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The Status of NPK in Soil with Contour Farming, Graded Bunding and Intercropping

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Abstract: *A field investigation in split plot design on clayey, montmorillonitic soil (Lithic Ustorthent, 22 cm depth and 1.5% slope gradient) indicated that contour farming along vetiver barrier significantly enhanced the economic yield by 18.7 and 35.2 per cent over cultivation along graded bunds and across the slope, respectively. Intercropping of sorghum + mung bean and cotton + mung bean also increased the crop yield significant ly over sole sorghum and cotton, respectively. There was significant gain in residual N by 26 and 39 kg, of available P_2O_5 by 1.6 and 4.5 kg and available K_2O by 29 and 42 kg ha^{-1} in contour farming (along vetiver barrier at 1.5 m vertical interval) over cultivation along graded bund (0.2% grade at 1 m vertical interval)and across the slope, respectively. Intercropping of sorghum + mung bean and cotton + mung bean enhanced residual N in soil to the extent of 75 and 57 kg ha^{-1} over sole sorghum and cotton, respectively.*

Contour farming provides a series of barriers restricting the velocity of running water along the slope and thus conserves soil moisture and nutrients by reducing soil loss (Dhruva Narayana 1983). It also improves residual fertility status of soil (Tejwani 1979). It is, therefore, pertinent to study the cropping system in several soil conservation measures to evaluate the balance sheet of total N, available P and K.

MATERIAL AND METHODS

A field experiment in split plot design was conducted during 1989-90. Experimental soil was a member of the fine, montmorillonitic, hyperthermic family of Lithic Ustorthents (22 cm deep and 1.5% slope). It is neutral to slightly alkaline (pH 7.5), moderate in total N (0.06%) and available P_2O_5 (31 kg ha^{-1}) and high in available K_2O (330 kg ha^{-1}). Main treatments comprised of moisture conservation practices: cultivation across slope, along contour with vetiver live bund (0.5 m vertical interval) and along graded bund (0.2% grade, I m VI). Subplot treatments consisted of sole sorghum, cotton and mung bean, sorghum + mung bean (2:1) and cotton + mung bean (1:1). Gross and net plot sizes were 100 x 10 and 98.2 x 8.8 m, respectively. Fertilizers at 75:50:40, 50:25:25 and 20:40:0 kg ha^{-1} were applied to sorghum and sorghum + mung bean; cotton and cotton + mung bean; and mung bean, respectively. NPK status was determined before and after the crops. The soils were sampled at a distance of 2 metre from up and down sides of vetiver barriers (base

and intercrop) and in the centre of plots (graded bunding and across the slope cultivation). Plant samples were collected at the harvest. Total N (modified Kjeldahl's method), available P_2O_5 (Olsen's method) and K_2O (1 N neutral ammonium acetate) were estimated as described by Jackson (1967). A balance sheet of nutrients was calculated from changes in soil, crop removals and fertilizer added.

RESULTS AND DISCUSSION

Biological yield: Contour farming along vetiver barriers significantly enhanced the yield by 18.7 and 35.2 per cent over cultivation along graded bunds and across the slope, respectively (Table 1). Contour tillage helps in conservation of moisture in arid and semiarid regions, resulting in enhancement of crop production (Mishra *et al.* 1979). Intercropping of sorghum + mung bean, and cotton + mung bean also increased the yield to the extent of 23.2 and 44.5 per cent over sole sorghum and cotton, respectively. Similar results were also reported by Morachan *et al.* (1977). Interaction effect between moisture conservation and cropping system was significant. The highest production was noticed due to interaction of contour cultivation of sorghum + mung bean.

Results regarding straw yield as influenced by various moisture conservation treatments were non-significant. However, intercropping of sorghum + mung bean and cotton + mung bean increased significantly

TABLE 1. Biological yield (q ha-1) of crops as influenced by various treatments

Treatment (sowing)	Sorghum	Cotton	Mung bean	Sorghum + Mung bean	Cotton + Mung bean	Mean
Economic yield						
Across slope	17.8	4.9	1.9	23.4	5.8	10.8
Along contour	24.6	5.5	3.2	30.7	9.0	14.6
Along graded bund	21.7	5.0	2.4	24.7	7.5	12.3
Mean	21.4	5.1	2.5	26.3	7.4	--
Straw yield						
Across slope	25.6	6.6	2.9	33.8	8.0	15.4
Along contour	35.5	7.5	4.7	36.3	12.4	19.3
Along graded bund	31.2	6.4	3.6	36.5	10.3	17.6
Mean	30.8	7.0	3.7	35.5	10.2	--
		Main		Subtreatment		Interaction
Economic Yield	SEm ±	0.4		0.3		0.5
	CD 5%	1.4		0.9		1.5
Straw Yield	SEm ±	0.8		0.9		1.6
	CD 5%	NS		2.6		NS

the straw yield by 15.6 and 46.4 per cent over sole sorghum and cotton, respectively. This indicated that moisture conserved due to contour farming was used in increasing economic yield rather than straw yield.

