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Degraded Land Hybridization with Tank Silt : Impact on Soil Quality and Productivity of Soybean

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ABSTRACT: The study was taken on very shallow skeletal soil underlined by saprolite in basaltic area and applied tank silt @ 0, 500, 1000, 1500, 3000, 4500 and 6000 cu m/ha (approximately 0, 5, 10, 15, 30, 45 and 60 cm thick layer). These soils are characterized as very shallow in depth, sandy clay loam in texture and has low cation exchange capacity (<20 cmol(p+)/kg). The applied tank silt was alkaline in nature, had high clay content (>60%), high cation exchange capacity (>65cmol (p+)/kg) and was highly calcareous in nature (>16%). The study indicated wide variability in morphological, physical, and chemical properties of soil after three years of application and had positive impact on yield of soybean. The colour of surface layer (Ap horizons) of this hybridized soil varied from 10 YR 3/2 to 10 YR 4/2, modified to clayey in texture from sandy clay loam and sub-angular blocky to angular blocky in structure. The clay content, moisture content and CEC increased while hydraulic conductivity decreased with increase in level of tank silt application. The yield of soybean increased up to 15 cm depth of tank silt application and later decreased. The maximum yield of soybean was recorded with 1500 cu m/ha of application (31.4 q/ha) corresponding to 15 cm depth, which was three-fold higher over no application (9.6 q//ha).

Key words: Soil hybridization, tank silt, soil quality and soybean

The tank silt application in agricultural land is a traditional activity for the benefit of better crop growth. The pressure on land is increase in due to population pressure and competitive demand from other sectors. The soil resource is dwindling very fast, thereby, demanding the need for rational use of precious soil resources. One of the basic challenges Indian agriculture facing today is to increase the productivity from limited land resource and meet the demand of growing population. In order to meet the need of growing population, first one is to increase the yield per unit area through better management and the second by bringing the degraded marginal land under sustainable land use. The tank sediment deposited over years contains all the nutrients required for plant growth and can amend the very degraded soil when recycled improves soil fertility (Padmaja *et al*., 2003; Osman *et al*., 2009). Addition of tank silt to cultivated land also improves the physical properties which results in good crop growth and higher yield (Keshavamurthy and Kotur 1996; Kabir *et al*., 1991; Vaidya and Dhawan, 2011). Most of the soils of Osmanabad district in Maharashtra State are very shallow in depth, poor in fertility and moisture holding capacity. With this in a view, the present investigation was carried out to understand the morphological, physical and chemical behavior of these hybridized soil when amended with tank silt and its impact on yield of soybean crop.

Materials and Methods

The study area was located in Osmanabad district (Maharashtra) extending from 18^0 17'52''N latitude and 76^0 05'00'' E longitudes at an altitude of 660 m above mean sea level (MSL). The experiment was laid at adjoining fields belonging to college of agriculture, Osmanabad. The soil is very shallow in depth underlined by murrum layer. Seven plots each measuring 4000 m^2 were identified in sequence having similar soil characteristics and were applied tank silt @ 0 (control), 500, 1000 1500, 3000, 4000 and 6000 cu m/ha, correspondingly to a approximate depth of 0, 5, 10, 15, 30, 45 and 60 cm. The yield of soybean was recorded during 2010-11, 2011-12 and 2012-13. Soil profile samplings were carried out after the harvest of soybean crop and studied CEC, $CaCo_3$ and bulk density. The soil moisture data were recorded both at flowering and harvesting stages of soybean crop. The soil profile pits were examined for their morphological properties as per Soil Survey Manual (Soil Survey Staff, 2000) after three years of completion of study. The horizon-wise soil samples were collected, processed and analyzed using standard analytical procedures. The particle size distribution was carried out by international pipette method according to the procedure given by Jackson (1979). The bulk density was determined by clod coating method (Black, 1965). The available water content was calculated using water retained between 33kPa and 1500 kPa of soil sample using pressure plate apparatus (Richards, 1954). The saturated hydraulic conductivity was determined using constant head methods (Richards, 1954). Soil pH and EC were determined in soil-water suspension of 1:2.5 proportion (Jackson, 1967). Soil organic carbon was determined by Walkley and Black method (Jackson, 1973). $CaCO_3$ was determined by rapid titration method (Piper, 1950). The CEC and exchangeable bases Na and K were determined by employing standard procedures (Richards,1954) and Ca and Mg were determined by Piper (1966) method. The available nitrogen was determined by alkaline potassium permanganate method (Subbaiah and Asija, 1956). Available phosphorous was determined by Olsen's method (Jackson, 1967). Potassium was determined by neutral ammonium acetate solution method (Jackson, 1973). The yield data of soybean crop were recorded from 6 x 4 m plot size from three different locations in each plot and average over three locations each year. The yield data were analyzed using two way ANOVA model with years as first factor and treatment as second factor.

