Effect of agriculture on soil properties associated with soil health and fertility in the Argentinean Pampas

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Introduction, scope and main objectives

During the last four decades, the Argentinean Pampas Region (APR) (lat: 33o 23'S to 38o 47'S, long: 57o 36'W to 65o 10'W) has been subjected to a land use change process known as "agriculturization", which is the conversion of native grasslands into croplands. This process can result in the depletion of soil organic matter (SOM) and nutrients availability. However, the extent of this degradation process remains unknown (Wyngaard, 2022). The aim of this study was to determine the current levels of SOM, pH, extractable P (Bray-P), and other nutrients (Ca, Mg, K, Zn, Mn, Cu and Fe) in pristine and cultivated soils.

Methodology

A total of 570 sites were sampled. At each site, composite soil samples (0-20 cm depth) were taken from a pristine condition (sampled in 2011.) and a cultivated field (sampled in 2011. and 2018). In these samples, pH (soil:water ratio of 1:2.5), P-Bray I, SOM, basic cations (1N ammonium acetate at pH 7), and micronutrients (extracted with DTPA) were determined.

Results

The SOM reduction between pristine and agricultural soils ranged from 25 percent to 41 percent (5.32 to 3.99 percent and 4.03 to 2.67 percent). The pH of the soils also decreased, as in 2011. 30 percent of the sites showed a pH below 6.26, while this percentage was 44 percent in 2018. From 2011. to 2018 there was a substantial depletion of nutrients which varied depending on the area within the APR: -21 to -38 percent for P-Bray, -19 to -29 percent for Ca, -30 to -40 percent for Mg, -12 to -30 percent for K, -40 to -57 percent for Mn, -29 to -74 percent for Zn. No significant change in exchangeable Fe and Cu was observed between 2011. and 2018, which presented values that are not limiting for agricultural production (Sainz Rozas, 2019.).

Discussion

Since SOM is a commonly used estimator of soil health, the observed SOM depletion indicates that the capacity of the soils to function within the agroecosystems has been compromised by agriculturization. The reduction in soil pH is associated with the observed depletion of basic cations caused by an extractive productive paradigm with limited replenishment of nutrients. The actual concentration of exchangeable basic cations was not currently limiting for agricultural production (from 1 650 to 3 939 mg kg-1 for Ca, 262 to 350 mg kg^{-1} for Mg, and 285 to 682 mg kg^{-1} for K). However, if the current depletion rates are maintained, basic cations would become limiting in 8 to 116 years, depending on the nutrient and the sub-region of the APR. From the evaluated macro- and micro- nutrients, P and Zn are currently at limiting levels in most of the soils, and the surface area

with concentration values below the critical thresholds has increased in the last decade. Along this line, the number of sites with concentration values below the critical threshold increased from 43 percent in 2011. to 66 percent in 2018 for P and from 47 percent to 67 percent for Zn.

Conclusion

The intensive agricultural activity in the APR is negatively affecting soil properties associated with its productive potential. Consequently, a change in the productive paradigm and management practices is required to revert this degradation process and decrease the crops yield gap, such as increasing the entry of carbon and N into the soil, liming, and fertilization with low-mobility nutrients.

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