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Evaluation of Soil Characteristics of Ravines of Dholpur

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ABSTRACT: Properties of ravine soils of Dholpur, Rajasthan, India were evaluated. Soil physico- chemical properties evaluated were bulk density, texture, water holding capacity, organic matter, pH, electrical conductivity and nutrient contents. The bulk density ranged from 0.83g/cm^3 to 0.95g/cm^3. Soils of all sites had higher proportion of sand ranged from 64.0% to 86.1%. Water holding capacity was low ranged from 35.0% to 39.4%. Soils of all sites had low organic matter ranged from 0.89% to 0.94%. pH of soils was slightly alkaline, the range of pH was from 7.5 to 7.7. Electrical conductivity ranged from 0.39 mS/cm to 0.51 mS/cm. Organic carbon in soils of all sites was low ranged from 0.52% to 0.55%. Nitrogen, phosphorus and potassium content was low, nitrogen ranged from 98.4 mg/Kg to 103.1 mg/Kg. Phosphorus content was in range of 4.7 mg/Kg- 6.2mg/Kg and potassium content was in the range of 109.7 mg/Kg- 166.3mg/Kg. Level of zinc, copper, manganese was optimal. Zinc ranged between 0.63mg/Kg and 0.70mg/Kg. Level of copper ranged from 0.2 mg/Kg to 0.5 mg/Kg and level of manganese ranged from 2.0 mg/Kg to 3.2 mg/Kg. Level of iron ranged from 3.1 mg/Kg to 5.3 mg/Kg. The level of iron was optimal (5.3mg/Kg) in soil of Shergarh and in other three soils the iron content was low. Physico- chemical properties of soil evaluated will be guiding factor for choice of plant cover for revegetation of this area. Organic carbon the key indicator of soil quality will be critical factor for restoration of ravine soils.

Keywords: Optimal nutrient contents; ravines; revegetation; restoration and soil key indicators.

INTRODUCTION: Soil is most basic resource, provides numerous ecosystem services such as food, feed, fibre, elemental cycling, water filtration, waste disposal, climate moderation through carbon cycling (Robinson et al., 2012). Human civilizations have developed based on performance of soils (Hillel, 2009).Major issue of this century such as food security, climate change, energy, water issues and biodiversity are governed by suitable use of soils (Jones et al., 2009). Key soil function is production of biomass which must be harnessed sustainably (Toth et al., 2007).

Soil structure is complex and key to physical, chemical and biological processes of soil (Roger- Estrade et al., 2009). Soil structure is vulnerable to soil erosion, and its conservation is necessary for restoration of soil and improving soil function.

There are specific techniques of restoring degraded soils such as conservation agriculture, afforestation, cover cropping and controlled grazing. Enhancing vegetation cover reduced soil erosion rates significantly, and decreased rate of erosion was exponential (Gyssel, 2005). Modelling approach to develop relationship between erosion and soil productivity has been attempted (Williams et al., 2013).Reforestation of ravine lands involves revegetation of table and marginal lands which are contributing to runoff of gullies (Chaturvedi et al., 2014). Knowledge of physico- chemical properties of soils is required for restoration of extremely degraded soils. The significance of plant cover in controlling soil erosion is widely accepted (Zuazo and Pleguezuelo, 2008). Choice of plant cover for revegetation depends upon soil properties, topographic factors and climatic factors. Different plant species have different capacity to stabilize soil and different plant species have different specific soil requirements for establishment.

Ravines of Dholpur consist of steep sharp hillocks, undulating surfaces and cut slopes formed by wide spread water erosion and soil loss. These ravines need rehabilitation and restoration. Very limited information is available with reference to ravine lands of Dholpur. The understanding of physico-chemical characteristics of ravine lands of Dholpur is of significance to evaluate the choice of revegetaion of area, for reclamation. Therefore, this study was undertaken to evaluate physico-chemical properties and nutrient status of ravine soils of Dholpur.

