Role of Moisture Conservation Practices for Semi-Arid Condition of Gujarat

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ABSTRACT

A field experiment was conducted during 1975-76 and 1976-77 at the B. A. College of Agriculture farm of the Gujarat Agricultural University at Anand under semi-arid condition to evaluate certain moisture conservation practices and subsequent utilization of moisture thus stored for sorghum and castor. Ridging and furrowing was found to be superior among different practices for conserving soil and moisture during crop growth period. Considering the values of both the seasons for test crops, hybrid sorghum 'CSH-1' and its ratooning gave the maximum production stability under both below and above average rainfall years. Recycling of runoff water was also found effective in increasing the yields. Runoff from the test crops was the heighest in the case of shallow ploughing followed by deep ploughing and ridges and furrows. However, reverse was the trend in respect of soil loss in runoff water.

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INTRODUCTION

The basic characteristic of semi- arid region is the wide spectrum of soil moisture regime under which crop production is followed. Moisture conditions range from season to season, predominating with below average conditions. It is, therefore, imperative to work out production methods that possess orientation towards such varied unpredictable situation.

Moisture conservation through tillage plays an important role in securing high crop yields. Its efficiency depends mainly upon the depth of cultivation to maximise moisture storage capacity of the soil and shaping of soil surface to reduce the water runoff and increase the infiltration rate of rain water. Among the systems of water harvesting, inter-row water harvesting appeared to be more practical as well as feasible and acceptable to farmers as no land was sacrificed for harvesting of water (Anonymous, 1975) as has been found under ridges and furrows lay out.

Increasing the depth of tillage has been reported to be beneficial for crop production by Malik *et al.* (1973) and Anonymous (1974). Talati and Mehta (1963) also have reported increased yield of pearl millet by 35 per cent on account of tractor ploughing 36 cm deep against ploughing with local wooden plough to a depth of 10 cm.

Paucity of information on moisture conservation by tillage practices with

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special reference to intra-plot water harvesting technique was the guiding factor behind the planning of present study.

MATERIALS AND METHODS

This field experiment was laid out on sandy loam soil of the Agronomy Farm of the B. A. College of Agriculture, Anand. Slope of the experimental site was 0.54 per cent in North-South direction and 0.19 per cent in the East-West direction in 1975-76. In 1976-77, slope of the experimental site was 0.65 per cent in the North-South direction and 0.21 in the East-West direction. The design of the experiment was a split-split plot with four replications. Each replication embodied combination of three moisture conservation practices (M) as main-plot treatments viz. M_1-shallow ploughing with bullock drawn country plough to a depth of about 10 cm, M_2-deep ploughing with a tractor operated mouldboard plough to a depth of about 30 cm and M_3-ploughing with a tractor operated mouldboard plough to a depth of about 30 cm and preparation of 45 cm wide ridges and furrows. Two test crops (C) as sub-plot treatments viz., C_1-'CSH-1' sorghum hybrid and its ratoon and C_2-'GCH-3' castor hybrid. Two treatments of recycling of runoff water (R), R_1-without recycling of water and R_2-with recyling of water occupied the sub-sub-plots.

Empty asphalt drums were embodied in the soil keeping 5 cm above ground level in the direction of slope for each plot (Fig. 1). The channels prepared from iron sheets were placed on the drums at the ground level of the plots to facilitate conveyance of runoff water from plots. The drums were covered with lids to check evaporation and avoid addition of direct rain water into them.

Runoff collected in the drums during each event was measured with the help of measuring cylinder. For determination of soil loss, samples of 100 cc of runoff water were taken per litre of runoff water. To tide over the problem of storage of large quantities of runoff water, it was disposed off after measurement and sampling for soil loss in runoff water.

Measured quantity of fresh water equivalent to runoff water was applied for recycling depending on the actual deficit of available soil mositure (Dastane, 1972) in the respective treatments.

Meteoroligical data recorded during the period of investigation are presented in Table 1. The rainfall received during the growth of test crops was 725.70 and 1246.99 mm in the years 1975-76 and 1976-77, respectively. In 1975-76, the monsoon ceased by the October while in 1976-77, 102.90 mm rain was received in four rainy days in November, 1976.

RESULTS AND DISCUSSION

Effect of moisture conservation practices:

The data indicated significant effect of different moisture conservation practices during both the years (Table 2).

