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Economic assessment of tank silt in terms of fertilizer equivalent of Latur and Osmanabad district in Maharashtra

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Abstract
The present investigation entitled "Economic assessment of tank silt and tank silt hybridized soils of Latur and Osmanabad district" were carried out to study the total nutrients status of already collected tank silt samples from 25 different tanks (0-150 cm depth). The data of tank silt uplifted from different tanks during 2012-16 were collected. The economic valuations of tank silt in term of fertilizer equivalent in rupees were carried out. The total recycles of tank silt in study area varied from 2470 to 2632905.6 ton. Total quantity of tank silt uplifted from twenty five selected tanks of Osmanabad and Latur District was about 98,66,558.1 tons during 2012-2016. The total cost incurred for removal of tank silt and its application on farmer field total amount Rs. 68,70,92,509. The fertilizer equivalent of recycle of tank silt of all selected twenty five tanks in study area was found to be Rs. 54,45,74,34,104. The B: C ratio of total nutrients returned to farmer field varies from 68.24 to 119.64 with an average value 79.99. This showed that the fertilizer equivalent cost was found to be very high than the cost incurred for tank silt hybridization on farmers field. From above results it is concluded that the tank silt desilted from water tanks and hybridized in agriculture field appears to be an economical viable option for returning the essential nutrients in soil.

Keywords: Tank silt, fertilizer equivalent, total nutrient status, benefit cost ratio

1. Introduction
In agriculture the removal of tank silt and its application on agricultural lands is traditional activity done by the villagers for the benefits of better crop growth. Poor management practices of catchment have resulted in silting of most of these water bodies and significant reduction of storage capacity. Silt deposit has not only reduced the storage capacity but also groundwater recharge, eutrophication of tanks and most importantly higher release of carbon to atmosphere through silt mediated anaerobic decomposition of organic carbon. Good practices such as desilting and application of silt to agricultural fields have been abandoned. Continued mining by crops and reduced application of organic manures has resulted in deficiency of several nutrients particularly that of micronutrients. Recycling of tank silt provides a win-win situation to both, improvement in soil health and renovation of the tank (Osman *et al.* 2009) [10].

With conventional assessments of soil loss measurements, it is hard to link soil losses with yield decline. The use of qualitative studies of the lost soil, which gets deposited as sediments in the tanks, may be another approach for this purpose. The approach to soil loss and its impact on productivity is different for agronomists and hydrologists. Analysis and interpretation of results from such studies in isolation does not provide plausible solutions to the problems of sustainability. An environmental approach with integration of different processes in the ecosystem needs to be studied. Qualitative assessment followed by quantification of parameters together help to understand the effects of land use on its degradation.

Runoff water carries along nutrients and fine organic matter particulates from agricultural lands. Often the sources and pathways of nutrients moved by sediments in the runoff are difficult to fully identify. For rainfed farming system there is a need to capture significant amount of rainwater, which is generally lost as runoff and deep drainage. This stored water can be used for supplemental irrigation, increasing crop productivity and resource-use efficiency. However, deposition of sediment in tanks reduces its capacity and also hampers the additional

water storage in the rainfed areas. Hence, removal of sediments from tanks is a relevant approach for rainfed farming systems.