MATERIALS AND METHODS:

Study sites: Study sites were ravine soils of Dholpur, Rajasthan state, India (Latitude 26°42′ North, Longitude, 77°44′ East), which is characterized by uneven topological profile. Climate is semi- aridand temperature in summer is above 40ºC and in winter temperature reaches near zero and sub- zero levels. The average annual rainfall is 67 cm. Four study sites were selected for this study and all sites showed symptoms of heavy gully erosion (Table 1 and Figure 1).

Table 1: Study Sites of Dholpur, Rajasthan.

Site No.	Name of the site	Characteristics of soil	Site No.	Name of the site	Characteristics of soil
D1	Achaleshwar mandir	Ravine, gully erosion	D3	Shergarh	Ravine, gully erosion
D2	Sadarpada	Ravine, gully erosion	D4	Hirnauda	Ravine, gully erosion.

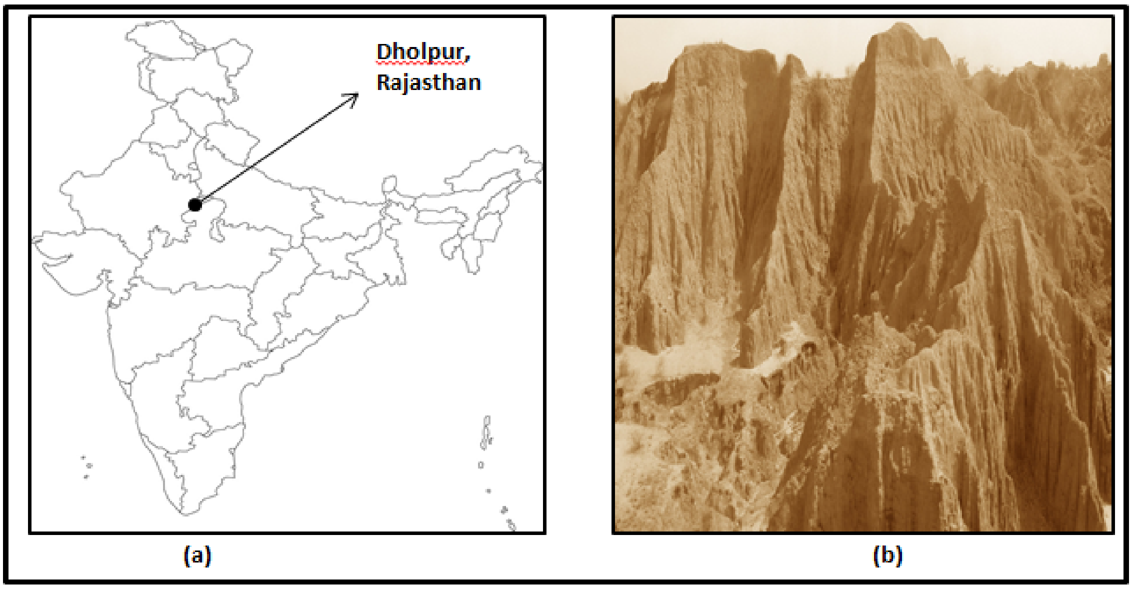

Figure 1: Map showing (a) Location of study site and (b) ravines of Dholpur, Rajasthan.

Soil sampling: Soil samples were collected from the surface layer (10- 15 cm)of soil with the help of stainless steel augers. Soil samples in five replicates were collected in plastic bags, were transferred to lab, cleaned, air dried for several days over pyrex petridishes. The air dried soil was crushed, homogenized sieved to obtain < 2 mm fraction.

Analytical procedures: All solutions were prepared in deionized water and all chemicals used were of analytical reagent grade. Physico- chemical parameters determined were bulk density, pH, electrical conductivity, texture, water holding capacity, organic matter, macronutrients and micronutrients.