Result and Discussion

Morphological properties of soils

The change in morphological properties of these soils with application of tank silt after three years are presented in Table 1. This indicated that the depth of soil was increased with increase in level of tank silt application. The maximum depth of tank silt was reported in pedon P7 (@ 6000 cu m/ ha). The soil colour of surface horizons (Ap) of hybridized soil (pedon P2, P3, P4, P5, P6 and P7) varied from yellowish brown colour (10 YR 4/3) to dark grayish brown colour (10 YR 3/2) where as non-hybridized soil pedon P1 (control) was yellowish brown (10 YR 5/6). The soil colour appears to be the outcome of chemical and mineralogical composition as well as textural makeup of soil (Walia and Rao, 1997). The soil structure and texture of very shallow soil were improved due to application of tank silt (Table 1) which was sub-angular blocky to angular blocky in structure to sandy clay loam to clayey in texture in pedon P2, P3, P4, P5, P6 and P7. The formation of blocky structure i.e. angular blocky and sub-angular blocky was attributed to the application of tank silt which had high clay fractions (65%). The soil consistency of surface layer of these hybridized soils were slightly sticky, slightly plastic to very sticky very plastic in nature when wet, firm to very firm and slightly hard to very hard when it was dry. This may be due to high amount of clay fraction in tank silt and also due to dominance of smectite clay minerals (Leelavathi *et al*., 2010).

Physical properties of soil

Physical properties of tank silt applied soil during third year (2012-13) presented in Table 2 indicated decrease in coarse fragment on volume basis up to rooting depth of soybean crop (30 cm depth). The bulk density of these hybridized soils P2, P3, P4, P5, P6 and P7 was varied from 1.31 to 1.78 Mg/ m^3 and which was less than control P1 (Tables 2 & 4). The clay content of these hybridized soils increased with increase in rate of tank silt application and also varied from 17.8 to 53.6%. However, it was observed that the clay content in sub-surface horizons of tank silt hybridized soils P2, P3, P4, P5 and P6 increased over control (without tank silt application) P1. This is due to *in situ* translocation of clay by eluviation (Sahgal, 1998) and also clay content increased gradually with time since 2011 to 2013 (Table 4). The hydraulic conductivity decreased with increase in rate of tank silt application and it was about three-fold decrease (11.7 cm/hr) in 1500 cu m/ha of tank silt applied plot over control (28.8 cm/h). The moisture content also showed increasing trend with increase in levels of tank silt application (Table 4) and which was threefold increase (36.7%) at flowering stage of soybean crop in 1500 cu m/ha of tank silt applied plot over control (14.4 %). The available water content in surface layer of hybridized soil at 1/3 bar and 15 bar was varied from 31.4 to 46.4% and 16.6 to 31.1%, respectively and over unhybridized soil pedon P1 (19.8 and 8.6%, respectively). These variations were due to differences in clay content. However, the rate of application of tank silt had significant positive correlation with moisture content at flowering and harvesting stages (r = 0.98) while it was negative with hydraulic conductivity (r = 0.98) of tank silt hybridized soils (Table 5). This suggested that the application of tank silt decreased the hydraulic conductivity whereas increased the moisture holding capacity of very shallow, degraded marginal lands in basaltic area which had positive influence on nutrients availability and productivity.

