CIÊNCIAS AGRÁRIAS

SOIL STRUCTURAL QUALITY IN PASTURELANDS IN THE CITY OF BURITIS (RO), BRAZIL

DOI: http://dx.doi.org/10.31072/rcf.v9i1.567

QUALIDADE DA ESTRUTURA DO SOLO EM ÁREAS DE PASTAGENS NO MUNICÍPIO DE BURITIS, RONDÔNIA

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ABSTRACT: This study aims to evaluate the soil structural quality of pasturelands in the city of Buritis (RO), Brazil. The analysis took place at Boa Esperança and Boa Sorte farms, in November 2017. Three areas at Boa Esperança were evaluated: 1 – cultivation of Panicum maximum cv. Mombaça planted for 19 years; 2 – cultivation of Panicum maximum cv. Mombaça planted for two years; and 3 – cultivation of Brachiaria brizantha cv. Xaraés planted for a year and a half. The area 4 was evaluated at Boa Sorte, having Brachiaria decumbens cultivated for two years. For structural evaluation purposes, the visual examination method was deployed and grades from 1 to 6 for Soil Structural Quality Index were attributed. The average of indexes in each area was: area 1 – 4,87 (good structural quality); area 2 – 3,64 (regular structural quality); area 3 – 4,67 (good structural quality); and area 4 – 3,36 (regular structural quality). The obtained grades for areas 2 and 4 show that land use in such areas should be treated with conservationist techniques to improve overall soil structural quality over time. The good quality shown in area 1 points out that keeping fodder plants for large periods of time does not compromise overall structural quality. In this scenario, for better production results, it is only needed to improve chemical factors by fertilizing and correcting soil acid levels. The evaluation of soil structural quality is proven to be useful to help producers enhance their methods of land use, also contributing to a sustainable livestock production.

Keywords: Fodder plants. Land use. Rapid soil structural quality diagnosis.

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RESUMO: *O objetivo desse trabalho foi avaliar a qualidade estrutural do solo, em áreas de pastagens no município de Buritis-RO. A análise foi realizada em outubro de 2017, nas fazendas Boa Esperança e Boa Sorte. Foram avaliadas três áreas na fazenda Boa esperança: 1- cultivo de Panicum maximum cv. Mombaça plantado há 19 anos; 2 – cultivo de Panicum maximum cv. Mombaça plantado há 2 anos e 3 – cultivo de Brachiaria brizantha cv. xaraés plantado há 1 ano e 6 meses. Na fazenda boa sorte foi analisada a área 4, com cultivo de Brachiaria decumbens plantado há 2 anos. Utilizou-se o método visual atribuindo notas para o Índice de qualidade estrutural do solo (IQES), variando de 1 a 6. Á média do IQES obtido por área foi: área 1 – 4,87 (qualidade estrutural boa); área 2 – 3,64 (qualidade estrutural regular); área 3 – 4,67 (qualidade estrutural boa); área 4 – 3,36 (qualidade estrutural regular). As notas obtidas para as áreas 2 e 4 demonstram que o manejo nestas áreas deve ser melhorado com a adoção de práticas conservacionistas. A boa qualidade da estrutura observada na área 1, indica que a permanência da forrageira, por um período de vários anos, não compromete a qualidade estrutural do solo. Neste caso, para a melhoria da produção, apenas é necessário melhorar a parte química do mesmo, realizando práticas de correção da acidez do solo e adubação. A avaliação da qualidade da estrutura do solo é útil para auxiliar os produtores nas medidas necessárias para a melhoria dos manejos adotados.*

Palavras-chave: Forrageiras. Manejo. Diagnóstico rápido da estrutura do solo.

INTRODUCTION

Increase in the world's food demand is one of the consequences of population growth and high consumption per capita as expected for the next decades, especially for milk and beef [1,2]. In this scenario, tropical livestock (particularly the kind practiced in Brazil) will strongly influence the global agricultural economy, for this category will be responsible for serving a major part of said demand [3, 4, 5, 2].

In Brazil, most of the cattle herds is raised on grass. The state of Rondônia (RO) cultivates pasturelands in at least five million hectares approximately, being the main source of food for more than 13.2 million cattle and ranking 8th largest national herd [6]. Due to this feature, the country has one of the smallest cost ranks for beef production in the world, for this is the cheapest and most practical way to provide food to ruminant species [7, 8].

