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Mapping the Impact of Intensive Rotational Grazing on Soil Fertility Over Time on Greenbrier Farms in Pickens County, South Carolina

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Introduction

Excessive population increases and negligent approaches to natural resource management and land use has prompted a global transformation into a predominantly anthropogenic era. Continued indifference to transition towards more sustainable lifestyles at a global scale will result in further irreversible alterations to the terrestrial biome. Additionally, the importance of rangelands and pastures is becoming more evident as agricultural systems now cover approximately 40% of the world’s ice-free land surface (Ramankutty et al., 2008). The need for cost effective sustainable food production and agricultural practices becomes increasingly imperative in supporting booming populations. Recent studies suggest that the potential detrimental impacts that unsustainable grazing intensities can have on valuable soil properties and fertility could be alleviated through thoughtful and effective management strategies (Wang et al., 2014). Wang et al. (2014) found that over a 4 year period of controlled grazing treatments, soil organic carbon and soil organic nitrogen content was greater with high intensity grazing and lower with low intensity grazing. Furthermore, research suggests that conservation tillage and sustainable land use and management will have the most benefit on soil quality in regions with low organic matter (Franzluebbers, 2005).

Intensive rotational grazing (IRG) is a management technique that involves a more intentional management approach which includes increased paddock numbers, shorter grazing periods, larger livestock presence per acre, and longer periods of rest on pasture (Figure 1). Potential advantages of this management technique include improved forage quality, greater yield, decreased erosion, stable production during adverse growing condition, and improved soil fertility (Undersander et al., 2002). This study collects and analyses data to understand the impact of rotational grazing on soil fertility as measured by SOC (soil organic carbon) and SON (soil organic nitrogen) on Greenbrier Farms in Easley, South Carolina. This study analyzes the transition from open grazing to five years of intensive rotational to observe the change in SOC and SON levels. The existing evidence on the intensive rotational grazing process is merely anecdotal and lacks sufficient data, but suggests that improved SOC and SON ratios should be expected. The purpose of this study is to provide some of the first, comprehensive scientific data regarding the impact that intensive rotational grazing has on soil fertility as measured by SOC and SON ratios and map the observed changes to visually portray the findings.

Mapping the changes in SOC and SON ratios overtime will provide an opportunity to analyze the trends in data and how they correspond to their location. The implications of scientifically supporting intensive rotational grazing as a method of improving soil fertility on pasture land has the potential to promote sustainable agriculture as a feasible practice, both environmentally and economically, which is becoming increasingly valuable considering the observed and projected global population growth.

Methods

Soil samples that were gathered prior to IRG in 2011 were compared with samples taken in the summer of 2016 to see the impact that IRG has had on the soil after 5 years. The two sets of samples were compared to identify the effect that land management has on soil fertility (as measured by soil organic carbon and soil organic nitrogen ratios). The study randomly sampled 33 of the 152 locations from the previous study by taking 60 cm soil core and 20 cm soil profiles (Figure 2). After the samples were processed in the lab, they were put into the LECO TruMac Carbon/Nitrogen Determinator, which heats samples to 1050°C and provides carbon and nitrogen analyses. Those carbon and nitrogen values were then analyzed and compared to the results of the 2011 study. GIS software (ArcMap) was used to plot the longitude/latitude coordinates of each sample location and the corresponding data with the Display XY data function.

Results

This study found that the management practices of intensive rotational grazing have generally had a positive impact on SOC and SON over time. The findings of this study will contribute to the baseline study done 5 years ago on the same farm to provide some of the first comprehensive data on the impact that intensive rotational grazing has on the soil organic carbon.

Carbon and Nitrogen values were measured in the LECO and that information was used to calculate the Carbon and Nitrogen content of soils in addition to the C:N ratio, which is used to identify and compare general soil fertility. Overall, both the average amount (mg) and percentage of Carbon and Nitrogen has increased since the 2011 study done before changing agricultural practices to intensive rotational grazing. The study further decreased in the upper 10 cm of the soil from 2011 to 2016 (due to a substantial increase in nitrogen values) and increased in the remainder of the samples, which is to be expected during grazing from erosion (Wang et al., 2016). Cecil Sandy Loam is the dominant soil series on Greenbrier Farms (representing 33.4%). The Cecil Sandy Loam soil cores exemplified the expected decrease in C:N ratio within the upper 10 cm and increase in C:N ratio from 10-60 cm (Figure 3). Some soil series, like Pacolet Sandy Loam, displayed a less dramatic effect of the decrease in C:N ratio within the upper 10 cm from 2013-2014. Hesse clay Loam, Hesse clay Loam, and Tallapoosa Sandy Loam also showed initial decreases in C:N ratios (which extended past the typical upper 10 cm depth) followed by an increase in C:N ratio. The Cecil Clay Loam soil series was the only one to differ from the expected results. Overall, the observed trends in changes in C:N ratios are generally representative of improved soil fertility and soil quality.

The maps in Figure 4, show the average changes in C:N ratios from 2011 to 2016 for the upper 10 cm of the soil and the lower 60-60 cm of the soil at each sample location. Larger points indicate more positive numbers while dark represents values greater than 1 and green represents values less than one. Most of the samples within the upper 10 cm of the soil have negative C:N ratio values and most of the samples within the lower 60-60 cm of the soil have positive C:N ratio values. The map makes is easy to identify patterns of where the outliers are located. For example, most of the positive values within the map of the upper 10 cm depths are clumped near one another, suggesting that there might be some similarities in the regional region. This information is helpful in altering IRG techniques at a local level to optimize the benefits and further strengthen to potential for sustainable agriculture.

Data Sources

Data was retrieved from Geospatial Data Gateway, which provides raster and vector data generated from USDA data. This data specifically utilized Soil Survey Spatial and Tabular Data (SSURGO 2.2, SC 077 Pickens County, South Carolina), Digital Ortho County Mosiac of 7.5’ quadrats by APLD, National Land Cover Dataset by State, and Coiled Data Layer by State. Data was analyzed with Microsoft Excel and ArcMap 10.4.1.

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