Chemical properties of soil

These soils are neutral to alkaline in pH and varied from 7.1 to 7.7 and low in salinity hazards (<0.25 dS/m) and no change was noted with different rates of tank silt application while these soils registered an improvement in organic carbon content at surface (Table 3). The CEC of surface horizon of hybridized soils varied from 37.6 to 57.9 c mol (p+)/ kg and which was two- fold increase with application of 15 cm depth of tank silt (48.7 c mol (p+)/ kg) over control pedon P1 (20.90 c mol (p+)/ kg) and was positively correlated with clay. This indicated that tank silt application improved CEC of soil which is closely related with soil fertility. The non-hybridized soil pedon P1 was slightly calcareous in nature (<2% $CaCO_3$) while hybridized soil with tank silt Pedon P2, P3, P4, P5, P6 and P7 was moderate to highly calcareous in nature and varied from 8.9 to 16.1%. This was attributed to application of highly calcareous tank silt (16.9 to 19.6 %). The $CaCO_3$ content was increased in sub-surface layer under hybridized soil pedon P2 to P7 when compared to un-hybridized soil pedon P1 which might be due to downward movement of carbonate. The exchangeable bases of all pedons were in the order of Ca^{2+}> Mg^{2+}> Na^{2+} > K^{+} on the exchange complex. The base saturation was varied from 80 to 94%. Soil fertility exhibits the status of different nutrients with regard to the amount and their availability essential for plant growth. The available N, P and K contents in tank silt hybridized soils varied from 230 to 313, 10.7 to 17.8 and 287 to 481 kg/ha, respectively (Table 3) and were higher over control (P1). This might be due to tank sediments have higher nutrient content value over their respective cultivated catchment soil (Padmaja *et al*., 2003). The clay content, CEC, $CaCO_3$ increased significantly with increase in depth of silt application while it was non-significant in case of bulk density (Table 4).

Yield of soybean crop

Yield is an important attribute of any crop and the variation in yield may be due to soil type, management practices and climatic factors. The yield of soybean under tank silt hybridized soil varied from 14.1 to 31.4 q/ha. The maximum yield of soybean was recorded in pedon P4 (31.4 q/ha) where tank silt was applied @ 1500 cu m/ha and it was three-fold increase over un-hybridized soil pedon P1 (9.3 q/ha). The yield data presented in Table 4 indicated that the yield of

Table 1 : Morphological characteristics of soil under different depth of tank silt application in very shallow soils of Osmanabad district

Horizons	Depth (cm)	Boundary	Matrix Colour	Structure	Texture	Pores	Roots	Consistency	Effervesces
Pedon :P1 without tank silt (Control Plot)									
Ap	0-9	cs	10YR5/4	1fgr	Scl	vfcfm	vfcfm	vfr ns np	e
Ac	9-18	di	10YR5/6	1mgr	Scl	vfc	vfc	vfr ns np	e
M	18-40		10YR5/6			--Murrum layer--			
Pedon :P2 Application of tank silt @ 500 cu m/ha (5 cm depth of tank silt)									
Ap	0-9	cs	10YR4/3	1f sbk	C	vfm	vfmfm	vfr ss ps	e
E	9-18	di	10YR5/4	1f gr	cl	vfm	vfmfm	vfr ns np	e
Ac	18-32	di	10YR5/6	1mgr	Scl	vfc	vfc	vfr ns np	e
M	32-50		10YR5/6			--Murrum layer--			
Pedon :P3 Application of tank silt @ 1000 cu m/ha (10 cm depth of tank silt)									
Ap	0-10	cs	10YR4/3	1 sbk	C	vfm	vfmfm	sh ss ps	e
AE	10-22	di	10YR5/4	1 sbk	cl	vfm	vfmfm	vfr ns np	e
Ac	22-38	di	10YR5/6	1mgr	Scl	vfc	vfc	vfr ns np	e
M	38-60		10YR5/6			--Murrum layer--			
Pedon :P 4 Application of tank silt @ 1500 cu m/ha (15 cm depth of tank silt)									
Ap	0-14	cs	10YR4/3	1m sbk	C	vfm	vfmfm	sh ss ps	e
AE	14-25	di	10YR5/4	1f sbk	cl	vfm	vfmfm	vfr ss ps	e
Ac	25-34	di	10YR5/6	1mgr	Scl	vfc	vfc	vfr ns np	e
M	34-58		10YR5/6			--Murrum layer--			
Pedon :P5 Application of tank silt @ 3000 cu m/ha (30 cm depth of tank silt)									
Ap	0-28	cs	10YR4/3	3m abk	C	vfm	vfmfm	mh vs vp	e
AE	28-36	di	10YR4/3	1m sbk	cl	vfm	vfmfm	vfr ss ps	e
Ac	36-56	di	10YR5/6	1mgr	Scl	vfc	vfc	vfr ns np	e
M	56-62		10YR5/6			--Murrum layer--			
Pedon :P6 Application of tank silt @ 4000 cu m/ha (40 cm depth of tank silt)									
Ap	0-37	cs	10YR4/3	3m abk	C	vfm	vfmfm	vh vs vp	e
AE	37-43	di	10YR4/3	1f sbk	cl	vfm	vfc	vfr ss ps	e
Ac	43-62	di	10YR5/6	1mgr	Scl	vfc	vfc	vfr ns np	e
M	62-78		10YR5/6			--Murrum layer--			
Pedon :P7 Application of tank silt @6000 cu m/ha (60 cm depth of tank silt)									
Ap	0-57	cs	10YR4/3	3m abk	C	vfm	vfmfm	vh vs vp	e
AE	57-64	di	10YR4/3	1f sbk	cl	vfm	vfc	vfr ss ps	e
Ac	64-82	di	10YR5/6	1mgr	Scl	vfc	vfc	vfr ns np	e
M	82-89		10YR5/6			--Murrum layer--			