Table 1: Latitude and longitude of tanks in Osmanabad and Latur district

Tank No.	Name of tank and village	Latitude and longitude
Tahsil Osmanabad Dist. Osmanabad		
1	Terna Dam	$18^0$20'02" N & $76^0$06'53" E
2	Alni talaw	$18^0$16'58" N & $76^0$59'55" E
3	Wagholi	$18^0$15'09" N & $76^0$06'18" E
4	Dhoki	$18^0$38'06" N & $76^0$10'91" E
5	HatlaiTalaw	$18^0$11'17" N & $76^0$00'29" E
Tahsil Bhoom Dist. Osmanabad		
6	PimpalgaonGhodki	$18^0$35'02" N & $76^0$06'72" E
7	Bangarwadi	$18^0$22'15" N & $76^0$49'39" E
8	HiwraTalaw	$18^0$28'59" N & $76^0$42'35" E
9	Ambi Tank	$18^0$30'34" N & $76^0$25'57" E
Tahsil Paranda Dist. Osmanabad		
10	Sina-Kolegaon Dam	$18^0$20'50" N & $76^0$22'37" E
11	Sonari Dam	$18^0$18'45" N & $76^0$29'17" E
12	Khasapuri Dam	$18^0$30'46" N & $76^0$48'68" E
Tahsil Tuljapur Dist. Osmanabad		
13	HangargaTalaw	$18^0$00'17" N & $76^0$00'19" E
14	BarudTalav	$17^0$97'35" N & $76^0$17'19" E
15	Bori Dam	$17^0$51'00" N & $76^0$15'37" E
Tahsil Lohara Dist. Osmanabad		
16	Nim-Terna	$18^0$02'05" N & $76^0$24'56" E
17	BhosgaTalaw	$18^0$11'54" N & $76^0$28'14" E
18	BenitraPrakalp	$17^0$58'16" N & $76^0$36'39" E
Tahsil Umerga Dist. Osmanabad		
19	Jakekur	$17^0$50'08" N & $76^0$33'57" E
20	BalsurTalaw	$17^0$58'03" N & $76^0$33'00" E
Tahsil Chakur Dist. Latur		
21	Nalegaon	$18^0$38'15" N & $76^0$82'46" E
22	Sakul prakalp	$18^0$30'94" N & $76^0$90'31" E
23	Mortalwadi	$18^0$55'47" N & $77^0$05'48" E
Tahsil Udagir Dist. Latur		
24	Sukni	$18^0$52'12" N & $77^0$04'13" E
25	Ekurka	$18^0$49'05" N & $77^0$07'95" E

2. Material and Methods

The present investigation on tank silt and tank silt hybridized soil of Osmanabad and Latur district located between 18^0 05' to 18^0 25' N latitude and 76^0 25' to 77^0 25' longitude and 18^0 28' to 19^0 28' North latitude and 76^0 25' to 77^0 25'East longitude respectively. The area is covered by the basaltic lava- flows. Same layer of the lava-flow are hard and compact while other are soft. These basalt flows are the result of intense volcanic activity during cretaceous Eocene period (almost seventy million year ago). When the lava flows were ejected through long narrow fissures on the earth surface. The area has very shallow cover of gravelly sediments over a hard basaltic Lithic or paralithic contact within 50 cm of the surface. These soils were treated with tank silt at different rate (0-6000 m^3/ha) from adjoining tank and mixed (hybridized) with underlined murrum layer of very shallow soil by deep ploughing and intercultural operation. This investigation was carried out to study the physico-chemical characteristics and total nutrients status of already collected 25 tank samples of different tanks of Osmanabad and Latur district (table no. 1).

2.1 Physical and Chemical properties of tank silt

The bulk density of tank silt was determined by clod coating technique (Black, 1965) [23]. pH of 1:2.5 soils (tank silt): water suspension was determined electrometrically using pH meter as per method described by Jackson, (1973) [5]. Electrical conductivity of 1:2.5 soils (tank silt): water suspension as per the method describe by Jackson, (1973) [5]. The calcium carbonate was estimated by rapid titration method as described by Piper (1950) [15]. Modified Walkley and Black's rapid titration method was followed for estimating the organic carbon content (Jackson, 1958) [4]. The total nitrogen was estimated by micro-kjeldhal distillation method after digestion of the tank silt samples with sulphuric acid and digestion mixture (K_2SO_4, $CuSO_4$and selenium in 100:20:1 ratio respectively) (Page *et al.*, 1982) [13]. The total phosphorus was estimated by Vanadomolybdate phosphoric yellow colour methods after perchloric acid digestion (Page *et al.*, 1982) [13]. The total potassium was estimated by using flame photometer after HF and $HClO_4$ digestion method (Page *et al.*, 1982) [13]. Total sulphur was estimated in diacid digestion mixture (Chapman and Pratt, 1961) [2] from the di acid extract of soil, total sulphur was determine by turbidimetric methods as described by Chesnin and Yein (1951) [3]. The total micronutrients (Fe, Cu, Zn, Mn) were estimated by using atomic absorption spectrophotometer after HF and $HClO_4$ digestion method (Page *et al.*, 1982) [13].