The pH values were determined using the classical methods, ten grams of soil <2 mm were mixed with 50 ml deionized water and soil suspension subjected to shaking for an hour by using shaker, suspension filtered and pH measured using pH meter (Systronics make, model 335). Electrical conductivity determined by using conductivity meter (Systronics make, model 304). Bulk density determined using the method of Blake and Hartage, 1986. Soil texture was determined by hydrometer method suggested by Jacob and Clarke, 2002. Water holding capacity measured by using method suggested by Harding and Ross, 1964. Organic carbon measured by chromic acid wet oxidation method described by Walkely and Black, 1934 and organic matter calculated by multiplying organic carbon by 1.72.Total nitrogen estimated by microjeldahl method suggested by AOAC, 1995. Potassium estimated by ammonium extraction method suggested by Black, 1965 and analysis was done by using flame photometer (Pelican equipments, model Elite Ex). Available phosphorus estimated by sodium bicarbonate extraction method suggested by Olsen et al., 1954, and analysis was done using spectrophotometer (UV- Vis spectrophotometer, Perkin- Elmer, Lambda 25). For estimation of micronutrients soil samples were digested using aqua regia ($HCl:HNO_3$ in ratio of 3:1) using hot plate for heating. Digested extract analyzed for micronutrients (Zn, Fe, Cu and Mn) by flame atomic absorption spectrophotometer (GBC Scientific Equipment Ltd., Australia, Model NB14).

RESULTS AND DISCUSSION: Data of physico-chemical characteristics of soil pH, electrical conductivity (EC), bulk density, texture, water holding capacity and organic matter is presented in Table 2. Data of nutrient contents, organic carbon (OC), nitrogen, potassium, phosphorus, zinc, iron, copper and manganese is presented in figure 2.

Bulk Density: Bulk density ranged from 0.83±0.05 to0.95±0.06 g/cm^3. The soil of Hirnauda had highest density and it also had highest proportion of sand (86.1%) among the sites studied.

Water holding capacity (WHC): Water holding capacity was low in all sites, ranged from 35.0 % to 39.4%, and highest WHC was in soil of Shergarh.

pH: pH of soils ranged from 7.5 to 7.7. Soils of all four sites were slightly alkaline category as per USDA classification of pH ranges of soil.

Electrical Conductivity (EC): The electrical conductivity ranged from 0.39 mS/cm to 0.51mS/cm, which indicated that soils had low quantity of soluble salts.

Soil Texture: Soil texture of all sites had higher proportion of sand. On the basis of texture the soil of Hirnauda was sandy soil and soils of other three sites were sandy loam. Proportion of sand ranged from 64.0% to 86.1%.The clay content was low in all soils, it ranged from 2.7% to 16.2%. The clay content was very low just 2.7% in soil of site Hirnauda. Silt content was low in all soils, it ranged from 11.2% to 23.4%. (Table 2). Pearson's correlation matrix is presented in table 3.

Table 2: Physico- chemical attributes of ravine soils of Dholpur.

Sites	Name of the site	Bulk Density (g/cm^3)	pH	Electrical conductivity (mS/cm)	Texture of soil			Water holding Capacity (WHC) (%)	Organic Matter (%)
					Sand (%)	Silt (%)	Clay (%)		
D1	Achaleshwar	0.86±0.05	7.6±0.37	0.49±0.038	70.5±4.1	13.3±1.3	16.2±2.4	37.9±3.2	0.89±0.07
D2	Sadarpada	0.84±0.04	7.7±0.39	0.51±0.036	66.4±3.9	21.1±2.2	12.5±2.8	39.0±3.6	0.92±0.08
D3	Shergarh	0.83±0.05	7.5±0.36	0.39±0.040	64.0±3.7	23.4±2.1	12.6±1.9	39.4±3.0	0.94±0.06
D4	Hirnauda	0.95±0.06	7.7±0.35	0.48±0.041	86.1±5.8	11.2±1.0	2.7±2.6	35.0±2.8	0.89±0.07

Values represent the mean ±standard error, (n=5).