The lowest grain yield under sorghum was obtained under shallow ploughing (10 cm) in both the years. It increased progressively with the increase in the depth of ploughing and preparing ridges and furrows. In the first year of study, the increase in the grain yield under deep ploughing over shallow plou-

ghing was 16.37 per cent. On the other hand under the ridges and furrows treatment, the increase was 60.26 per cent. For second year, the corresponding increases were 12.67 and 17.21 per cent, respectively. The results of pooled data

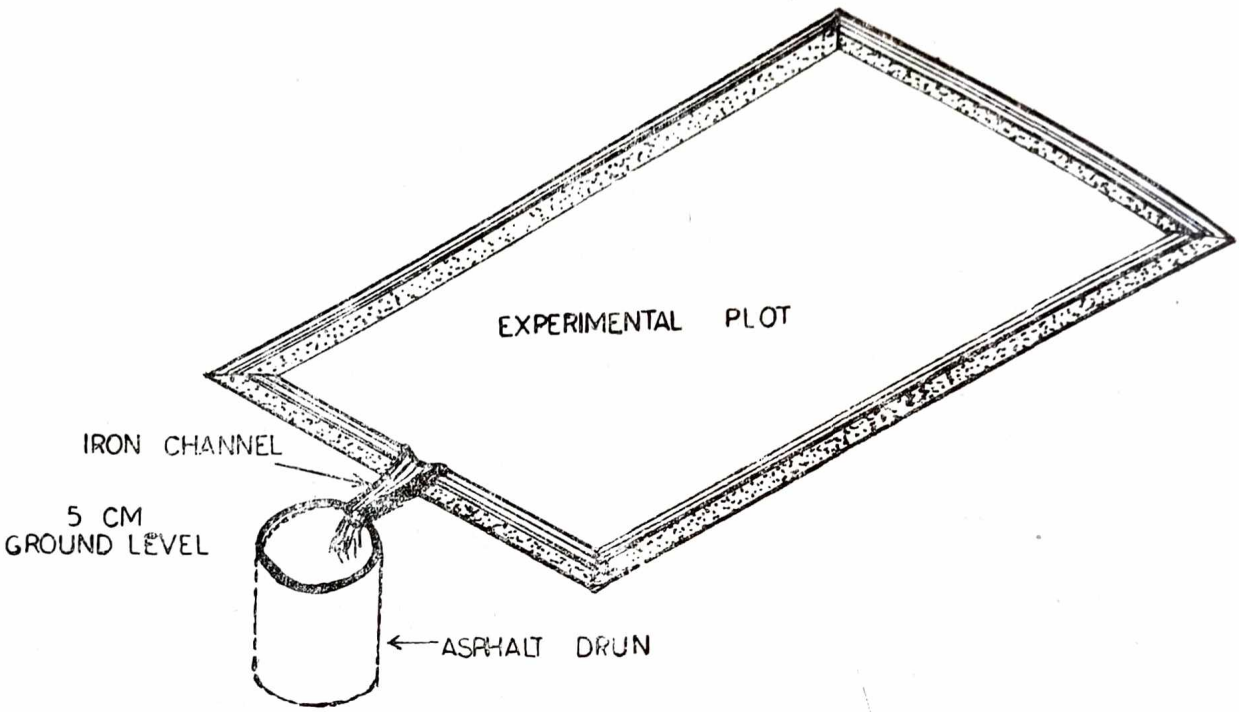

FIG: 1 EMBODIED ASPHALT DRUM IN SOIL

showed 25.06 and 49.30 per cent increases under deep ploughing and ridges and furrows, respectively over shallow ploughing. It was thus evident that for securing the maximum grain yield from sandy loam soil, it is necessary to cultivate soil up to a depth of 30 cm with tractor drawn mouldboard plough. Ridges and furrows layout also reduced water runoff as well as soil loss in the runoff water (Table 4). Tejwani *et al.* (1971) observed maximum water loss from bare fallow plot, whereas the maxmum soil loss occurred in bare fallow ploughed plot. Verma *et al.* (1979) in a similar study concluded that deep tillage (25 cm depth) reduced the runoff. Moreover, even after enhancing profile water storage through deep tillage, considerable amount of runoff could be harvested for protective irrigation.

For sorhgum ratoon, the lowest yield of grain was obtained under shallow ploughing during both the years. In the first year of study, the increase in the grain yield under deep ploughing over shallow ploughing was 36.45 per cent. Under ridges and furrows treatment the increase was 22.64 per cent. The respective increases were 34.58 and 20.80 per cent in 1976-77 and 35.34, 21.55 per cent for pooled data.

