Food security and greenhouse gas emissions for cereals in sub-Saharan Africa towards 2050

M.K. van Ittersum[1], R. Hijbeek[1], M. P. van Loon[1], H.F.M. ten Berge[2], P.W. Mtakwa[4], K. Tesfaye[3]

[1]Plant Production Systems, Wageningen University and Research, the Netherlands
[2]Wageningen Plant Research, Wageningen University and Research, the Netherlands
[3]International Maize and Wheat Improvement Centre (CIMMYT), Ethiopia
[4]Department of Soil Science, Sokoine University of Agriculture, Tanzania

Contact: martin.vanittersum@wur.nl

Abstract

We assessed the increase in cereal demand and associated greenhouse gas (GHG) emissions for ten countries in sub-Saharan Africa (SSA) in 2050, based on different scenarios of intensification or cropland area expansion. Our results show that intensification brings lower GHG emissions than area expansion, but gains depend on the level of agronomic nitrogen use efficiency (N-AE) achieved. With current N-AE and yield trends, GHG emissions will increase by 5-6 fold.

Keywords: sub-Saharan Africa, food security, greenhouse gas emissions, nutrient inputs, agronomic nitrogen use efficiency, nitrous oxide, carbon dioxide

1. Background

In projecting increases in food demand towards 2050, regional differences are more relevant than global estimates. In SSA, cereal demand is likely to nearly triple between 2015 and 2050 due to rapid population growth. This study assesses whether SSA can be self-sufficient in cereals by 2050 under different scenarios of intensification on existing cereal area. In addition, we assessed associated GHG emissions for each scenario.

2. Methods

Demand increase for cereals (maize, millet, rice, sorghum, wheat) were based on population growth and dietary change for ten countries (Burkina Faso, Ethiopia, Ghana, Kenya, Mali, Niger, Nigeria, Tanzania, Uganda and Zambia). Spatially differentiated water-limited (rainfed) yield potentials were simulated using crop growth models. Following, we assessed the impact of achieving cereal self-sufficiency on GHG emissions for the same ten countries by 2050 through scenarios of intensification using more crop nutrients per ha and through agricultural area expansion (at the expense of forest and grasslands). Nutrient input requirements were based on a high N-AE variant using an equilibrium model. In addition, for maize a low N-AE variant was used based on the empirical mean N-AE obtained from large sets of on-farm experiments.

3. Results

We show that cereal self-sufficiency in SSA is possible with current cereal area, but only just so. Current yields of ca. 20% of yield potential will have to increase to ca. 80% of the potential, which requires an unprecedented steep and continuous increase in production for rainfed systems. Intensification brings lower GHG emissions than cropland area expansion, but gains depend on the level of N-AE achieved. Regardless of scenario, GHG emissions will be at least 50% higher in 2050 than 2015 and will increase by 5-6 fold with current yield trends and N-AE values.

4. Discussion

Intensification scenarios will lead to less GHG emissions than area expansion scenarios, but this requires substantial advancements in N-AE values. As such, intensifying cereal production with good agronomy and nutrient management is essential to moderate inevitable increases in GHG emissions while producing sufficient cereals for the growing African population. We will discuss empirical examples on the feasibility to achieve such good agronomy with high N-AEs.

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