Table 3: Pearson's correlation matrix of physico-chemical characteristics of ravine soils of Dholpur.

	pH	EC	Sand	Silt	Clay	WHC	OM	OC	N	P	K	Zn	Cu	Mn
pH	1.00													
EC	0.87**	1.00												
Sand	0.587	0.331	1.00											
Silt	-0.492	-0.506	-0.852**	1.00										
Clay	-0.505	-0.051	-0.845**	0.441	1.00									
WHC	-0.425	-0.183	-0.982**	0.854**	0.812	1.00								
OM	-0.523	-0.617	-0.759*	0.983**	0.299	0.746*	1.00							
OC	-0.522	-0.616	-0.759*	0.982**	0.299	0.747*	1.00	1.00						
N	-0.699	-0.604	-0.931**	0.954**	0.622	0.888**	0.926**	0.926**	1.00					
P	-0.716*	-0.406	-0.972**	0.749*	0.902**	0.917**	0.661	0.661	0.894**	1.00				
K	-0.529	-0.88**	0.087	0.279	-0.435	-0.201	0.446	0.446	0.271	-0.057	1.00			
Zn	0.816	0.422	0.669	-0.289	-0.853**	-0.545	-0.218	-0.218	-0.557	-0.823	0.048	1.00		
Cu	0.943**	0.704	0.808	-0.628	-0.744*	-0.682	-0.602	-0.602	-0.829**	-0.905**	-0.274	0.899**	1.00	
Mn	-0.98**	-0.783*	-0.575	0.396	0.582	0.411	0.407	0.407	0.636	0.728*	0.411	-0.89**	-0.947**	1.00
Fe	-0.753*	-0.775*	0.088	-0.112	-0.037	-0.274	-0.006	-0.006	0.089	0.101	0.686	-0.487	-0.510	0.754*