Total Nitrogen : The maximum gain to the extent of 26 and 39 kg ha^{-1} was recorded in residual N. The unaccounted gain due to contour farming along with vetiver bund was 30 to 47 kg ha^{-1} over the graded bund and across the slope, respectively (Table 2). This might be attributed to increasing available moisture with contour sowing (Anonymous 1989); which resulted in enhancing the growth of root and root nodules and finally the N status in soil.

Intercropping of sorghum + mung bean, and cotton + mung bean enriched the soil significantly to the extent of 75 and 57 kg N ha^{-1}. However, unaccounted gain was 178 and 64 kg N ha^{-1} over sole sorghum and cotton, respectively. This might be attributed to fixation of atmospheric N by root nodules of mung as an intercrop (Kadwe and Badhe 1973; Sagare *et al.* 1986). Cultivation of sole sorghum actually depleted N status of soil by 19 kg ha^{-1}, and unaccounted loss due to this system was 53 kg ha^{-1}. Unaccounted loss of 12 kg N ha^{-1} was also noticed due to cotton cultivation. Interaction effect between moisture conservation and cropping system treatments was significant in respect of residual N in soil and unaccounted gain. Highest gain in residual N in soil and unaccounted gain was recorded due to interaction of contour cultivation (along with vetiver) of mung bean.

Available Phosphorus : Contour cultivation along vetiver barriers enhanced significantly residual P in soil by 1.6 and 4.5 kg P_2O_5 ha^{-1} and unaccounted gain by 6.4 and 11.2 kg P_2O_5 ha^{-1} over cultivation along graded bund and across the slope, respectively (Table 3). Similar observations were reported by Gawande (1989). It further showed that there was enhancement in P due to cultivation of sorghum (47.3 kg ha^{-1}), cotton (30.5 kg ha^{-1}) and mung bean (37.2 kg ha^{-1}). However, unaccounted gain due to cultivation of sorghum and cotton was to the extent of 24.7 and 12.7 kg ha^{-1}, respectively. It is interesting to note that mung bean cultivation has significant effect on increasing unaccounted N status, whereas no such effect was noticed in case of available P_2O_5. This might be due to utilization of P preferentially by nitrogen fixing bacteria during atmospheric N fixation. The effect of intercropping over the sole cropping was not beneficial in increasing available residual P status in soil.

Available Potash : Increase in residual status of available K in soil was significantly higher by 29 and 42 kg K_2O ha^{-1}, whereas unaccounted benefit was 33 and 50 kg ha^{-1} due to contour farming over graded bunding and across the slope, respectively (Table 4). Beneficial effect of sole and intercropping was also recorded in increasing residual available K status in soil and its unaccounted gain. Intercropping of sorghum + mung bean enriched residual K in soil by 24 kg K_2O ha^{-1}. However, unaccounted gain by 33.9 and 10.6 kg K_2O ha^{-1} was recorded due to intercropping of sor-

TABLE 2. Gain (+) /loss (-) of N (kg ha^{-1}) in soil after crop harvest (Initial N 1316 kg ha^{-1})

Treatments	After harvest	Gain/ loss	Crop removal	Net gain/ loss	Added through fert.	Unaccounted gain/ loss
Across slope						
Sorghum	1288	- 28	33	+ 5	75	- 70
Cotton	1316	+ 0	9	+ 9	50	- 41
Mung bean	1428	+ 112	9	+ 121	20	+ 101
Sorghum+ Mung bean	1372	+ 56	45	+ 101	75	+ 26
Cotton+ Mung bean	1372	+ 56	14	70	50	+ 20
Mean	1355	+39	22	61	54	+ 7
Along Contour						
Sorghum	1316	+ 0	48	48	75	- 27
Cotton	1372	+56	11	66	50	-16
Mung bean	1480	+ 164	15	179	20	+ 159
Sorghum +Mung bean	1372	+56	57	113	75	+ 38
Cotton + Mung bean	1428	+112	21	133	50	+ 83
Mean	1394	+78	30	108	54	+ 54
Along graded bund						
Sorghum	1288	- 28	41	13	75	- 62
Cotton	1344	+28	9	37	50	- 13
Mung bean	1440	+ 124	12	136	20	+ 116
Sorghum +Mung bean	1372	+56	48	104	75	+ 29
Cotton +Mung bean	1400	+84	18	102	50	+ 52
Mean	1368	+52	26	78	54	+ 24
Main SEm (±)	9	4	0.5	5	--	5
CD 5%	28	12	2.0	14	--	16
Sub. SEm (±)	13	10	0.5	10	--	12
CD 5%	40	30	1.4	30	--	35
Int. SEm (±)	19	12	0.8	14	--	16
CD 5%	56	40	2.4	40	--	46

