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Research Article

SOIL QUALITY ASSESSMENT UNDER DIFFERENT CROPPING SYSTEMS IN SUB-HUMID (DRY) ECOSYSTEM OF CENTRAL INDIA

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Abstract- Effect of different cropping systems (CS) on the soil quality (SQ) was assessed for soils of Sub-humid (dry) ecosystem of Central India in *Rahat* watershed of Nagpur District, India. Forty two surface and subsurface samples were analyzed for two physical indicators *viz.* bulk density (BD) and particle size distribution; four chemical indicators *viz.* electrical conductivity (EC), soil organic carbon (OC), Free Calcium Carbonate ($CaCO_3$) and soil available nitrogen (AN). SQ indicators were compared with its value under different CS in three different landforms. The components of each CS highly affects the soil properties *viz.* BD, clay content, OC and AN. The higher values of BD i.e. 1.31, 1.38 and 1.48 g cm^{-3} in Citrus + wheat under plateau top landform, sole tur– fallow under pediment landform and cotton–fallow under alluvial landform, respectively indicated the deterioration of the soil physical condition. The cotton–fallow CS also showed highest i.e. 60.59 per cent of clay. The sorghum-fallow CS adversely influenced the chemical environment in case of OC and AN, which showed lowest value (0.57% & 208 kg ha^{-1}, respectively). In alluvial landform, AN content was high in different CSs (278 to 348 kg ha^{-1}). The CSs, which does not add biomass in the soil, resulted in decreased OC and increased BD due to its anti-microbial effect in soil. The adverse impact of these CS on SQ indicators resulted in deterioration in quality of soil. Therefore, such CS should be prevented for long-term cultivation. Appropriate crop rotation with CS Soybean- Wheat-- Sorghum- Gram-- Soybean-Gram-- Sorghum--Wheat for *kharif*- *rabi* season in four consequent years should be followed.

Keywords- Cropping system, Landforms, Soil chemical indicator, Soil physical indicator, Soil quality

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Introduction

Vertisols are a group of heavy-textured soils, which occur extensively in the tropics, subtropics and warm temperate zones and are known as Black Cotton soils. India contains 24 per cent i.e. 60 mha area of the total area of 250 mha of Vertisols in the world.

In vertisol assessment of soil quality (SQ) and change of CS with time are the prerequisites to define the agricultural sustainability. The concept of SQ emerged in the early 1990s and defined as the capacity of a reference soil to function, within boundaries of natural or managed ecosystem, to sustain productivity of plant and animal, to maintain or enhance quality of water and air and to support the health and habitation of human being [1]. Soil quality can be expressed by a unique set of indicators that include the physical and chemical properties of soil. An ultimate function of soil of agricultural land is the crop production. Different management practices are followed under different cropping systems (CS) to optimize the biomass/agronomic production per unit area, per unit time and per unit input [2] and the soil attributes that are most sensitive to these managements are most desirable SQ indicators. The effect of CS on SQ can be assessed by measuring a range of physical and chemical soil properties. CS has significant effects on all soil properties measured especially in the surface soil layer [3].

In order to optimize the soil conditions required for enhancement of the sustainability of cropping system, the impact of continuous cropping on physical and chemical properties of soil should be well understood [4]. The effects of various CS on SQ is mainly due to accumulation of soil organic matter, which can be affected by the quantity and type of carbon input from crop biomass and manure and by management such as tillage that affect the decomposition rate and stratification of soil organic matter [5]. Soil organic matter accumulation can improve SQ by decreasing bulk density (BD), surface sealing and crust formation [6], and by increasing aggregate stability cation exchange capacity, nutrient cycling, and biological activity. Dependence on fertilizers and other input can be reduced by enhancing biological nitrogen fixation and water and nutrients use efficiency through adopting appropriate CS [2].

Though the advances in management practices for improvements in soil condition in order to enhance the performance of CS are recommended, the broad spectrum research is necessary to understand the effect of crop sequence and cropping intensity and their interactions on physico-chemical and biological soil properties [7].

Therefore, the present study summarizes;

(i) The impact of different cropping systems on soil properties which considered as SQ indicators,
(ii) The relationship among soil physical and chemical SQ indicators, quantifying SQ under different CS in SH (d) arid ecosystem of Central India.