**Correlation is significant at the 0.05 level (2-tailed)*
***Correlation is significant at the 0.01 level (2-tailed)*

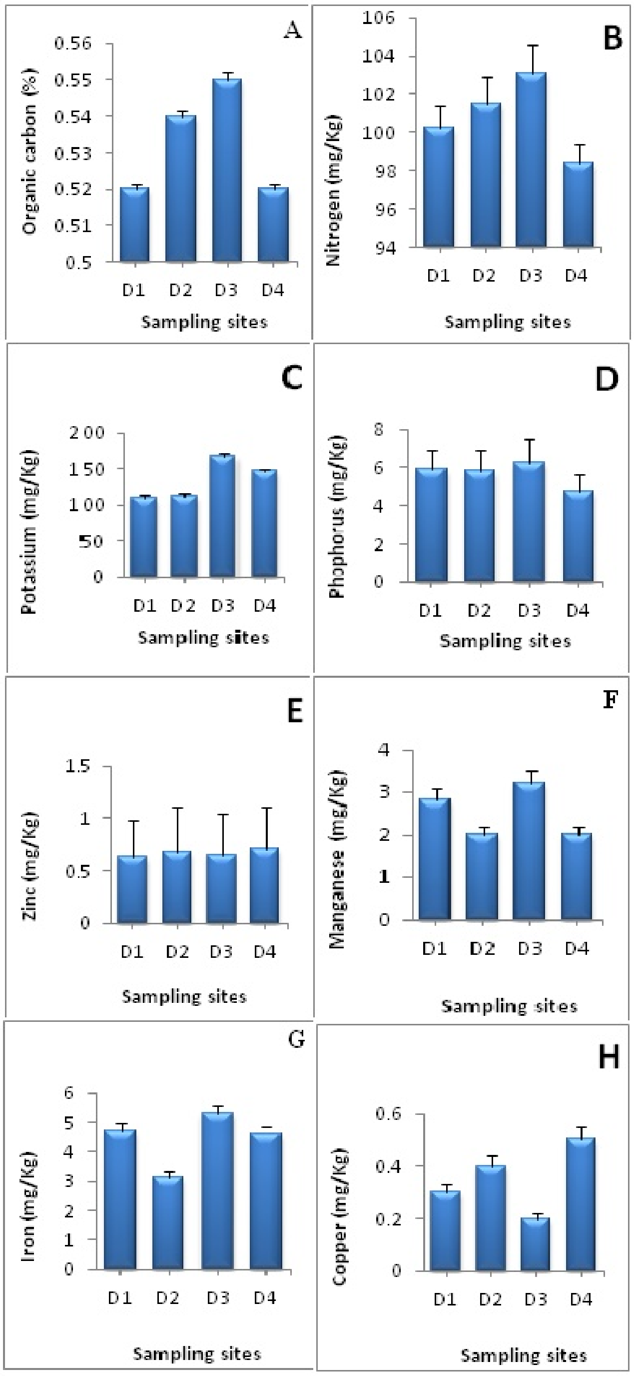

Figure 2: Nutrients in ravine soils of Dholpur (Rajasthan.): (A) organic carbon, (B) nitrogen, (C) potassium, (D) phosphorus, (E) zinc, (F)manganese (G)iron and (H) copper.Sampling sites: D1 (Achaleshwar), D2 (Sadarpada), D3 (Shergarh) and D4 (Hirnauda).Error bars indicate mean±SE (n=5).

Organic matter: All soil samples had low Organic matter ranged from 0.89% to 0.94%.

Nutrient contents: Organic carbon level was low in all sites ranged from 0.52% to 0.55%. Nitrogen was low in all sites ranged from 98.4 mg/Kg to 103.1mg/Kg. Phosphorus content of soil was low ranged from 4.7mg/Kg at Hirnauda to 6.2 mg/Kg at Shergarh. Potassium content of soil was low ranged from 109.7mg/Kg to 166.3mg/Kg. Highest potassium content was in soil of Shergarh. Level of zinc was optimal ranged from 0.63 mg/Kg to 0.70mg/Kg. Level of manganese was optimal ranged from 2.0 mg/Kg to 3.2mg/Kg. Level of copper was optimal ranged from 0.2 mg/Kg to 0.5mg/Kg. Level of iron ranged from 3.1mg/Kg to 5.3mg/Kg. The level of iron in soil of Shergarh was optimal and iron content was low in soil of other three sites. The inorganic metal composition of soil depends on both natural and anthropogenic factors. Erosion depletes nutrient reserves (Pimentel, 1995). Eroded soil particles contained nutrients about three times more than the nutrients left in soil behind (Young, 1989). In this study in general macronutrient contents were low in all soil samples. It is due to heavy soil erosion of the ravine lands.

15 soil attributes representing physical and chemical characteristics were analyzed through Pearson's correlation matrix revealed significant correlation in 37 pairs out of 105 pairs. Soil pH was positively correlated with electrical conductivity and copper and negatively correlated with phosphorus, manganese and iron. Electrical conductivity was negatively correlated with potassium, manganese and iron. Several authors including Molin and Castro, (2008) have reported strong correlation between clay content and soil electrical conductivity, whereas others have found no such correlation (Valente et al., 2012). In this study we did not find significant correlation between clay content and electrical conductivity. Valente et al., 2012 found correlation between electrical conductivity and phosphorus.

Sand was negatively correlated with silt, clay, water holding capacity, organic matter, organic carbon, nitrogen and phosphorus. Silt had positive correlation with water holding capacity, organic matter, organic carbon, nitrogen and phosphorus. Augustin and Cihacek (2016), found sand negatively correlated with organic carbon and silt strongly correlated with soil organic carbon, which reflected greater water holding capacity, which in turn increased plant productivity and carbon sequestration in soil.

