30	39:30	799			3.05	
39:30	40:30	423	7.16	1.70	3.14	
40:30	42:30	840			3.31	
42.30	43.30	398	6.84	1.73	3.39	
43:30	45:30	803			3.56	
45:30	47:30	804			3.73	
47:30	48:30	415	7.27	1.75	3.82	
48:30	50:30	800			3.98	
50:30	52:30	803			4.15	
52:30	53:30	416	7.39	1.78	4.24	
53:30	55:30	800			4.40	
55:30	57:30	807			4.57	
57:30	58:30	410	7.59	1.85	4.65	Soil tray covered and intensity test begun at 60 min., ended at 66 min.
58:30		647			4.79	