Materials and Methods

Experimental site

The *Rahat* micro-watershed occurs in the basaltic terrain of Nagpur district in the state of Maharashtra in Central India. Geographically, the *Rahat* micro-watershed is located between 78° 33' to 78° 36'E longitudes and 21° 04' to 21°06'N latitudes. The general elevation of the area ranges from 500 to 525 meters above sea level (masl). The total area of the watershed is 363.02 ha. The watershed was divided into four major physiographic landforms *viz.;*(1) Plateau top (2) Isolated mound (3) Sloping Pediment (4) Alluvial plain. Soils are vertisols often rich in montmorillonitic and beidlite group of minerals. The climate of the area is sub-tropical, and sub-humid dry, which is mainly dry with very hot summer (March to May) and cold winter (November to February) except during the monsoon season (June to October). The maximum temperature shows sharp increase from 35° C in the first week of March to about 44° C till the end of May, occasionally reaching to around 47° C. The minimum temperature also have a similar rising tendency from about 19° C in the beginning of March to about 29° C by the end of May. The normal annual rainfall of the district is 1050 mm, which is unevenly distributed over 43 rainy days. The southwest monsoon sets in from last week of June and withdraws in the end of September, contributing to about 86 per cent of annual rainfall [8]. July and August are the wettest months in the region. Rest of 14 per cent rainfall is received during the non-monsoon period as western disturbances and thunderstorms.

Experimental details and laboratory analysis

Total seven fields of different cropping systems (CS) followed by farmers from last five years were selected from each of plateau top, sloping pediment and alluvial landform for study. Thus, total 21 farmers were selected; seven (fields of each CS) from each landform [Table-1]. Thus, two representative soil samples from selected field were collected from the surface and subsurface at depth of 0-20 and 21 to 40 cm, respectively. Soil samples collected were processed for laboratory analysis using standard procedure. When SQ is assessed for its capability to produce agricultural yield, the indicators selected to represent the soil were Bulk Density (BD) and particle size distribution as physical indicators; soil electrical conductivity (EC), soil organic carbon (OC), Free Calcium Carbonate ($CaCO_3$) and soil available nitrogen (AN) as chemical indicators. The particle size distribution analysis was determined as per procedure described by Jackson [9]. The textural class was determined using the USDA textural triangle as given in Soil Survey manual [10]. Bulk Density (BD) was determined by core method technique [11]. EC of soil was determined in 1:2.5 soil water supernatant using conductivity bridge [12].OC was determined by wet digestion method [13]. Free $CaCO_3$ was determined by rapid titration method [14]. Available nitrogen (N) was determined by alkaline permanganate method [15].

Table-1 *Different CS under three landforms of Sub-humid (dry) ecosystem of Central India*

Sr. No.	Cropping Systems		
	Plateau top landform	Pediment landform	Alluvial landform
1	Soybean-Gram	Cotton + Tur - Fallow	Soybean-Gram
2	Soybean-Wheat	Soybean-Wheat	Soybean – Wheat
3	Soybean- Fallow	Sorghum-Gram	Sorghum- Wheat
4	Sole Tur- Fallow	Sole Tur- Fallow	Sorghum – Gram
5	Citrus+Gram	Soybean - Gram	Sole Tur- Fallow
6	Sorghum- Fallow	Cotton- Fallow	Cotton- Fallow
7	Citrus + Wheat	Sorghum- Wheat	Sugarcane

Soybean (*Glycine max*), Gram (*Cicer arietinum*), Wheat (*Triticum aestivum*), Tur (*Cajanus cajan*), Cotton (*Gossypium spp.*), Sorghum (*Sorghum bicolor*), Citrus (*Citrus sinensis*), Sugarcane (*Saccharum officinarum*)

Statistical analysis

Statistical analysis was performed using UNIVARIATE, GLM and PFA of SAS 6.12 (SAS inst. INC 1996) [16]. The mean values and standard deviations were computed for comparison.

Results and Discussion

Impact of cropping systems on soil physical quality indicator

Bulk Density (BD)

The impacts of various seven CS on soil physical indicators under different landforms are given in [Table-2, Table-3, Table-4].