Table 2 : Physical characteristics of soil under different depth of tank silt application

Horizons	Depth (cm)	Coarse fragment (%)	BD (Mg/m^3)	Partial size analysis			HC (cm/ hr)	Moisture content (%) at		AWC (%)
				Sand (%)	Silt (%)	Clay (%)		1/3 bar	15 bar	
Pedon :P1 without tank silt (Control Plot)										
Ap	0-9	25.0	1.61	57.2	23.3	19.5	28.4	19.8	8.6	11.2
Ac	9-18	54.4	1.65	64.0	16.2	19.8	29.2	18.3	7.2	11.1
M	18-40	92.0	1.67	80.0	15.9	04.1	--	--	--	--
Pedon :P2 Application of tank silt @ 500 cu m/ha (5 cm depth of tank silt)										
Ap	0-9	10.9	1.34	38.0	31.4	29.7	16.1	31.4	19.2	12.2
AE	9-18	22.4	1.39	49.0	24.1	26.9	29.1	--	--	
Ac	18-32	58.2	1.74	62.1	19.4	18.5	30.1	--	--	
M	32-50	86.4	1.62	82.2	15.0	02.4	--	--	--	
Pedon :P3 Application of tank silt @ 1000 cu m/ha (10 cm depth of tank silt)										
Ap	0-10	8.9	1.39	13.0	42.6	44.4	11.3	30.0	16.6	13.4
AE	10-22	18.0	1.34	47.5	24.2	25.3	19.2	--	--	
Ac	22-38	25.9	1.64	52.0	22.6	25.4	27.5	--	--	
M	38-60	93.6	1.67	84.6	12.8	02.6	--	--	--	
Pedon :P 4 Application of tank silt @ 1500 cu m/ha (15 cm depth of tank silt)										
Ap	0-14	13.0	1.40	14.0	38.2	47.8	05.4	34.7	21.0	13.7
AE	14-25	22.0	1.41	50.0	22.0	28.0	20.2	29.4	18.2	11.2
Ac	25-34	51.0	1.62	60.6	19.0	21.4	29.2	18.6	08.3	10.3
M	34-58	90.0	1.62	81.4	15.1	03.5	--	--	--	--
Pedon :P5 Application of tank silt @ 3000 cu m/ha (30 cm depth of tank silt)										
Ap	0-28	8.9	1.57	12.3	30.9	54.0	04.9	46.5	31.7	14.8
AE	28-36	24.2	1.49	28.9	42.7	28.4	19.2	--	--	--
Ac	36-56	54.3	1.65	41.5	33.4	25.0	31.1	--	--	--
M	56-62	93.4	1.74	79.3	12.2	08.5	--			
Pedon :P6 Application of tank silt @ 4000 cu m/ha (40 cm depth of tank silt)										
Ap	0-37	8.9	1.59	06.9	37.9	55.2	05.1	45.5	31.3	14.2
AE	37-43	27.5	1.54	43.8	37.3	18.9	18.3	--	--	--
Ac	43-62	56.6	1.67	54.3	29.6	16.1	30.4	--	--	--
M	62-78	95.5	--	75.8	13.4	10.8	--	--	--	
Pedon :P7 Application of tank silt @6000 cu m/ha (60 cm depth of tank silt)										
Ap	0-57	9.7	1.63	07.1	34.9	58.0	03.7	46.4	31.1	15.5
AE	57-64	22.9	1.52	52.9	31.6	15.5	18.3	--	--	--
Ac	64-82	55.4	1.71	55.0	34.7	10.3	29.2	--	--	--
M	82-89	89.3	1.78	72.6	15.5	11.9	--	--	--	--

