Ex-ante farm-scale analysis of the impacts of livestock intensification on greenhouse gas emissions in mixed crop-livestock systems in Sub-Saharan Africa

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Short title

Effect of livestock intensification on the farm GHG balance

Summary text

Sub-Saharan livestock contribute significantly to global warming. Substantial progress can be made via livestock intensification if this is accompanied by techniques that limit nutrient losses during the biomass cycle between livestock and crops on the farm. In many sub-Saharan African countries, local farmers already apply more intensive forms of livestock production, so African research institutions now need to focus on the design and dissemination of locally adapted nutrient conservation techniques to reinforce these dynamics.

Abstract

Livestock intensification is widely assumed to be an effective way to mitigate the environmental footprint of livestock products in sub-Saharan Africa (SSA). However it does not make sense to evaluate livestock farming separately when the majority of farming systems in SSA are mixed crop-livestock systems. The aim of this study was consequently to use a whole-farm simulation model to properly evaluate the impacts of livestock intensification.

The model, FarmAC, is a stock-flow model representing the carbon (C) and nitrogen (N) cycles. The calculated greenhouse gas (GHG) balance takes both direct and indirect on-farm emissions in account. Three mixed millet-groundnut-beef cattle farming systems typical of those in the groundnut basin of Senegal were simulated: (i) a traditional extensive farm based on free-grazing and night corralling (Farm 1), (ii) an intensive farm where manure is collected from fattening cattle and used to fertilize crops (Farm 2), and (iii) an improved intensive farm similar to Farm 2 but where further nutrient conservation techniques such as covering the manure heap and in-soil manure incorporation are used (Farm 3).

Our findings confirm the effectiveness of livestock intensification and underline the mitigation effect of nutrient conservation. The GHG balance decreased by 17% after intensification (from Farm 1 to Farm 2), and by a further 12% when nutrient conservation techniques were also applied (from Farm 2 to Farm 3). In fact, better feeding practices also increased the amount of C and N available throughout the cycles via manure management, and consequently also improve crop production if the nutrients are well conserved.

While in the 20th century, efforts in SSA were mainly concentrated on intensification, our results suggest that current agricultural policies should now also support the design and dissemination of nutrient conservation techniques to reinforce observed livestock intensification dynamics.

Keywords: Mitigation; Whole farm model; Nitrogen and carbon cycles; Livestock intensification; Nutrient conservation; Mixed cereal-legume-ruminant farming systems; Senegal