Table-2 *Physical Properties of Soil in Plateau top landform in Rahat Watershed*

Soil Properties	Soil Depth (cm)	Cropping System							Mean	SD
		Soybean-Gram	Soybean-Wheat	Soybean - fallow	Sole Tur - fallow	Citrus + Gram	Sorghum-fallow	Citrus + Wheat		
BD	0-20	1.28	1.17	1.24	1.21	1.18	1.28	1.31	1.24	0.05
(g cm^{-3})	21-40	1.39	1.24	1.36	1.34	1.23	1.16	1.41	1.30	0.09
Sand (%)	0-20	23.21	23.46	22.18	19.53	21.56	25.96	22.68	22.65	1.82
	21-40	22.64	21.85	20.30	19.37	21.19	24.89	23.71	21.99	1.78
Silt (%)	0-20	29.09	25.34	28.75	25.20	24.66	31.96	29.32	27.76	2.53
	21-40	28.01	25.78	28.90	23.79	23.77	30.13	26.40	26.68	2.28
Clay (%)	0-20	47.70	51.20	49.07	55.27	53.78	44.07	48.00	49.87	3.56
	21-40	49.35	52.37	50.80	56.84	55.04	46.98	49.89	51.61	3.16
Textural Class	0-20	Scly	Cly	Si Cly	Cly	Cly	Si Cly	Si Cly	-	-
	21-40	Scly	Cly	Si Cly	Cly	Cly	Si Cly	Cly	-	-

Table-3 *Physical Properties of Soil in Pediment landform in Rahat Watershed*

Soil Properties	Soil Depth (cm)	Cropping System							Mean	SD
		Cotton + Tur-fallow	Soybean-Wheat	Sorghum-Gram	Sole Tur-fallow	Soybean-Gram	Cotton--fallow	Sorghum-Wheat		
BD	0-20	1.27	1.28	1.31	1.38	1.23	1.31	1.12	1.27	0.08
(g cm^{-3})	21-40	1.50	1.35	1.40	1.46	1.36	1.42	1.29	1.40	0.07
Sand (%)	0-20	17.52	22.45	22.59	20.93	22.87	18.96	20.04	20.77	1.89
	21-40	15.78	20.54	21.72	20.22	21.10	19.91	20.00	19.90	1.78
Silt (%)	0-20	24.04	22.46	24.17	22.07	26.70	21.07	23.24	23.39	1.69
	21-40	24.20	21.35	23.51	21.53	24.87	20.07	22.53	22.58	1.59
Clay (%)	0-20	58.24	55.09	53.24	57.00	50.43	59.97	55.72	55.67	2.94
	21-40	60.02	58.11	54.77	58.25	54.03	60.02	57.47	57.52	2.18
Textural Class	0-20	Cly	Cly	Cly	Cly	Cly	Cly	Cly	-	-
	21-40	Cly	Cly	Cly	Cly L	Cly L	Cly	Cly	-	-

The lowest BD (1.17 g cm^{-3}) under Soybean - wheat CS and the highest BD (1.31 g cm^{-3}) under Citrus + wheat CS were observed in surface layer of Plateau top landform. In subsurface layer of this landform the BD varied from 1.16 to 1.41 g cm^{-3}. In Pediment landform the lowest BD (1.12 g cm^{-3}) under sorghum – wheat CS and the highest BD 1.38 (g cm^{-3}) under Sole Tur–fallow CS in surface layer were observed. The BD varied from 1.29 to 1.50 g cm^{-3} in subsurface layer of this landform. The lowest (1.19 g cm^{-3}) and highest (1.48 g cm^{-3}) BD in surface layer of Alluvial landform was under Soybean-wheat CS and Cotton–fallow CS, respectively. In subsurface layer of alluvial landform, the BD varied from 1.22 to 1.56 g cm^{-3}. In soybean-wheat CS and sorghum–wheat CS farmers adopt the practice of harvesting soybean and wheat crop above the ground level and leave the stubbles and roots in field subsequently incorporate in soil. The lower values of BD under soybean-wheat CS and sorghum–wheat CS might be due to the continuous biomass added to soil under these CS that increases the porosity and decreases the BD. On the contrary, as the farmers practice to up root cotton and tur-crops after harvest, overexploitation of available moisture, depletion of soil O_2 by crop makes soil particles denser. The similar trend of BD was also observed by Sinha *et al.*[17].

BD is an indicator of plant growth with respect to how well plant roots are able to extend into the soil [18]. It is used to calculate porosity.

