# Theme 3
Impacts of soil nutrient management on the environment and climate change

# Linking straw use, carbon balance, greenhouse gas emissions, and crop growth for a sustainable sugarcane production


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## INTRODUCTION

Sugarcane is one of the world's largest biomass-producing crops and its production is expected to rise as global demand for bioenergy increases[1], (Fig. 1). After harvest, a huge amount of straw can be used for energy purposes, which could threaten soil conservation. This study aimed to determine a suitable removal rate of sugarcane straw based on its impact on greenhouse gas (GHG) emissions, soil carbon (C) balance, and crop growth

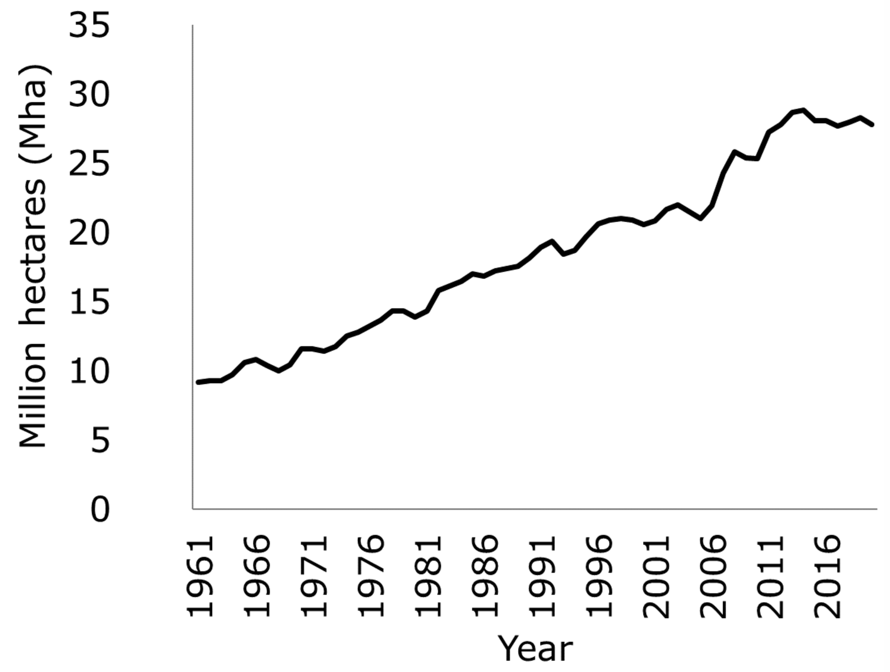


**Fig. 1.** Worldwide sugarcane cultivation area (Source, FAO 2022[2])

**Fig. 2.** Gas sampling by static chamber method

## METHODOLOGY

A field experiment with a horizon of three years was arranged in a completely randomized block design with three replicates in October 2021 in the department of Ledesma, Jujuy, Argentina. Treatments applied were: 100, 65, 30, and 0% of straw removal. We report the effects of these treatments on GHG emissions for the period of 135 days from straw removal. Gas samplings were performed 1, 7, and 24 days after harvest (October 5th, 2021), 3, 4, 7, and 10 days after N fertilization (November 1st, 2021), and monthly thereafter, by using the static chamber method (Fig. 2).

## RESULTS

Straw removal treatments had no significant effect ($p > 0.05$) on the adjusted mean values of $CO_2$ and $N_2O$ emission fluxes. The differential response of cumulative $CO_2$ and $N_2O$ emissions through time by treatments was not significant ($p > 0.05$) in this period and environment. This response, however, showed a consistent trend for cumulative $N_2O$: 32.7 ± 19.1; 21.3 ± 11.8; 12.7 ± 5.6; and 10.4 ± 5.1 mg $N_2O$ -N $m^{-2}$ for 100, 30, 0, and 65 % straw removal, respectively (Fig. 3). Unexpectedly, the treatment with 65% of straw removal showed the lowest cumulative $N_2O$ emissions. We hypothesize that $N_2O$ emissions reflect the availability of inorganic soil N as a result of the balance between soil and/or fertilizer N immobilization[3] and soil and/or straw N mineralization[4]. At 100% of removal, there was almost no N immobilization, leading to high N availability and the highest $N_2O$ emissions. At 30% of removal, cumulative straw N mineralization counterbalanced fertilizer N immobilization, resulting in considerable N available and cumulative $N_2O$ emissions. At 0% of removal, cumulative straw N mineralization could not offset fertilizer N immobilization, resulting in low N availability and $N_2O$ emissions. Finally, at 65% of removal, cumulative N mineralization (limited by a low straw amount) was also overcome by N immobilization, leading to low N availability and similar $N_2O$ emissions than 0% of removal. At 100% of removal, straw exploitation was penalized by the highest cumulative $N_2O$ emissions and lack of C input to the soil (which is unsustainable). In contrast, 0% of removal allowed C to enter the soil and reduced cumulative $N_2O$ emissions, but this practice did not allow its exploitation.