Table 3 : Chemical characteristics of soil under different depths of tank silt application

Horizons	Depth (cm)	pH	EC (dS/m)	O.C. (%)	Ca CO_3 (%)	CEC c mol (p+) /kg)	Cations (c mol (p+)/kg)				Available N (kg/ha)	Available p (kg/ha)	Available K (kg/ha)
							Ca^{++}	Mg^{++}	Na^{+}	K^{+}			
Pedon :P1 without tank silt (Control Plot)													
Ap	0-9	7.1	0.21	0.7	2.28	19.90	11.42	7.60	0.38	0.17	312	11.6	278
Ac	9-18	7.2	0.25	0.7	2.11	20.80	11.42	7.40	0.22	0.11	233	10.7	254
M	18-40	7.2	0.20	0.3	2.08	19.83	10.36	5.00	0.20	0.05	183	09.7	121
Pedon :P2 Application of tank silt @ 500 cu m/ha (5 cm depth of tank silt)													
Ap	0-9	7.2	0.13	0.79	10.9	31.86	24.60	5.40	0.69	0.22	271	12.6	350
AE	9-18	7.2	0.21	0.78	8.9	29.85	24.41	7.40	0.28	0.32	271	12.5	254
Ac	18-32	7.1	0.23	0.38	3.6	20.80	11.42	7.20	0.22	0.29	174	07.1	148
M	32-50	7.1	0.22	0.20	2.3	20.80	12.36	6.30	0.20	0.12	174	09.7	121
Pedon :P3 Application of tank silt @ 1000 cu m/ha (10 cm depth of tank silt)													
Ap	0-10	7.2	014	0.80	11.6	45.54	34.80	7.20	0.91	0.43	230	11.6	287
AE	10-22	7.1	018	0.94	8.4	30.05	20.60	7.60	0.30	0.35	302	10.7	171
Ac	22-38	7.2	024	0.35	3.4	22.08	14.20	5.40	0.22	0.29	233	09.7	148
M	38-60	7.3	022	0.19	2.8	20.20	12.36	6.30	0.22	0.14	189	09.7	121
Pedon :P 4 Application of tank silt @ 1500 cu m/ha (15 cm depth of tank silt)													
Ap	0-14	7.2	0.15	0.88	12.9	43.77	36.00	5.32	0.38	0.35	271	10.7	305
AE	14-25	7.2	0.19	0.91	8.9	31.79	24.80	7.20	0.24	0.32	302	12.5	254
Ac	25-34	7.2	0.24	0.29	3.7	25.85	20.41	5.60	0.22	0.29	233	09.7	171
M	34-58	7.1	0.21	0.24	2.8	21.45	12.42	5.30	0.22	0.11	188	09.7	121
Pedon :P5 Application of tank silt @ 3000 cu m/ha (30 cm depth of tank silt)													
Ap	0-28	7.5	0.33	0.84	17.6	61.9	39.2	16.1	2.13	0.49	276	17.8	359
AE	28-36	7.5	0.27	0.72	5,2	31.9	23.6	7.1	0.32	0.25	276	15,2	282
Ac	36-56	7.2	0.19	0.37	2.1	27.3	16.3	6.6	0.26	0.17	233	11.6	192
M	56-62	7.3	0.21	0.28	2.1	21.6	13.3	5.6	0.28	0.14	188	07.1	158
Pedon :P6 Application of tank silt @ 4000 cu m/ha (40 cm depth of tank silt)													
Ap	0-37	7.7	0.32	0.95	16.8	62.9	43.5	11.8	3.60	0.51	271	15.2	404
AE	37-43	7.6	0.28	0.69	5.3	33.1	24.1	7.2	0.26	0.31	239	15.2	351
Ac	43-62	7.4	0.27	0.34	3.5	29.5	17.3	6.3	0.22	0.16	233	09.7	192
M	62-78	7.2	0.21	0.31	2.3	20.4	11.6	5.9	0.23	0.18	188	07.1	277
Pedon :P7 Application of tank silt @ 6000 cu m/ha (60 cm depth of tank silt)													
Ap	0-57	7.8	0.33	0.91	19.7	61.9	44.0	13.0	3.40	0.57	313	15.2	481
AE	57-64	7.5	0.31	0.67	2.9	29.0	16.5	7.6	0.32	0.23	302	12.5	271
Ac	64-82	7.2	0.26	0.29	2.8	24.9	15.3	6.9	0.29	0.19	233	10.7	192
M	82-89	7.1	0.22	0.21	2.3	20.0	11.5	5.3	0.21	0.15	188	07.1	169