Table-4 *Physical Properties of Soil in Alluvial landform in Rahat Watershed*

Soil Properties	Soil Depth (cm)	Cropping System							Mean	SD
		Soybean-Gram	Soybean-Wheat	Sorghum-Wheat	Sorghum- Gram	Sole Tur-Fallow	Cotton- Fallow	Sugar-cane		
BD (g cm^{-3})	0-20	1.31	1.19	1.28	1.35	1.46	1.48	1.29	1.34	0.10
	21-40	1.42	1.22	1.37	1.45	1.51	1.56	1.36	1.41	0.10
Sand (%)	0-20	18.47	19.98	16.28	18.71	16.59	15.92	21.07	18.15	1.82
	21-40	17.67	18.20	15.87	17.05	16.45	15.59	20.64	17.35	1.60
Silt (%)	0-20	23.08	24.59	23.47	24.05	23.52	23.49	21.13	23.33	1.01
	21-40	21.89	26.82	22.94	24.37	24.53	21.31	20.86	23.25	1.97
Clay (%)	0-20	58.45	55.43	60.25	57.24	59.89	60.59	57.80	58.52	1.73
	21-40	60.44	54.98	61.19	58.58	59.02	63.10	58.50	59.40	2.36
Textural Class	0-20	Cly	Cly	Cly	Cly L	Cly L	Cly	Cly	-	-
	21-40	Cly	Cly	Cly	Cly	Cly L	Cly	Cly	-	-

Particle Size Distribution

The particle size distribution of the soils has been given in [Table-2, Table-3, Table-4] in different cropping system of *Rahat* watershed.

Generally, the clay content increased gradually with the depth in Black soils of all the landform. The lowest clay content observed in surface layer was 44.07 per cent in sorghum-fallow CS of plateau top landform and the highest value of surface was 60.59 per cent in cotton - fallow CS in alluvial landform. The lowest value of subsurface layer was 46.98 per cent in sorghum cropping system in plateau top landform and the highest value of clay was 63.10 per cent in cotton - fallow CS of alluvial landform.

The clay was highest in alluvial landform (63.10%) in 40 cm depth and lowest in plateau top landform of 20 cm depth (42.97%). However, most of the soils were clay loam to clay in texture.

Impact of cropping systems on Soil Chemical quality indicator

Impact of cropping systems on Electrical conductivity

The detrimental effects of soil salinity are quantified in terms of soil EC. It may occur due to inappropriate soil drainage and use of saline water for irrigation. The data [Table-5-7] indicate that EC of surface soils under study area varied from 0.120 to 0.202 dS m^{-1} in plateau top landform, 0.142 to 0.302 dS m^{-1} pediment landform and 0.201 to 0.370 dSm^{-1} in alluvial landform of different cropping system area of *Rahat* watershed. The soil EC of entire study area showed non saline nature of soil and safe limit of less than 1.0 dS m^{-1} for all crops as prescribed by Richards [12] and Jackson [9]. This might be due to lower $CaCO_3$ content that does not affect the soil drainage. Secondly, the soils were irrigated with good quality non saline water. The soil EC in subsurface soils also observed in safe limit (0.090 to 0.331 dS m^{-1}) under entire study area.

Impact of cropping systems on Organic carbon

It is well established fact that the soil organic carbon (OC) plays a key role in pedogenic processes and maintenance of soil fertility [19]. It also contributes the various biogeochemical exchanges between the atmosphere and other components of environment [20-21].

The OC of surface soils under different CS were varied from 0.57 to 0.88 per cent for entire study area, which ranged from 0.57 to 0. 68 per cent, 0.65 to 0.75 per cent and 0.71 to 0.88 per cent in plateau top landform, pediment landform and alluvial landform, respectively. In subsurface soils it was ranged from 0.42 to 0.61 per cent, 0.59 to 0.68 per cent and 0.65 to 0.79 per cent in plateau landform, pediment landform and alluvial landform, respectively.

The data indicate that, in plateau top landform higher OC was recorded in soybean -wheat and soybean – gram CS i.e. 0.68 per cent and 0.67 per cent, respectively. The increase in OC under these CSs is attributed to decomposition of root and stubble biomass of soybean, wheat and gram crop as farmers' regular practice to leave these residues in field and incorporate in soil. The similar observations were reported by Hati *et al.*[22]; in case of soybean - wheat CS in vertisol of central India.