The results of this study were similar to that of Augustin and Ciahacek (2016) that sand was negatively correlated with organic carbon and silt positively correlated with organic carbon. Clay had positive correlation with phosphorus and negative correlation with zinc and copper.

Water holding capacity (WHC) had positive correlation with organic matter, organic carbon, nitrogen and phosphorus. Organic matter and organic carbon had positive correlation with nitrogen. The consensus opinion among researchers has been that soil organic matter has little or no effect on available water capacity of soil. However Hudson (1994) reported soil organic matter is an important determinant of available water capacity. Chitranshi and Bhat, 2018, have observed significant positive correlation between water holding capacity and soil organic matter in ravine soils of Morena. Water holding capacity was found related to texture of soils (Mukhraiya and Bhat, 2017). In this study there was significant positive correlation between water holding capacity and organic matter.

Nitrogen had positive correlation with phosphorus and negative correlation with copper. Phosphorus was positively correlated with manganese and negatively correlated with copper. Zinc was positively correlated with copper and negatively correlated with manganese. Copper was negatively correlated with manganese and manganese negatively correlated with iron. Interaction among plant nutrients may be zero interaction or antagonistic or synergistic interaction (Rietra et al., 2017). Synergistic interactions are well known for N X K and N X P interaction (Aulakh and Mahi, 2005). Interaction of micronutrients and major nutrients synergism and antagonism between two mineral nutrients becomes even more important when the contents of both elements are near deficiency range (Malvi, 2011). In this study the correlation between various nutrients was highly variable from no correlation, positive or negative correlation depending on the mineral nutrient.

CONCLUSION: Ravine soils of Dholpur had higher proportion of sand and low water holding capacity. The level of macronutrients was low, while the level of micronutrients was mostly optimal. Organic carbon the key indicator of soil quality was low and pH was slightly alkaline. On the basis of physico-chemical properties this area can be restored by initially growing grasses.

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REFERENCES:

1. AOAC (1995) Official method of analysis. 16^{th} edition. Association of official analytical chemists, Washington DC.
2. Augustin, C. and Cihacek, L. J. (2016) Relationship between soil carbon and soil texture in the Northen Great Plains. *Soil Science* 181(8), 386-392.
3. Aulakh, M. S. and Mahi, S. S. (2005) Interaction of nitrogen with other nutrients and water: Effect on crop yield and quality, nutrient use efficiency, carbon sequestration and environmental pollution, *Advances in Agronomy,* 86, 341- 409.
4. Black, C. A. (1965) Method of soil analysis Part I. *Am. Soc. Agron*. Inc. Madison Wisconsin USA.
5. Blake, G.H. and Heritage, K. H. (1986) Bulk density. In Klute, A. (ed.). Methods of soil analysis. *Am. Soc. Agron.* 2^{nd} ed. No. 9 (Part I: 363- 375).
6. Chaturvedi, O. P., Kaushal, R., Tomar, J. M. S., Prandiyal, A. K. and Panwar, P. (2014) Agroforestry for Wasteland Rehabilitation: Mined, Ravine, and Degraded Watershed Areasin Agroforestry systems in India: Livelihood security and ecosystem services. (Eds.) J. C. Dagar, A. K. Singh and A. Arunachalam. Springer.pp. 233-271.
7. Chitranshi, S. and Bhat, J. L. (2018) Assessment of Physico-Chemical characteristics of ravine soils of Morena (Madhya Pradesh). *International Journal of Theoretical and Applied Sciences.* 10(1), 95-100.
8. Gyssel, G., Poesen, J., Bochet, E. and Li, Y. (2005) Impact of plant roots on the resistance of soils to erosion by water: a review, *Progress in physical geography,* 29(2), 189-217.
9. Harding, D. E. and Ross, D. J. (1964) Some factors in low temperature storage influencing the mineralizable nitrogen of soils, *J. Sci. food agri*., 15, 829-834.
10. Hillel D. (2009) The mission of soil science in a changing world, *J. Plant Nutr. Soil Science,* 172, 5-9.
11. Hudson, B. D. (1994). Soil organic matter and available water capacity, *Journal of soil and water conservation*, 49(2), 189- 194.
12. Jacob, H. and Clarke. G. (2002) Physical Method, Methods of soil Analysis. *Soil Science Society of America*, Madison, Wisconsin, USA.
13. Jones A., Stolbovoy V., Rusco E., Gentile A.-R., Gardi C., Marechal B.,Montanarella L., (2009) Climate change in Europe: Impact on soil. A review, *Agron. Sustain., Dev*., 29, 423–432.
14. Malvi, U. (2011) Interaction of micronutrients with major nutrients with special reference to potassium, *Karnataka, J. Agric. Sci.,* 24(1), 106-109.
15. Molin, J. P., Castro, C. N. E. (2008) Stabilizing management zones using soil electrical conductivity and other soil properties by fuzzy clustering technique, *Scienta Agricola*., 65, 567-573.
16. Mukhraiya D. and Bhat J. L. (2017) Evaluation of soil properties and lead content in agricultural soils of Gwalior, *Advances in Bioresearch*., 8(3), 46-53.