TABLE 3. Gain (+)/loss (-) of P_2O_5 (kg ha^{-1}) in soil after crop harvest (Initial P_2O_5 = 13.2 kg ha^{-1})

Treatments	After harvest	Gain/ loss	Crop removal	Net gain/ loss	Added through fert.	Unaccounted gain/ loss
Across slope						
Sorghum	75.8	-44.6	22.5	+67.1	50	+ 17.1
Cotton	59.3	+28.1	6.5	+ 34.6	25	+ 9.6
Mung bean	67.6	+36.4	2.7	+ 39.1	40	- 0.9
Sorghum +Mung bean	74.6	+43.4	29.4	+27.8	50	+ 22.8
Cotton +Mung bean	61.7	+ 30.5	7.8	+ 38.3	25	+ 13.3
Mean	67.7	+36.5	13.8	+50.3	38	+ 12.3
Along Contour						
Sorghum	80.5	+49.3	33.0	+82.3	50	+ 32.3
Cotton	64.0	+32.8	8.2	+ 41.0	25	+ 16.0
Mung bean	68.7	+ 37.5	4.5	+ 42.1	40	+ 2.1
Sorghum + Mung bean	81.6	+50.4	36.5	+87.0	50	+ 37.0
Cotton +Mung bean	66.4	+35.2	13.0	+48.2	25	+ 23.2
Mean	72.2	+41.0	20.4	+61.4	38	+ 23.4
Along graded bund						
Sorghum	79.3	+48.1	26.6	+74.7	50	+ 24.7
Cotton	61.7	+30.5	6.8	+37.4	25	+ 12.4
Mung bean	68.7	+37.5	3.3	+ 40.8	40	+ 0.8
Sorghum +Mung bean	80.5	+49.3	31.3	+80.6	50	+ 30.6
Cotton +Mung bean	62.9	+31.7	10.1	+41.8	25	+ 16.8
Mean	70.6	+39.4	15.6	+55.0	38	+ 17.0
Main SEm ±	1.2	0.5	0.2	0.8	--	0.9
CD 5%	3.2	1.5	0.9	2.4	--	2.9
Sub. SEm ±	1.5	2.1	0.2	1.2	--	1.1
CD 5%	4.5	NS	0.5	3.5	--	3.3
Int. SEm ±	3.2	2.3	0.3	1.4	--	1.5
CD 5%	9.3	NS	0.9	4.1	--	4.9

TABLE 4. Gain (+)/loss (-) of K_2O (kg ha^{-1}) in soil after crop harvest (Initial K_2O = 330 kg ha^{-1})

Treatments	After harvest	Gain/ loss	Crop removal	Net gain/ loss	Added through fert.	Unaccounted gain/ loss
Across slope						
Sorghum	364	+ 34	47	+ 81	40	+ 41
Cotton	358	+ 28	7	+35	25	+ 10
Mung bean	342	+ 12	5	+17	00	+ 17
Sorghum +Mung bean	386	+ 58	62	+ 118	40	+ 78
Cotton +Mung bean	364	+ 34	10	+44	25	+ 19
Mean	363	+ 33	26	+59	26	+ 33
Along Contour						
Sorghum	403	+ 73	67	+140	40	+100
Cotton	403	+ 73	8	+ 81	25	+ 56
Mung bean	375	+ 45	9	+ 54	00	+ 54
Sorghum +Mung bean	437	+107	70	+117	40	+137
Cotton +Mung bean	409	+ 79	15	+ 94	25	+ 69
Mean	405	+ 75	34	+109	26	+ 83
Along Graded bund						
Sorghum	375	+ 45	58	+103	40	+ 63
Cotton	375	+ 45	7	+ 52	25	+ 27
Mung bean	358	+ 28	6	+ 34	00	+ 34
Sorghum +Mung bean	392	+ 62	68	+130	40	+ 90
Cotton +Mung bean	381	+ 51	12	+ 63	25	+ 38
Mean	376	+ 46	30	+ 76	26	+ 50
Main SEm ±	2	1	1.1	3	--	3
CD 5%	7	3	4.4	9	--	9
Sub. SEm ±	3	2	1.2	3	--	2
CD 5% NS	5	3.6	10	--	7	
Int. SEm ±	4	2	2.2	5	--	3
CD 5%	NS	7	NS	15	--	11

ghum + mung bean and cotton + mung bean over sole sorghum and cotton, respectively. Amongst sole cropping, maximum increase in K in soil and its unaccounted gain was recorded due to cultivation of sorghum. Interaction effect between moisture conservation and cropping system treatments was significant in respect of K gain in soil and unaccounted gain. Gain in residual K in soil and its unaccounted gain was highest due to the combination of contour farming of sorghum + mung bean. Contour farming alongwith vegetative barriers enhanced surface roughness and holds up overland flow which reduces runoff and nutrient loss and improves soil fertility (Bhatia and Choudhary 1977). This resulted in increasing residual NPK in soil due to contour cultivation alongwith vetiver barrier under similar conditions.

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