The lowest value (0.57%) of OC was observed in surface layer in sorghum - fallow CS in plateau top landform. This might be attributed to at least two reasons. First, the sorghum crop produces higher quantity of biomass and hence exploits higher soil nitrogen that reduces the OC levels. Second, the entire biomass of sorghum is removed by farmers and as no any residues of sorghum are left in field leads to decrease the OC. No significant increase in OC under sorghum CS was also reported by Dou *et al.*[23].

The highest value 0.88 per cent of OC was observed in tur- fallow CS in alluvial landform. All the soils under alluvial landform were found rich in OC. The higher level of OC under alluvial landform might be due to the deposition of higher quantity of biomass, and higher microbial activity due to alluvial nature of soils.

All the soils of study area fall under low to high range of OC. It showed a decreased trend with depth. Similar trend was also observed by Goyal and Singh [24].

Impact of cropping systems on Calcium carbonate

From the [Table-5, Table-6, Table--7] under different CS, the calcium carbonate in the surface layer of plateau top landform was 3.68 to 5.14 per cent and in subsurface layer was 3.57 to 5.64 per cent. The range occurred from 3.12 to 6.12 per cent and 3.62 to 6.42 per cent in surface and subsurface layers of pediment landform, respectively. In alluvial landform of watershed calcium carbonate was recorded 3.76 to 6.24 per cent and 4.38 to 6.12 per cent in surface and subsurface soils, respectively. The highest value of 6.42 per cent was recorded in pediment landform. The variation in calcium carbonate content in the study area might be due to variation in the parent material and pedogenic processes by which soils have developed. Similar trend of results were also obtained by Pharande and Sonar [25] working in important vertisol soil series of Maharashtra, India and Singh *et al.* [26] for the soils of Udaipur, Rajasthan (India).

Calcium carbonate in surface layer was 3.12 per cent in sole tur-CS under pediment landform, which was very low, and the highest value was recorded 6.24 per cent in sorghum-gram CS of alluvial landform. In subsurface layer lowest calcium carbonate was 3.57 per cent observed in citrus -gram CS in plateau top landform and the highest value 6.42 per cent was recorded in cotton + tur –fallow CS in pediment landform.

Impact of cropping systems on Soil Available Nitrogen (AN)

Nitrogen is the most vital major nutrient required by plants, which is an essential component of all proteins and its deficiency results in stunted growth, slow growth and chlorosis in plants. The AN content of the soils ranged from 217 to 310 kg ha^{-1} and 208 to 286 kg ha^{-1} in surface and subsurface layer of plateau top landform respectively [Table-5]. The AN recorded were 245 to 330 kg ha^{-1} and 211 to 319 kg ha^{-1} in surface and subsurface soils in pediment landform [Table-6]. All the soils of watershed area fall under low to medium category of AN. The highest values of AN were recorded 278 to 348 kg ha^{-1} and 260 to 332 kg ha^{-1} in surface and subsurface layer of alluvial landform respectively [Table-7]. Data indicate that AN decreased with increased depth in the study area. Goyal *et. al* [24] also found the similar results in soil of Haryana, India.

Table-5 *Chemical Properties of Soil in Plateau top landform in Rahat Watershed*

Soil Properties	Soil Depth (cm)	Cropping System							Mean	SD
		Soybean-Gram	Soybean-Wheat	Soybean - fallow	Sole Tur - fallow	Citrus + Gram	Sorghum-fallow	Citrus + Wheat		
EC -1:2.5 (dSm^{-1})	0-20	0.120	0.123	0.190	0.202	0.129	0.140	0.187	0.16	0.03
	21-40	0.090	0.100	0.100	0.128	0.150	0.130	0.142	0.12	0.02
Organic Carbon (%)	0-20	0.67	0.68	0.61	0.67	0.65	0.57	0.63	0.64	0.04
	21-40	0.59	0.61	0.53	0.52	0.58	0.42	0.59	0.55	0.06
$CaCO_3$ (%)	0-20	4.50	4.37	5.14	4.12	4.00	3.68	4.56	4.34	0.43
	21-40	4.75	4.76	4.37	3.87	3.57	4.75	5.64	4.53	0.63
AN (kg ha^{-1})	0-20	310	269	302	284	220	217	225	261.00	37.01
	21-40	286	243	280	255	258	208	210	248.57	28.49