Interaction of moisture conservation practices and recycling of runoff water was significant during both the years and also in respect of pooled data. (Table 3). The results of both the years as well as pooled data indicated that when the water was recycled, the highest grain yield was secured from deep ploughing treatment. This clearly brought out the fact that for securing the maximum

TABLE 1

Meteorological data recorded at the meteorological observatory of the college farm of the Gujarat Agricultural University at Anand, during 1975-76 and 1976-77.

Month	*Rainfall, mm*		*Number of rainy days**		*Evaporation from U.S.W.B. evaporimeter, mm*		*Mean monthly max. temp. °C*		*Mean monthly min. temp. max. temp. °C*		*Mean monthly R.H. per cent*		*Mean monthly velocity, kph*		*Mean daily duration of bright sunshine hrs.*	
	75-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77	75-76	76-77
June	117.09	423.16	5	5	260.9	216.3	36.69	30.43	25.86	25.68	81.37	88.35	5.79	10.62	6.22	7.28
July	128.30	377.04	6	14	154.2	154.1	32.11	31.61	24.97	24.58	86.69	91.28	3.70	8.05	6.33	6.67
Aug.	284.30	562.40	9	12	164.2	102.6	30.69	29.14	25.38	23.86	85.05	88.73	2.90	7.72	3.18	2.42
Sep.	216.70	135.20	10	5	104.9	113.9	30.67	30.64	25.28	23.25	79.80	81.03	**	7.40	5.87	6.20
Oct.	83.20	—	3	—	135.1	138.6	31.72	35.08	22.07	19.89	81.55	75.53	**	6.28	6.88	6.42
Nov.	—	102.90	—	4	119.8	119.9	29.24	29.16	13.80	19.65	64.38	74.35	12.87	3.86	7.20	8.03
Dec.	—	—	—	—	193.7	89.9	28.17	27.43	10.56	13.04	70.56	66.80	3.70	3.86	8.48	9.38
Jan.	—	—	—	—	95.7	122.2	27.57	26.33	13.94	10.64	77.78	66.18	4.67	4.50	9.03	9.35
Feb.	—	—	—	—	129.0	130.2	28.89	29.89	11.56	13.17	75.98	64.75	4.67	4.02	9.07	9.75
Mar.	—	—	—	—	202.6	215.2	35.52	26.72	16.15	16.53	73.90	54.53	4.83	3.86	9.75	10.58
Apr.	—	—	—	—	250.1	243.8	37.00	37.28	19.44	22.41	77.35	66.80	5.79	5.79	10.00	9.02
May	—	—	—	—	298.5	287.5	38.38	38.58	25.54	25.35	82.68	69.20	8.53	8.21	10.57	10.52

*Any day receiving rainfall of more than 5 mm in 24 hours was considered as a rainy day.

**Not available.

Effect of moisture conservation practices and recycling of runoff water on the grain/seed and stalk yield (kg/ha) of test crops.

Treatmens	Grain/seed yield									Stalk yield*							
	Sorghum			Sorghum ratoon			Castor			Sorghum			Sorghum ratoon			Castor	
	1975-76	1976-77	Mean	1975-76	1976-77	Mean	1975-76	1976-77	Mean	1975-76	1976-77	Mean	1975-76	1976-77	Mean	1975-76	1976-77	Mean
Moisture conservation practices (T)																		
T_1 Shallow ploughing	3483	3833	3659	963	1096	1030	1196	1735	1465	4393	6101	5247	3339	4928	4133	4488	5403	4945
T_2 Deep ploughing	4053	5100	4576	1314	1475	1394	1735	1881	1808	6157	6954	6555	4497	5950	5223	6492	6542	6517
T_3 Ridges and furrows	5382	5545	5463	1181	1324	1252	1742	2098	1920	6470	8404	7437	4546	5747	5146	6751	6644	6697
S. Em. ±	128	141	123	29	30	20	39	69	41	228	125	—	106	111	—	294	287	—
CD at 5%	443	490	369	100	103	61	134	240	123	791	431	—	367	385	—	1020	993	—
C.V. %	8	8	8	7	7	7	7	10	9	11	5	—	7	6	—	14	13	—
Recycling of water (R)																		
R_1 Runoff water not applied	4367	4740	4553	986	1112	1050	1395	1815	1604	5472	7150	6311	3580	4876	4228	5236	5669	5452
R_2 Runoff water applied	4245	4912	4579	1318	1439	1401	1720	1994	1858	5880	7156	6518	4579	6207	5393	6584	6722	6653
S. Em. ±	178	12	107	21	21	15	28	52	30	117	194	—	54	118	—	218	339	—
C.D. at 5%	N.S.	N.S.	N.S.	68	67	45	89	166	83	N.S.	N.S.	—	171	411	—	698	N.S.	—
C.V%	14	9	12	6	6	6	6	9	8	11	9	—	5	7	—	13	19	—