However, technologies used in most of the properties are scarce, without any concern with the grass culture and the proper land use. In addition to a poor native fertility of the soil, these are critical factors for technical, economic and ecological inconsistencies in the production process [6, 9]. Because of such irregularities, Brazilian pasturelands have a certain level of degradation [10]. Once deployed, the productivity of fodder plants tends to decline after the first years of cultivation. Consequently, within ten years, pasture areas are severely deteriorated [11]. Soil quality is a result of a blend of chemical, physical and biological processes that act simultaneously to provide adequate environment for developing organisms that inhabit it [12]. Rondônia lands have poor chemical quality that needs to be bypassed through fertilizing and liming – an essential procedure to every agriculture. However, local breeders are not known for commonly using such practice [13].

The city of Buritis is in the northern region of the state. With 3,247 km^2, the most part of its territory consists of livestock and agricultural properties, along with remnant native forests. Deteriorated areas were first noticed in the early 2000s and intensified as of 2005. The soil structure clearly shows the effects of previous adopted land use, whose mechanic, chemical and biological actions impacted either the processes of degradation or construction of the soil, affecting its fertility, biological activity and productive capability [12].

Therefore, an evaluation of soil structure quality is useful to diagnose signs of degradation that may compromise its quality overtime. Such evaluation may also demonstrate whether the land use with permanent grass for years physically compromises the soil quality.

This research aimed to evaluate the soil structural quality of pasturelands in the city of Buritis (RO), Brazil.

2 MATERIALS AND METHODS

Two different locations were chosen for this experiment to take place: the farm of Boa Esperança and the farm of Boa Sorte, both located in Buritis. Between 10°12’42’’S and 63°49’44’’W, the city has an elevation of 200 m. The climate is tropical – according to Köppen & Geiger [14], it is classified as Am, with average temperatures of 25.7 °C and average annual precipitation of 2,200 mm.

Boa Esperança has been raising cattle for beef production for more than two decades. Three lots of 10 hectares inside the farm were chosen, with distinct seasoning and grass species. In area 1, the present species was the *Panicum maximum* cv. Mombaça planted for 19 years. The area had not been treated with lime or fertilizers for such time. Area 2 had the same species, but the cultivation period was significantly shorter – two years. Again, no soil correction or fertilizing treatment had been deployed. The third area was composed by MG5 grass (*Brachiaria brizantha* cv. Xaraes), also known as bread grass, planted for 1.5 year. The pasture prior to the renovation showed signs of degradation.

Boa Sorte has also been raising cattle for beef production since it was founded. The evaluated area had 10 hectares growing signal grass (*Brachiaria decumbens*) planted for two years. No additional treatment had been deployed. Three samples were collected from each lot and later analyzed and graded according to the rapid diagnosis for soil quality method. To collect such samples, the following tools were utilized:

Table 1 - Sample collecting tools.

TOOLS	QUANTITY
Hoe	01
Spade	01
Plastic tray (W x L x H = 25 x 50 x 15 cm)	01
Machete and/or knife for handling samples	01
Tape measure	02
Layer separator	03
Camera	01

Source: Rapid Soil Structural Quality Diagnosis.

Collecting data consisted on picking the sampling spot and cleaning the superficial layer so that stubble from plants and other particles were removed. Then, using the hoe, a little trench (W x L x D = 20 x 40 x 25 cm) was dug. In each end, a portion of the soil (W x L x D = 10 x 20 x 25 cm) was moved with the spade. Exceeding parts were removed with the machete and discarded. The sample was positioned so that its depth overlapped the tray width of 25 cm. Using a light pressure with the index finger and thumb kept all resulting aggregates in their natural position after gently smashing the soil.

The first observations regarded signs of degradation, conservation and/or recovery, size of aggregates and their volume percentage, as seen in **Table 2**. Each layer was graded (Layer Structure Quality = LSQ), and later used to calculate the sample structural quality (Sample Structural Quality Index = SSQI). Finally, the sample index served as a base to calculate the whole terrain area index (Soil Structural Quality Index = SoSQI).

Table 2 - Layer structure quality.

