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EVOLUTION OF THE SOIL ORGANIC MATTER CONTENT AFTER 15 YEARS OF CROP LIVESTOCK SYSTEM

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ABSTRACT

Soil organic matter (SOM) is sensitive to changes in land use and is a key indicator of soil quality. This work evaluates the evolution of the organic matter of an oxisol under a crop-livestock integration system (CLS) installed in 2005 and located in the Cerrado Biome, in Sete Lagoas, Brazil. The CLS system consists of four plots of 5.5 ha each, which in the spring/summer were cultivated in annual rotation with the crops of soybean+ intercropping Urochloa, corn+Urochloa consortium, sorghum+Megathyrsus consortium and Megathyrsus pasture. In autumn/winter, after crops' harvesting, succession pasture was used with beef cattle grazing. An area of native savanna ("cerrado"), above the experimental site, is used as a reference site. The organic matter content was measured by the method of wet digestion. The SOM values under CLS showed a tendency to approach the soil under native Cerrado. There was no significant difference in the global average levels and the analysis of the time series shows a general trend of increasing values under the CLS. There was a stability of SOM after 2012, with an average value of 4%.

Key words: Soil carbon stock; Sustainability; Soil quality

INTRODUCTION

The integrated systems are, beyond their technical and economic benefits, a way to achieve the goals of the sustainable development commitments signed by the government. The crop livestock and crop livestock forest systems (CLS/CLFS) are production systems included in the public policies' strategies for the agriculture aiming to achieve the COP 15 commitments for the climatic change mitigation (UN, 2015). For that goal, the federal law 12.187 and the decree 7.390 (National Policy for Climate Change) were done, and the Sector Plans for Mitigation and Adaptation, which include the CLS/CLFS in the top six methods concerning Brazil's Low Carbon Agriculture Plan (ABC Plan), a sector plan for the consolidation of the low carbon emission economy in agriculture and livestock). It aims to mitigate 133.9 to 162.9 million ton of CO_{2eq} emissions, through to recovering 15 million ha of degraded pastures and to increase in 4 million ha of CLS/CLFS. The measurement of some soil parameters is necessary to evaluate the efficiency of these systems, and to help their management strategies (RODRIGUES et al., 2010). The soil organic matter (SOM) is one of these parameters that is sensitive to land use changes (BALDOTTO et al., 2015; CONCEIÇÃO et al., 2005; NIAZ et al., 2017), and is a key indicator of soil quality (CONCEIÇÃO et al., 2005). The soil organic matter and its components are used as to evaluate the crop systems and their conversion to more sustainable ones. The conversion of degraded pastures to CLS system led to the increase of the biological components and of the organic carbon levels in the soil ecosystem (MUNIZ et al., 2011). This work presents and discuss the results of the evolution of the soil organic matter in a CLS experiment, along its 15 years since the implantation, compared to a native reference soil (cerrado).

MATERIAL AND METHODS

The soil was sampled in four experimental fields in the Technological Reference Research Unit of Crop Livestock Integrated Systems, started in 2005 in the Embrapa Milho e Sorgo's experimental station, at 19º 28'S, 44º 15'W and 732 m ASL. The unit is 22 hectares in area, split in four fields of 5.5 ha. A native savanna ("cerrado") area, in the upper area close to the experimental site, is used as a reference site. The soil of the area is a Typic Haplustox with high clay content. The samples were taken in the years of 2005, 2006, 2008, 2009, 2010, 2012, 2014, 2015, 2017, 2018 and 2019, through hand augering. Twenty single samples were taken for each compound sample, by random walking in the areas. In 2005, the samples were taken from the 0 to 20 cm and 20 to 40 cm soil depths. In 2006, 2009, 2010 and 2012, from 0 to 10 cm, 10 to 20 cm and 20 to 40 cm. in 2008, the sampling depths were at 0 to 10 cm and 10 to 20 cm, but the lines and the in-between lines were samples separately, and the results presented separately. In 2014 and 2015, the sampling depths were at 0 to 5 cm, 5 to 10 cm, 10 to 20 cm, 20 to 40 cm and 40 to 60 cm. From 2017 to 2019, the sampling depths were at 0 to 10 cm, 10 to 20 cm, 20 to 40 cm and 40 to 60 cm. The soil organic matter content was measured by the wet digestionmethod (TEIXEIRA et al., 2017). The results were subjected to the statistical analyses using the R system's (R Core Team 2018) packages "MASS" (VENABLES; RIPLEY, 2002) and "data.table" (DOWLE; SRINIVASAN, 2021).