17. Olsen, S. R., Cole, C. V., Watanabe, F. S., and Dean L. A. (1954) Estimation of available phosphorus in soils by extraction with sodium bi carbonate. U. S. Dept. Agric. Circ. No. 939, 1- 19.

18. Pimentel, D., Harvey, C., Resosudarno, P., Sinclair, K., Kurz, D., Mcnair, M., Crist, S., Shpritz, L., Fitton, L., Saffouri, R., Blair, R. (1995) Environmental and economic cost of soil erosion and conservation benefits, *Science, New Series.*, 267, 1117- 1123.

19. Rietra, R. P. J. J., Heinen, M., Dimpka, O. and Bindraban, P. S. (2017) Effect of nutrient antagonism and synergism on yield and fertilizer use efficiency, *Soil Science and Plant analysis*., 48(16), 1895-1920.

20. Robinson, D., Emmett, B., Reynolds B., Rowe, E., Spurgeon, D., Keith, A., Lebron, I., Hockley, N., Hester, R. and Harrison, R. (2012) Soil natural capital and ecosystem service delivering in a world of global soil change, *Soils and Food Security.*, 35, 41- 48.

21. Roger-Estrade J., Richard G., Dexter A. R., Boizard H., De Tourdonnet, S., Bertrand M., Caneill J. (2009) Integration of soil structure variations with time and space into models for crop management, A review, *Agron. Sustain. Dev*., 29, 135–142.

22. Tóth G., Stolbovoy V., Montanarella L. (2007) Soil quality and sustainability evaluation, An integrated approach to support soil-related policies of the European Union, *A JRC* position paper, 40 p.

23. Valente, D. S. M., Queiroz, D. M. D., Pinto, F. A. C., Santos, N. T. and Santos, F. L. (2012) The relationship between apparent soil electrical conductivity and soil properties, *Revista Ciencia Agronomica*., 43(4), 683-690. Doi. Org/10.1590/s.1806.

24. Walkley, A. and Black I. A. (1934) An examination of Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method, *Soil Sci.*, 37(1), 29-38.

25. Williams, J. R., Jones, C. A. and Dyke, P. T. (2013) A modeling approach to determining the relationship between erosion and soil productivity, *Transactions of the ASAE,* 27(1), 129-144. Doi. 13031/2013.32748.

26. Young, A. (1989) Agroforestry for soil conservation CAB international, Wallingford, U.K.

27. Zuazo, V. H. D and Pleguezuelo, C. R. R, (2008) Soil- erosion and runoff prevention by plant covers. A review, *Agron. Sustain Dev*., 28, 65-86.