2.2 Economic valuation of tank silt in term of nutrients recycling

Quantity of tank silt uplifted in cu.m.per tank was collected from irrigation department, Latur and Osmanabad. The cost incurred for removal tank silt was derived from total expenditure per ton on tank silt application by the farmers with the help of interview with the farmer and pretested questionnaires. The mean value of total cost of tank silt transport was Rs. 69 per ton and calculated the total cost incurred for tank silt application. Total N, P, K, S and total micronutrients (Zn, Fe, Cu & Mn) in tank silt (Ton) was calculated by multiplying the amount of tank silt uplifted in ton with total nutrient(N, P, K, S, Zn, Fe, Cu & Mn) content in per cent of respective tank and expressed in ton. NPK & S fertilizers equivalent (Rs.) Valuation N, P, K and S equivalent in tank silt was based on market cost of urea, single supper phosphate, muriate of potash and elemental sulphur. The fertilizer equivalents were calculated by cost of nutrient per ton through the respective fertilizer and multiply with respective nutrient in tank silt in ton and expressed in rupees. Micronutrients (Zn, Fe, Cu and Mn) fertilizers equivalent (Rs.) Fe, Zn, Cu and Mn equivalent in tank silt was based on the existing market cost of ferrous sulphate, zinc sulphate, copper sulphate and manganese sulphate. The fertilizers equivalent were calculated by cost of nutrient per ton through the respective fertilizer and multiplies with ton of respective nutrient in tank silt. B:C ratio was calculated by the ratio of total fertilizer equivalent to cost incurred for removal of tank silt per tank.

3. Result and Discussion

The present investigation was carried on an economic evaluation of tank silt of Twenty five tanks of Osmanabad and Latur district.

3.1 Chemical Properties of tank silt

The tank silt samples were analyzed for total nutrient status. The data presented in table 2 shows that the tank silt of the study area was found alkaline in nature (7.3 to 8.1), low to high organic carbon (0.41 to 7.13) and medium to highly calcareous in nature (3.8-22.5). The total macro nutrients status viz. Total N, P, K and S varies from 0.046 to 0.094,

0.027 to 0.073, 0.11 to 1.12 and 0.199 to 0.619 per cent respectively with the mean values 0.065, 0.042, 0.506 and 0.29 per cent respectively. Total micronutrient status in tank silt for total Fe, total Zn total Mn and total Cu range between 4.05 to 7.56, 0.0064 to 0.0124, 0.001 to 0.159 and 0.0014 to 0.0138 per cent respectively with the mean values 5.43, 0.00777, 0.092 and 0.00917 per cent respectively.

3.2 Economics of removal tank silt from tanks for Osmanabad and Latur district during 2012 to 2016

As the quantity of the tank sediment deposited in the tank was huge, an economic feasibility for the tank desiltion process was required to be under taken. The data presented in table 3. shows that the volume of tank silt removed in different tanks ranged from 1,900 to 20,25,312 cu. m. The total volume of tank silt removed from different tanks amounted to 7,665,048 cu. m. from selected twenty five tanks of Osmanabad and Latur district. The highest quantity of tank silt removed ranged from 2,470 (Bhosga talaw) to 26,32,905.6 ton (Terna dam). Total quantity of tank silt removed from all tank was about 9,866,558.1 ton. The cost incurred varied from Rs. 1,70,430 to Rs. 18,16,70,486. The total cost incurred for removal of tank silt and its application on farmer field total an amount Rs. 68,07,92,509.

Table 2: Cost incurred for removal of tank silt from tanks and its application in farmer's field for tank silt hybridization under very shallow soil during 2012 to 2016.