*Pooled analysis of stalk yields not carried out.

TABLE 3

Interaction of moisture conservation practices and recycling of water (M x R) on grain yield of sorghum ratoon and seed yield of castor, kg/ha.

M \ R	Sorghum ratoon						Castor					
	1975-76		1976-77		Mean		1975-76		1976-77		Mean	
	R_1	R_2	R_1	R_2	R_1	R_2	R_1	R_2	R_1	R_2	R_1	R_2
M_1	848	1078	966	1227	907	1153	1102	1291	1626	1844	1364	1568
M_2	1021	1606	1133	1815	1077	1711	1375	2095	1806	1956	1591	2026
M_3	1090	1272	1238	1410	1164	1341	1708	1775	2012	2185	1860	1980
S.Em.	37		36		26		48		89		N.S.	
C.D. at 5%	117		115		77		155					

yield from sorghum ratoon under middle Gujarat condition, it is advisable to plough the soil up to 30 cm depth and recycle the runoff water harvested from the main crop of sorghum.

On the whole, the yield of sorghum combined with its ratoon was the maximum under ridges and furrows as compared with deep ploughing and shallow ploughing treatments.

In regard to castor, the lowest seed yield was recorded under shallow ploughing during both the years. The increases in the seed yield were 45.07 and 45.65 per cent in the year 1975-76; 8.41 and 20.92 per cent in the year 1976-77; while 23.41 and 31.06 per cent for the pooled data for deep ploughing and ridges and furrows treatments over shallow ploughing, respectively. This revealed that for producing the maximum seed yield it is advisable to prepare ridges and furrows lay out after ploughing the land up to 30 cm depth.

Effect of recycling of water:

Main crop of sorghum was not recycled with runoff water during both the years of experimentation as it was harvested before recycling of runoff water was necessary.

The effect of recycling of runoff water on grain yield of sorghum ratoon was found to be significant during both the years and also in the case of the pooled data. Stalk yield was also found to be significant during both the years. In the case of pooled data with the application of runoff, the increase in the grain yield was 33.42 per cent in comparison with that obtained from the treatment without recycling. Singh (1977), Krishnamoorthy (1977) and Verma *et al.* (1978, 1979) also reported such increases due to application of runoff water. The effect of recycling of water on seed yield of castor was found to be significant for both the years and also in respect of the pooled data. For the pooled data, the application of runoff water increased the seed yield by 15.83 per cent over the control. Tejwani (1979) also reported that 5 cm harvested runoff water applied either at presowing or at crown root initiation stage increased the yield of wheat grain by 57 per cent under rainfed condition at Dehradun.

The interaction between moisture conservation practices and recycling of runoff treatments was significant for the year 1975-76 and for pooled data. Under the shallow ploughing and deep ploughing, there was a significant difference between the effects due to recycling of runoff water and no recycling of runoff water. However, such differences under ridges and furrows were not significant. Similar results were also recorded for the pooled data (Table 4).

The stalk yield differences due to water recycling treatment were significant during 1975-76 only. There was 102.90 mm of rainfall received in November, 1976, which was unusual. This favoured the crop growth. Hence, the effect of recycling of runoff water on stalk yield was nullified in 1976-77.

Economics:

The study of main effects of the different moisture conservation practices indicated maximum net profit from the ridges and furrows treatment for sorghum, sorghum + sorghum ratoon and castor in both the years (Table 5). This was because of increased gross realiza-

TABLE 4

Effect of different treatments on water runoff and soil loss in runoff water.