Table 4 : Soil properties based on weighted mean of soil profiles, moisture content at flowering and harvesting stage, hydraulic conductivity at rooting depth (0- 30cm) and yield of soybean during (2010-11 to 2012-13, pooled over three years)

Treatments Depth and volume of tank silt application	Clay content (%)	CEC (c mol (p+) / kg)	$CaCO_3$ (%)	Bulk density (Mg/m^3)	Soil moisture content at flowering (%)	Soil moisture content at harvesting (%)	HC (cm/hr)	Yield of soybean (q/ha)
T1: Control	11.2	20.3	2.1	1.7	14.4	10.9	28.8	9.7
T2: 05 cm (500 cu m/ha)	17.8	24.7	5.6	1.6	20.6	20.1	24.2	14.1
T3: 10 cm (1000 cu m/ha)	21.0	28.9	5.7	1.5	34.6	32.5	14.7	23.4
T4: 15 cm (1500 cu m/ha)	23.3	30.3	6.7	1.5	36.7	36.8	11.7	31.5
T5: 30 cm (3000 cu m/ha)	35.3	42.9	10.4	1.5	41.9	39.2	3.9	23.0
T6: 40 cm (4000 cu m/ha)	39.6	45.2	11.7	1.5	45.3	41.3	3.5	22.4
T7: 60 cm (6000 cu m/ha)	53.6	54.3	14.3	1.4	47.3	41.5	3.5	22.2
Mean	28.7	35.2	8.0	1.5	34.3	31.7	12.9	20.9
SEm±	0.75	1.22	0.36	0.04	1.39	1.53	0.77	1.52
CD (P=0.05)	1.64	2.67	0.79	NS	3.03	3.33	1.67	3.33

HC = Hydraulic conductivity

Table 5 : Correlation coefficient matrix between soil attributes and yield of soybean (2010-11 to 2012-13, pooled over three years)

Parameters	Depth of tank silt application (cm)	Clay %	CEC (c mol (p+) /kg)	Soil moisture content at flowering (%)	Soil moisture content at harvesting (%)	HC (cm/hr)	$CaCO_3$ (%)
Depth of tank silt application (cm)							
Clay (%)	0.98*						
CEC(c mol (p+) /kg)	0.99*	0.99*					
Soil moisture content at flowering (%)	0.86*	0.87*	0.91*				
Soil moisture content at harvesting (%)	0.80*	0.96*	0.85*	0.98*			
HC (cm/hr)	-0.86*	-0.87*	-0.92*	-0.99*	-0.97*		
CaCO3 (%)	0.97*	0.98*	0.99*	0.91*	0.86*	-0.92*	
Yield of soybean q/ha	0.38	0.41	0.44	0.64	0.82*	-0.71**	0.46

*Significant at 1% level **Significant at 5% level HC = Hydraulic Conductivity soybean increased up to 1500 cu m/ha application and later decreased. This is attributed to water logging condition with higher rate of application of tank silt during wet period as evident from higher moisture content in root zone at flowering stage (Table 4) and it adversely affected the crop growth. Yield of soybean was positively correlated with clay content, CEC, depth of silt, moisture content, $CaCO_3$ while it was negatively correlated with hydraulic conductivity (Table 5) indicating the importance of drainage.

Conclusions

Tank silt hybridization of very shallow soil underlined by murrum layer in basaltic area helps in improving the soil quality and crop productivity. Tank silt hybridization has good scope for marginal land to become productive and may be given the preference in the on-going state and central level schemes like *Jalyukt Shivar Abhiyaan* and Mahatama Gandhi National Rural Employment Guarantee Scheme (MGNREGS), respectively. The depth of silt application should be restricted to 15 cm depth or 1500 cu m per hectare on volume basis which is an upper limit for highly degraded lands.

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