RESULTS AND DISCUSSIONS

The values of SOM of the experimental fields under CLS showed a trend to get closer to the native soil references, and were related to the crop planted in the year of sampling. The experimental fields were cropped in a no-till system, and as it was consolidated, the deposition of crop residues was stabilized and the vertical distribution of the SOM followed the standard decrease with depth (Figure 1). The surface values were in the "good" level, according to standard recommendations and relatively high at 50 cm depth (CFSEMG, 1999), with no difference to the references. Also, no significant difference was found in the global average leves. The time series analysis of the fields shows a general trend to the increase of the SOM values under the CLS, and a no clear trend of the native reference, as the reference "cerrado 1" had increasing values and the "cerrado 2" decreasing values (Figure 2). It seems that a stable state was achieved after 2012, with an SOM average value of 4%. This result indicates that tha CLS has potential to capture carbon in the soil, with an adequate management. It also helps to improve the overall soil quality, as the SOM is a key factor to many soil properties and is a good indicator of soil quality. The comparison among the years indicates that the fields present different trends, and that the native references do not show clear trends, which may suggest that the variations here found are natural fluctuation along the time (Figura 5). The field "gleba 3" presents the higher SOM rise, while the "gleba 4" remained similar to the references without any apparent trend, which is coherent to its neighborhood plots to them. The natural spatial variability sums to the management effects on the total SOM values before the beginning of the experiment.

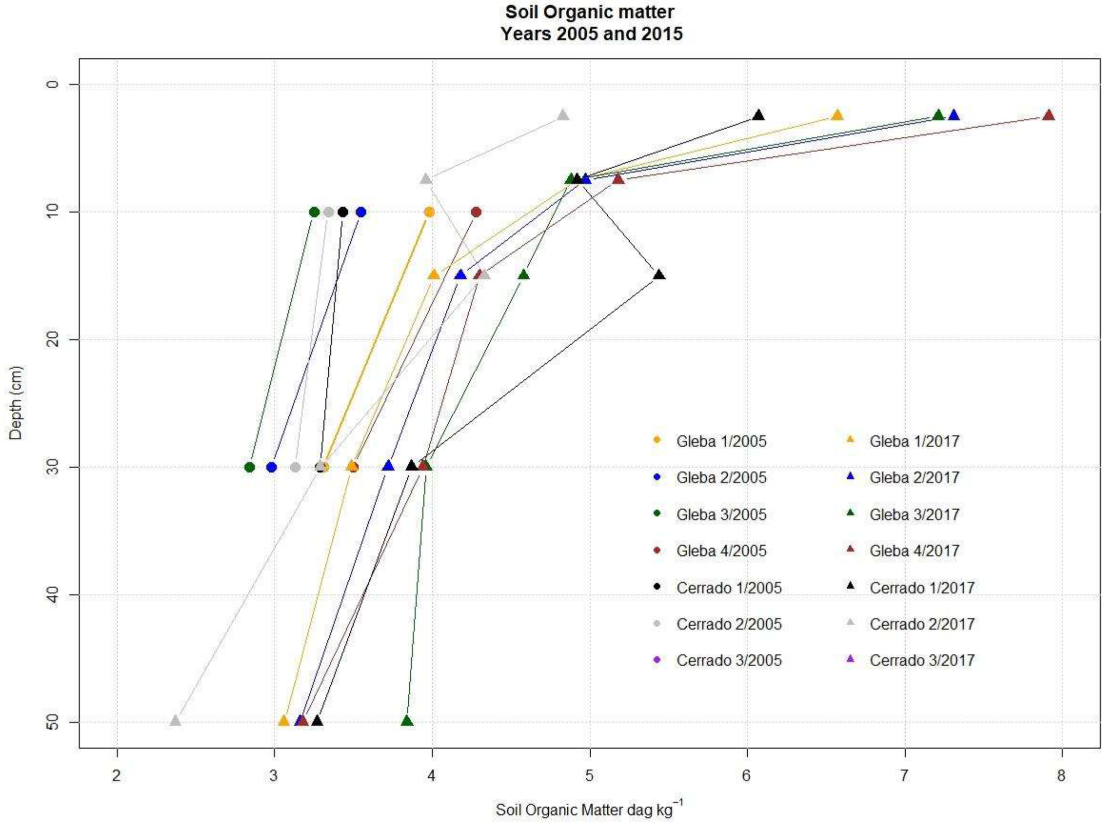

Figure 1. In-depth distribution of all samples collected in the plots sampled in the CLS and in Cerrado.