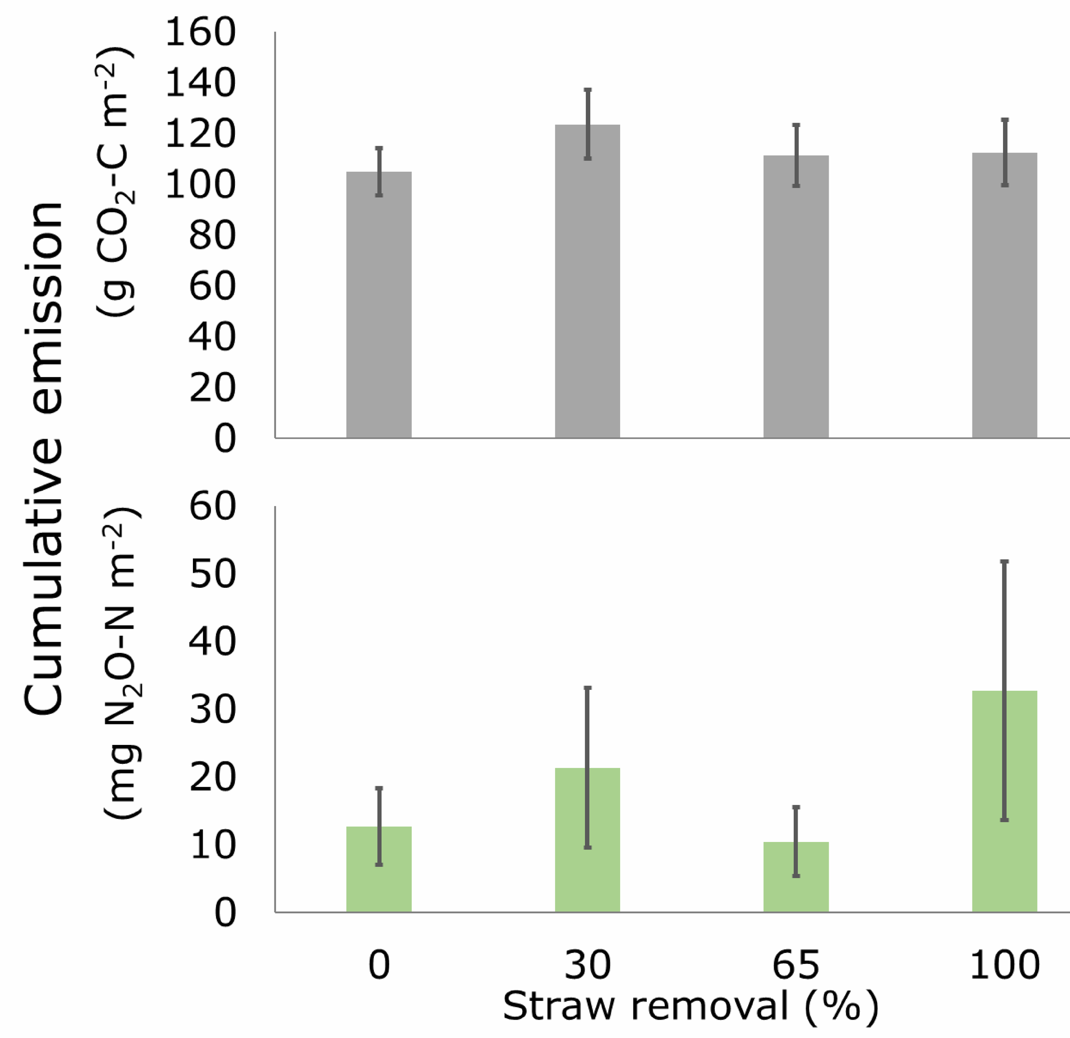


**Fig. 3.** Cumulative $CO_2$ and $N_2O$ emissions over a period 135 days from straw removal

## CONCLUSIONS

The range of 30 to 65% of removal seems to be the desirable sustainable straw use. In fact, when $N_2O$ emissions were relativized to C inputs, these treatments showed mean and similar ratios among them, whereas 100% and 0% of removal showed the lowest and highest ratios. Thus, depending on soil C stock, these two management strategies could be used to exploit straw while decreasing the environmental impact. Measurements and analyses need to be continued to determine the impact of straw removal rates on the rate of change of soil carbon, crop yield, and annual cumulative $CO_2$ and $N_2O$ emissions.

## ACKNOWLEDGMENTS


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