Treatments	*Runoff, mm/ha*		*Soil loss, tonne/ha*	
	1975-76	1976-77	1975-76	1976-77
Moisture conservation practice (M)				
M_1–Shallow ploughing	215.6	282.5	2.4	2.6
M_2–Deep ploughing	167.9	224.4	2.5	2.9
M_3–Ridges and furrows	84.6	105.0	1.2	1.4
S. Em. ±	4.9	6.9	0.05	0.09
C.D. at 5%	17.8	23.9	0.18	0.22
C.V.%	12.7	13.6	10.2	11.1
Crop (C)				
C_1–Sorghum	150.6	206.8	1.9	2.2
C_2–Castor	161.6	204.2	2.0	2.4
S. Em. ±	3.6	3.2	0.07	0.07
C. D. at 5%	N.S.	N.S.	N.S.	N.S.
C.V.%	11.3	7.7	17.3	15.9
Recycling of water (R)				
R_1–Runoff water not applied	154.2	203.7	2.0	2.2
R_2–Runoff water applied	157.9	204.2	2.1	2.3
S. Em. ±	5.9	7.5	0.05	0.05
C.D. at 5%	N.S.	N.S.	N.S.	N.S.
C.V.%	18.7	18.3	10.9	11.9

tion from that treatment as compared to other treatments with proportionally slight increase in cost of cultivation.

The data of sorghum ratoon revealed negligible difference in net profit between deep ploughing and ridges and furrows treatments during both the years. These treatments were highly profitable as compared to shallow ploughing treatment. This was due to reduced yield under shallow ploughing.

The treatment of recycling of runoff water was more profitable than the treatment without recycling of runoff water during both the years for sorghum ratoon, sorghum + sorghum ratoon and castor because of increased yields due to recycling of runoff water.

In both the years of experimentation, sorghum + its ratooning (Var. 'CSH-1') produced higher yield than that of castor. (Table 2). It is thus evident that the former test crop showed the maximum production stability under both below and above average rainfall conditions.

TABLE 5

Main effects of different treatments on gross realisation, cost of production and net profit, Rs/ha.*

Treatments	1975-*76*			*1976-77*			*Mean of net realisation*
	Gross realisation	*Cost of production*	*Net realisation*	*Gross realisation*	*Cost of production*	*Net realisation*	
Sorghum							
M_1	3354	1889	1465	3755	1934	1821	1643
M_2	3956	2179	1777	4938	2219	2719	2248
M_3	5167	2324	2843	5411	2507	2904	2874
R_1	4204	2131	2073	4624	2220	2404	2239
R_2	4115	2131	1984	4779	2220	2559	2272
Sorghum ratoon							
M_1	1034	639	395	1143	764	379	387
M_2	1407	580	827	1625	714	911	869
M_3	1290	478	812	1479	576	903	858
R_1	1066	463	603	1245	548	697	650
R_2	1415	688	727	1646	820	826	777
Sorghum + sorghum ratoon							
M_1	4388	2528	1860	4898	2698	2200	2030
M_2	5363	2759	2604	6563	2933	3630	3117
M_3	6457	2802	3655	6890	3088	3807	3731
R_1	5270	2593	2677	5869	2768	3101	2889
R_2	5530	2819	2711	6425	3040	3385	3048
Castor							
M_1	2362	1868	494	3404	2040	1364	929
M_2	3426	2326	1100	3704	2321	1383	1242
M_3	3444	2095	1349	4119	2337	1782	1566
R_1	2755	1897	858	3561	2097	1464	1161
R_2	3399	2296	1103	3923	2367	1556	1330

*Basis of calculations:

1. Ploughing with local plough, Rs. 16/day and deep ploughing with tractor drawn mould-board plough, 40/hr..
2. Preparation of ridges and furrows, Rs. 150/ha.
3. Sorghum (Variety 'CSH-1'), and Castor (Variety 'GCH-3') seed Rs. 14/- and 10/- per kg, respectively.
4. Lifting of runoff water for recycling, Rs. 4.06/hr.
5. Nitrogen from ammonium sulphate and urea, Rs. 4.62 and Rs. 3.30/kg, respectively.
6. P_2O_5 from super phosphate, Rs. 4.13/kg
7. Cost of Metasystox, endrin grannuls and sevin, Rs. 63/litre, 5.50/kg and 5.50/kg, respectively.
8. Labour charge Rs. 5.50/day.
9. Average sale price of sorghum grain and castor seed, Rs. 90 and 190 per quintal, respectively; sorghum and castor stalks, Rs. 5/- and 2/- per quintal, respectively.

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