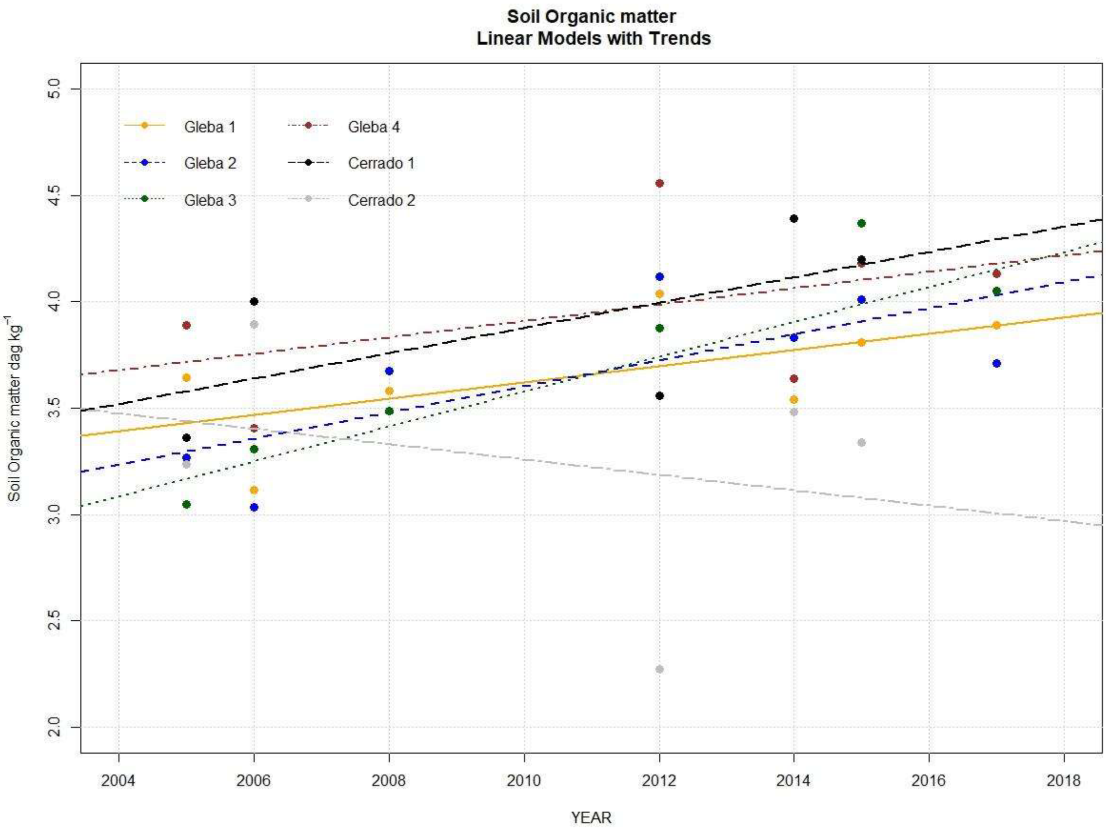

Figure 2. Linear regression models with the general trends of variation for the organic matter values (MOS) of the plots sampled in the CLS and in Cerrado.

CONCLUSIONS

The results of the monitoring of the soil carbon in the experimental long term CLS system indicates the it was able to increase the soil organic matter content, compared to the native reference. The system fields showed a general trend to accumulate SOM in the initial years and to stabilize these values afterwards, indicating the benefits of the CLS to them. The continued monitoring of the SOM in this experiment shows the importance of the long-term experiments with periodic sampling, to the adequate evaluation of the intensified crop systems as tools to achieve environmental goals, concerning its capacity to work as carbon sink. The result also shows the adequacy of the inclusion of the CLS/CLFS in the strategies for the public policies for the agriculture aiming to achieve the COP 15 commitments for the climatic change mitigation.

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