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Replacing oxen with tractors: Reduction or shift in greenhouse gas emissions?

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Abstract

Cattle supply over 60% of draft power employed to increase labor productivity in mixed crop-livestock (MCL) systems within Africa. They also emit more than 60% of greenhouse gas (GHG) emissions from the livestock sector, such that replacing oxen with tractors has also been proposed as an emission mitigation strategy. Using survey data from Ethiopia, this study estimated and compared GHG emissions from MCL farmers pre- and post- adoption of tractor services, to elucidate the change in total GHG emissions.

Forty-eight farmers in the Arsi zone of Oromia, Ethiopia were purposively selected following consultative talks with key stakeholders (e.g., Oromia Mechanization Office). A farmer was interviewed if he/she (i) practiced MCL farming; (ii) used tractor services of local farmer cooperatives; and (iii) was willing and able to provide information on their production practices pre- and post-adoption (between 2002 and 2022) of tractor services. Employing a semi-structured questionnaire, we collected data on cattle herd structure and size, feed and manure management, as well as use of animals and tractors for crop production activities. Additionally, data on the types of crops grown, land cultivated, fertilizer and pesticide application, and yields were collected. Combining these data with information from the Oromia cattle Tier 2 GHG Inventory, we followed the IPCC Tier 2 approach and estimated the total GHG emissions from livestock and crop production activities.

On average, the total herd size in this study decreased by 59.5% while cropland increased by 52.3% from pre- to post- adoption of tractor services for farming activities. The reduced herd size resulted in a decrease from 528.7 to 223.7 tCO₂ equivalents (CO_{2e}) in livestock emissions while crop-related emissions increased from 84.2 to 187.4 tCO_{2e} pre- and post- adoption of tractor services for farming activities. As such, replacing draught power with tractors resulted in a 33% net decrease in total GHG emissions within this study. Therefore, replacing oxen with tractors on MCL farms is an effective mitigation strategy for reducing the total GHGs emitted.

Keywords: Africa, cattle, greenhouse gases, mitigation strategies, mixed crop-livestock systems