Tank. No	Name of tank and village	Bulk Density ton /cu.m.	Quantity Of uplifted TS Cu.m.	Quantity of uplifted TS ton	Total cost Incurred for tank silt application @ Rs. 69/ton of TS (Rs.)
1.	Terna Dam	1.3	2025312	2632905	181670486
2.	Khed&Alnitalaw	1.4	0096090	0134526	009282294
3.	Wagholi	1.3	0089160	0115908	007997652
4.	Dhoki	1.2	0098300	0117960	008139240
5.	HatlaiTalaw	1.3	0096090	0124917	008619273
6.	PimpalgaonGhodki	1.3	0128092	0166519	011489852
7.	BangarwadiTalaw	1.3	0100519	0130674	009016554
8.	HiwraTalaw	1.3	0036615	0047599	003284365
9.	Ambi Tank	1.3	0037600	0048880	003372720
10.	Sina-Kolegaon Dam	1.3	0525717	0683432	047156815
11.	Sonari Dam	1.3	0105300	0136890	009445410
12.	Khasapuri Dam	1.3	0238685	0310290	021410044
13.	HangargaTalaw	1.3	0004200	0005460	000376740
14.	BarudTalav	1.3	0027900	0036270	002502630
15.	Bori Dam	1.4	0175860	0246204	016988076
16.	Nim-Terna	1.3	1379547	1793411	123745366
17.	BhosgaTalaw	1.3	0001900	0002470	000170430
18.	BenitraPrakalp	1.4	0238740	0334236	023062284
19.	Jakekur	1.2	0209380	0251256	017336664
20.	BalsurTalaw	1.3	0040000	0052000	003588000
21.	Nalegaon	1.2	1183053	1419663	097956788
22.	Sakulprakalp	1.3	0433071	0562992	038846469
23.	Mortalwadi	1.3	0158900	0206570	014253330
24.	Sukni	1.3	0160417	0208542	014389405
25.	Ekurka	1.3	0074600	0096980	006691620
Total/Average*		1.3*	7665048	9866558	680792509

TS: Tank silt

Table 3: Physicochemical properties of tank silt

Tank No.	Name of tank and village	Bulk density (Mgm^{-3})	pH	EC ($d\ Sm^{-1}$)	$CaCO_3$ (%)	OC (%)	Total N (%)	Total P (%)	Total K (%)	Total S (%)	Total Fe (%)	Total Zn (%)	Total Mn (%)	Total Cu (%)
1	Terna Dam	1.3	7.3	0.22	14.3	0.71	0.052	0.046	0.73	0.286	4.80	0.0065	0.021	0.00675
2	Khed&Alnitalaw	1.4	8.0	0.42	15.0	0.90	0.087	0.027	0.26	0.419	5.22	0.0082	0.158	0.00290
3	Wagholi	1.3	7.8	0.21	12.3	0.62	0.073	0.047	0.36	0.235	6.16	0.0079	0.034	0.00795
4	Dhoki	1.2	7.5	0.10	15.0	0.63	0.066	0.031	0.59	0.215	4.68	0.0070	0.159	0.00845
5	HatlaiTalaw	1.3	7.8	0.12	10.8	0.91	0.080	0.027	0.22	0.283	4.89	0.0081	0.137	0.01345
6	PimpalgaonGhodki	1.3	7.6	0.62	08.7	0.71	0.075	0.044	0.83	0.288	4.77	0.0066	0.001	0.0088
7	BangarwadiTalaw	1.3	7.7	0.32	04.4	1.00	0.094	0.027	0.26	0.272	7.56	0.0071	0.014	0.01265
8	HiwraTalaw	1.3	7.8	0.10	04.4	0.71	0.062	0.028	0.28	0.199	6.18	0.0124	0.015	0.0138
9	Ambi Tank	1.3	8.1	0.31	22.5	0.50	0.058	0.033	0.55	0.218	4.87	0.0082	0.024	0.01265
10	Sina-Kolegaon Dam	1.3	7.9	0.43	18.8	0.41	0.069	0.039	0.81	0.329	4.86	0.0080	0.129	0.01155
11	Sonari Dam	1.3	7.8	0.22	10.1	0.52	0.065	0.035	0.28	0.268	5.46	0.0082	0.136	0.01085
12	Khasapuri Dam	1.3	7.9	0.20	12.1	0.70	0.055	0.03	0.26	0.244	5.39	0.0078	0.156	0.00855
13	HangargaTalaw	1.3	7.9	0.10	15.1	0.42	0.094	0.045	0.73	0.268	5.08	0.0074	0.083	0.00835
14	BarudTalav	1.3	8.0	0.20	13.8	0.80	0.052	0.051	0.31	0.235	4.83	0.0074	0.151	0.01265
15	Bori Dam	1.4	7.8	0.21	03.8	0.51	0.049	0.043	0.64	0.249	7.41	0.0096	0.136	0.01200
16	Nim-Terna	1.3	7.9	0.30	08.0	0.41	0.049	0.055	0.74	0.252	4.56	0.0070	0.013	0.00590
17	BhosgaTalaw	1.3	8.0	0.20	15.0	0.60	0.084	0.06	0.42	0.619	7.34	0.0064	0.121	0.00690
18	BenitraPrakalp	1.4	7.8	0.20	06.9	0.60	0.046	0.037	0.77	0.230	4.78	0.0078	0.001	0.00335