Initial condition	Layers with signs of recovery			Layers with signs of degradation		
Lsq	Lsq = 6	Lsq = 5	Lsq = 4	Lsq = 3	Lsq = 2	Lsq = 1
Size of aggregates and their % within sample	More than 70% of aggregates, 1 to 4 cm	50 to 70% of aggregates, 1 to 4 cm	50 to 70% of aggregates, 1 to 4 cm	Less than 50% of aggregates, shorter than 1 cm and taller than 7 cm	50 to 70% of aggregates, shorter than 1 cm and taller than 7 cm	More than 70% of aggregates, shorter than 1 cm and taller than 7 cm.

Source: Rapid Soil Structural Quality Diagnosis.

With each layer grade (Lsq) and thickness, it was time to calculate the Sample Structural Quality Index (SSQI) through the following equation:

$$SSQI = \frac{(Lt_1 \times Lsq_1) + (Lt_2 \times Lsq_2) + (Lt_3 \times Lsq_3)}{T_{total}}$$

Where SSQI = sample structural quality index; Lt = layer thickness, in centimeters; Lsq = layer structural quality index; and T_{total} = total sample thickness/depth (25 cm). The average obtained from all three samples is the soil structural quality index (SoSQI).

3 RESULTS AND DISCUSSION

Table 3 features all numbers for SSQI and SoSQI, as well as variance outlines for each studied area. There was no significant difference in soil structural quality between the sampled lots. The variation coefficient obtained through analysis reached 17%. According to Pimentel Gomes [15], this coefficient is rated *low* if under 10% and *average* if between 10 and 20%.

Table 3: Soil structural quality results.

AREA	SSQI			SoSQI
Area 1	5.00	5.00	4.60	4.87 a*
Area 2	3.16	3.20	4.56	3.64 a
Area 3	5.00	5.00	4.00	4.67 a
Area 4	3.40	3.04	3.64	3.36 a

Data: Soil structural quality results. Data: Sample Structural Quality Index (SSQI); Soil Structural Quality Index (SoSQI). *Averages followed by the same letter are not statistically different from each other in the Tukey's range test at 5% of probability.

The highest grades were given to areas 1 and 3 (SoSQI = 4.87 and 4.67, respectively) from Boa Esperança farm. According to Ralich *et al.* [12], grades between 4.0 and 4.9 indicate good soil structural quality. Under these conditions, the authors recommend increasing the use of diversification systems that greatly contribute to aerial and root phytomass. In areas 2 and 4, grades obtained were equal to 3.64 and 3.66. SoSQI grades between 3.0 and 3.9 denote regular soil structural quality [12].

These grades – even those obtained from areas without any proper land use – are obtained because of the effect of grass in improving the soil structure. According to Ferreira *et al.* [16], systems featuring permanent pastures or a rotation between crops by direct seeding promote the formation of stable aggregates in larger sizes. The absence of soil inversion and the activity of grass rooting systems allow stable macroaggregates to form. In general, the presence of organic material could be observed in all samples, as well as the presence of large quantity of roots affecting aggregation, as seen in **Picture 1**.

Systems such the ones featuring permanent pastures can maintain the soil structure with no dramatic changes, even if undergone outer forces, namely animal stepping or mechanized processes [16]. This explains the good soil structural quality found in area 1, even though it had been 19 years after planting. Castro Filho & Logan [17] highlight that grasses contribute to an accumulation of vegetable residues inside the layer between 0 and 10 cm depth, causing better indexes of soil aggregation. Brandão & Silva [18] concluded that the rooting system of *Brachiaria ruziziensis* favors a higher occurrence of aggregates formation and stabilization. Many other researches confirm the contribution of organic material to such process in soils [19, 20, 21, 22, 23]. Therefore, organic material also helps reducing losses by erosion and increasing the water retention ability in soils [13].

Picture 1 - Abundance of aggregate roots from 1 to 4 cm (A); presence of organic material (B).

4 CONCLUSION

The presence and permanence of fodder plants for many years do not compromise overall soil structural quality. In this case, to improve the production process, it is only necessary to calibrate chemical aspects by correcting soil acidity and by fertilizing. The soil quality evaluation is useful to help producers plan measurements to best enhance the adopted land use.

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How to quote (Vancouver)

Zebalos CHS, Leite EG, Monteiro VG, Lima APD, Fogaça LGL, Soares ER, Nogueira AE. Soil structural quality In pasturelands in the city of Buritis (RO), Brazil. Rev Cient Fac Educ e Meio Ambiente [Internet]. 2018;9(1):245-252. DOI: http://dx.doi.org/10.31072/rcf.v9i1.567