Table-6 *Chemical Properties of Soil in Pediment landform in Rahat Watershed*

Soil Properties	Soil Depth (cm)	Cropping System							Mean	SD
		Cotton + Tur-fallow	Soybean-Wheat	Sorghum-Gram	Sole Tur-fallow	Soybean-Gram	Cotton--fallow	Sorghum-Wheat		
EC -1:2.5 (dSm^{-1})	0-20	0.169	0.149	0.157	0.184	0.142	0.203	0.302	0.19	0.05
	21-40	0.159	0.145	0.154	0.183	0.140	0.202	0.331	0.19	0.06
Organic Carbon (%)	0-20	0.65	0.71	0.68	0.70	0.75	0.71	0.73	0.70	0.03
	21-40	0.59	0.61	0.61	0.63	0.64	0.62	0.68	0.63	0.03
$CaCO_3$ (%)	0-20	5.61	3.61	6.12	3.12	3.25	4.90	4.80	4.49	1.09
	21-40	6.42	4.50	3.80	5.76	3.62	5.09	6.10	5.04	1.03
AN (kg ha^{-1})	0-20	301	287	315	330	325	245	277	297.14	27.82
	21-40	289	269	280	319	310	211	217	270.71	39.19

Table-7 *Chemical Properties of Soil in Alluvial landform in Rahat Watershed*

Soil Properties	Soil Depth (cm)	Cropping System							Mean	SD
		Soybean-Gram	Soybean-Wheat	Sorghum-Wheat	Sorghum- Gram	Sole Tur-Fallow	Cotton-Fallow	Sugar-cane		
EC -1:2.5 (dSm^{-1})	0-20	0.287	0.236	0.302	0.370	0.201	0.237	0.243	0.27	0.05
	21-40	0.307	0.234	0.289	0.305	0.200	0.255	0.221	0.26	0.04
Organic Carbon (%)	0-20	0.77	0.79	0.81	0.71	0.88	0.82	0.85	0.80	0.05
	21-40	0.71	0.68	0.73	0.65	0.79	0.67	0.72	0.71	0.04
$CaCO_3$ (%)	0-20	4.61	5.51	4.60	6.24	5.63	5.26	3.76	5.09	0.76
	21-40	5.36	5.61	6.12	4.54	5.87	4.76	4.38	5.23	0.63
AN (kg ha^{-1})	0-20	348	315	278	329	341	298	300	315.57	23.43
	21-40	329	297	260	316	332	280	280	299.14	25.42

In surface layer, AN was lowest *i.e.* 208 kg ha^{-1} in sorghum – fallow CS of plateau top landform and highest *i. e.* 348 kg ha^{-1} in soybean- gram CS of alluvial landform. In subsurface layer, the lowest value of AN 217 kg ha^{-1} was observed in sorghum-wheat CS of pediment landform and the highest value 332 kg ha^{-1} was observed in tur- fallow CS of alluvial landform.

The lowest AN in soil under sorghum - wheat CS may be due to higher N removed by these crops and no further addition of any organic inputs. AN in soil under soybean -gram and tur- fallow CSs might have been improved due to incorporation of crop residues in soil rhizosphere of these CSs. Sundara and Subramanian [27] also recorded the similar results in case of sugarcane CS.

Conclusion

The assessment of SQ indicators under different CS in Sub-humid (dry) ecosystem of Central India showed that, the soils of *Rahat* watershed are clay loam to clay in texture. The physical condition of soil is influenced by the CS. Citrus + wheat under plateau top landform, sole tur-fallow under pediment landform and cotton-fallow under alluvial landform deteriorated the physical condition of soil as is expressed by higher BD under CSs. The cotton- fallow CS also showed highest clay content. The various CSs did not influence chemical environment significantly with the only exception of sorghum - wheat CS in case of OC and AN, which showed lowest value thereof. In alluvial landform the AN content were high in different CSs. In general, the CS, which does not add biomass in the soil, resulted in decreased OC and BD due to its anti-microbial effect in soil. The adverse impact of these CS on SQ indicators results in deterioration in quality of soil. Therefore, such CS should be prevented for long-term cultivation. Appropriate crop rotation with CS Soybean- Wheat-- Sorghum-Gram-Soybean-Gram- Sorghum-Wheat for *kharif-rabi* season in four consequent years should be followed.

Conflict of Interest: None declared

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