19	Jakekur	1.2	7.6	0.52	11.8	0.83	0.047	0.033	1.12	0.251	4.56	0.0070	0.013	0.0094
20	Balsur Talaw	1.3	7.8	0.20	10.0	0.60	0.081	0.051	0.78	0.235	5.24	0.0090	0.149	0.0130
21	Nalegaon	1.2	7.7	0.31	11.6	0.67	0.063	0.050	0.44	0.309	4.77	0.0066	0.144	0.0032
22	Sakulprakalp	1.3	7.6	0.31	09.4	0.51	0.058	0.066	0.11	0.340	4.81	0.0069	0.141	0.0014
23	Mortalwadi	1.3	7.6	0.39	09.6	0.73	0.048	0.027	0.59	0.329	6.12	0.0081	0.101	0.0128
24	Sukni	1.3	7.7	0.33	09.8	0.85	0.064	0.073	0.22	0.345	4.05	0.0080	0.122	0.0120
25	Ekurka	1.3	7.8	0.21	13.8	0.57	0.051	0.051	0.35	0.359	7.45	0.0071	0.152	0.01005
Mean		1.3	7.7	0.28	10.9	0.70	0.060	0.040	0.510	0.290	5.43421	0.0077	0.0924	0.00917

Table 4: Economic valuation of tank sediments in term of total macro and micronutrientreturns to farmers field and its fertilizer equivalent in rupees.

Sr. No.	Name of tank and village	N fertilizer equivalent (Rs.)	P_2O_5 fertilizer equivalent (Rs.)	K_2O fertilizer equivalent (Rs.)	S fertilizer equivalent (Rs.)	Fe fertilizer equivalent (Rs.)	Zn fertilizer equivalent (Rs.)	Mn fertilizer equivalent (Rs.)	Cu fertilizer equivalent (Rs.)	Total fertilizer equivalent (Rs.)
1	2	3	4	5	6	7	8	9	10	11
1	Terna Dam	17560217	49959384	399780160	715360452	12637946880	36672491.50	63363506.20	133290846	14053933937
2	Alnitalaw	1501125	1498283	7275216	53548074	702225720	2363806.12	24358353.80	2925940.5	795696518.7
3	Wagholi	1085244	2247166	8679216	25876461	713993280	1962150.32	4516239.31	6911014.5	765270771.1
4	Dhoki	998550	1508414	14475968	24093330	552052800	1769394.10	21493963.40	7475715	623868134.5
5	HatlaiTalaw	1281748	1391263	5716256	33583935	610844130	2168194.99	19612218.80	12601002.4	687198748.7
6	PimpalgaonGhodki	1601835	3022331	28747888	45559762	794298492	2355055.06	190831.462	10990293.6	886766488.7
7	Bangarwadi	1575472	1455389	7066800	33766342	987900732	1988115.59	2096544.89	12397762.2	1048247158
8	HiwraTalaw	378517	549774	2772224	8998685	294164910	1264782.50	818235.40	4926548.25	313873676.6
9	Ambi Tank	363622	665379	5591872	10123048	238045600	858888.56	1344395.52	4637490	261630295.1
10	Sina-Kolegaon Dam	6048333	10994714	115144640	213606703	3321480006	11715939.80	101034501	59202305.7	3839227143
11	Sonari Dam	1141238	1976349	7972432	34852194	747419400	2405344.84	21335127.80	11139423.8	828241509.4
12	Khasapuri Dam	2188882	3839845	16780608	71925337	1672465795	5186266.78	55472494.40	19897378.3	1847756607
13	HangargaTalaw	65828	101351	829088	1390116	27736800	86579.71	519344.28	341932.5	31071039.49
14	BarudTalav	241903	763030	2338752	8097277	175184100	575136.65	6276378.42	3441116.25	196917693.8
15	Bori Dam	1547328	4367043	32774768	58239556	1824371640	5064751.12	38372370.60	22158360	1986895817
16	Nim-Terna	11271122	40688014	276040960	429342617	8177954616	26901076.8	26718238.6	79358441.2	9068275086
17	BhosgaTalaw	26611	61133	215696	1452483.5	18129800	33874.1728	342505.02	127822.5	20389925.19
18	BenitraPrakalp	1971979	5101277	53531296	73030566	1597648080	5586497.38	383034.456	8397679.5	1745650409
19	Jakekur	1514626	3420222	58532656	59911993.2	1145727360	3768827.44	3743211.89	17713548	1294332445
20	BalsurTalaw	540231	1093950	8436480	11609000	272480000	1002853.8	8879208	5070000	309111722.8
21	Nalegaon	11471421	29280562	129927616	416742250	6771795372	20078032.6	234278566	34071926.4	7647645746
22	Sakulprakalp	4188145	15327465	12881232	181846513	2707992963	8324215.55	90971673.8	5911419.15	3027443627
23	Mortalwadi	1271744	2300673	25350208	64563453.5	1264208400	3585453.05	23909651.2	19830720	1405020303
24	Sukni	1711847	6279724	9542832	68349673.3	844595505	3574995.51	29156688.1	18768789	981980053.9
25	Ekurka	634371	2040217	7060144	33075029	722501000	1475476.51	16893140.2	7309867.5	790989245.2
	Total/Average*	72181942.6	189932953	1237465008	2678944854	48823163381	150768200	796080423	508897342	54457434104

3.3 Economic valuation of tank silt in terms of fertilizer equivalent and benefit cost ratio during 2012 to 2016

In order to check whether the task of tank silt removal and their recommendation to apply to field makes sense, the economic feasibility of such investment cost was estimated. The value of the sediment was quantified in terms of fertilizers equivalent costs. The nutrient received from the sediment was conserved to be a profit (benefit) against the expenditure (cost) incurred in removal of sediment from the tanks. The quantity of nitrogen phosphorus potash and sulphur recycled to field was evaluated from the per cent nitrogen, phosphorus, potash and sulphur content in tank silt and quantity of tank silt uplifted from the tank. The total quantity of nitrogen, phosphorus, potash and sulphur returned to farmer field from selected 25 tanks was found to be 5, 627. 78 ton, 4,604.4 ton, 59, 493.5 ton and 28, 199.4 ton respectively (table 4). The quantity of iron, zinc, manganese and copper recycled to field was evaluated from the per cent Fe, Zn, Mn and Cu content in tank silt and quantity of tank silt uplifted from the respective tank. The total quantity of micronutrients return to farmer field.

4. Conclusion

The total recycles of tank silt in study area ranged from 2,470 to 26,32,905.6 ton. Total quantity of tank silt uplifted from twenty five selected tanks of Osmanabad and Latur District was about 98,66,558.1 ton during 2012-2016. The cost incurred for removal of tank silt and its application on farmer field was varied from Rs. 1,70,430 to Rs. 1,81,670,486. The total cost incurred for removal of tank silt and its application on farmer field total amount Rs. 68,70,92,509. The fertilizer equivalent of recycle of tank silt in study area varies from Rs.1,74,56,50,409 to 14,05,39,33,937 and the fertilizer equivalent of tank silt of all selected twenty five tanks in study area was found to be Rs. 54,45,74,34,104. The B: C ratio of total nutrients returned to farmer field varies from 68.24 to 119.64 with an average of 79.99. This showed that the fertilizer equivalent cost was found to be very high than the cost incurred for tank silt hybridization.

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