A generic methodology for calculating water and nutrient requirements for attaining target crop yields

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Introduction

Crop yield gaps quantify the potential for yield increases. Closing yield gaps may require more inputs, and a question is: how much?

In analogy with the yield gap, *the input gap* is the difference between the minimum amount of input(s) required for a target yield and the input use under current practice.

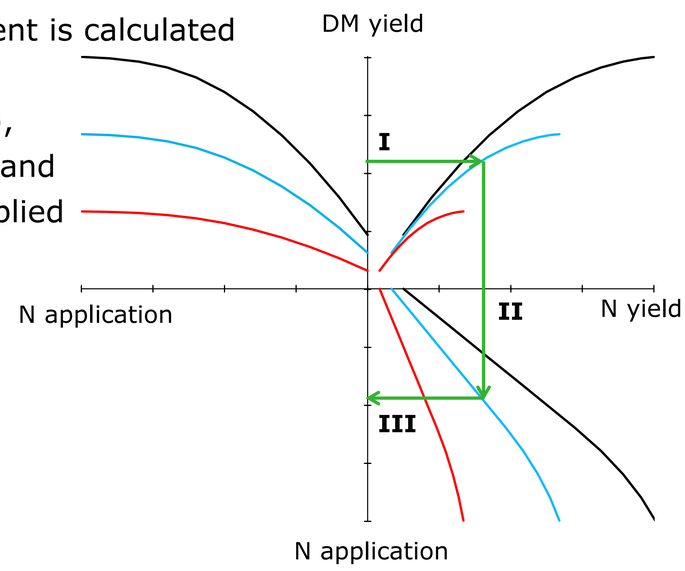
We developed a methodology to calculate nitrogen fertilizer requirements and input gaps and present preliminary results for maize in Africa.

Methodology

We have combined existing model approaches:

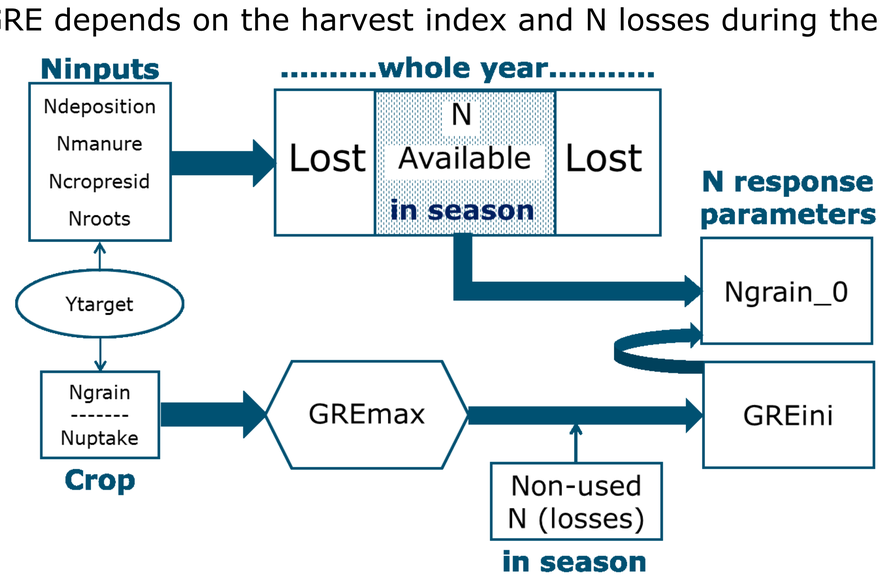
1. Potential yield and water use are calculated with a crop model as function of crop characteristics and global grid-based data of weather and soils (CRU-TS 3.20; FAO-DSMW & ISRIC-WISE v1.0).

2. Minimum fertilizer N requirement is calculated as function of target yield, indigenous soil N supply (SNS), applied animal manure (MAN) and grain recovery efficiency of applied fertilizer N (GRE), while maintaining soil N equilibrium.



Calculation steps:
I. select target DM yield
II. calculate N yield
III. calculate N application

3. In maintaining soil N equilibrium, we have calculated SNS depending on the amount of crop residues left in the field and MAN depending on part of the aboveground biomass fed to animals, while GRE depends on the harvest index and N losses during the cropping cycle.



Basic equilibrium equations of annual crop and soil N balances:
a) Nuptake = Nroots + Ncropresidue + Nbyproduct + Ngrain
b) Ndeposition + Nroots + Ncropresidue + Nmanure + Napplication = Nuptake + NsoilLosses

Results

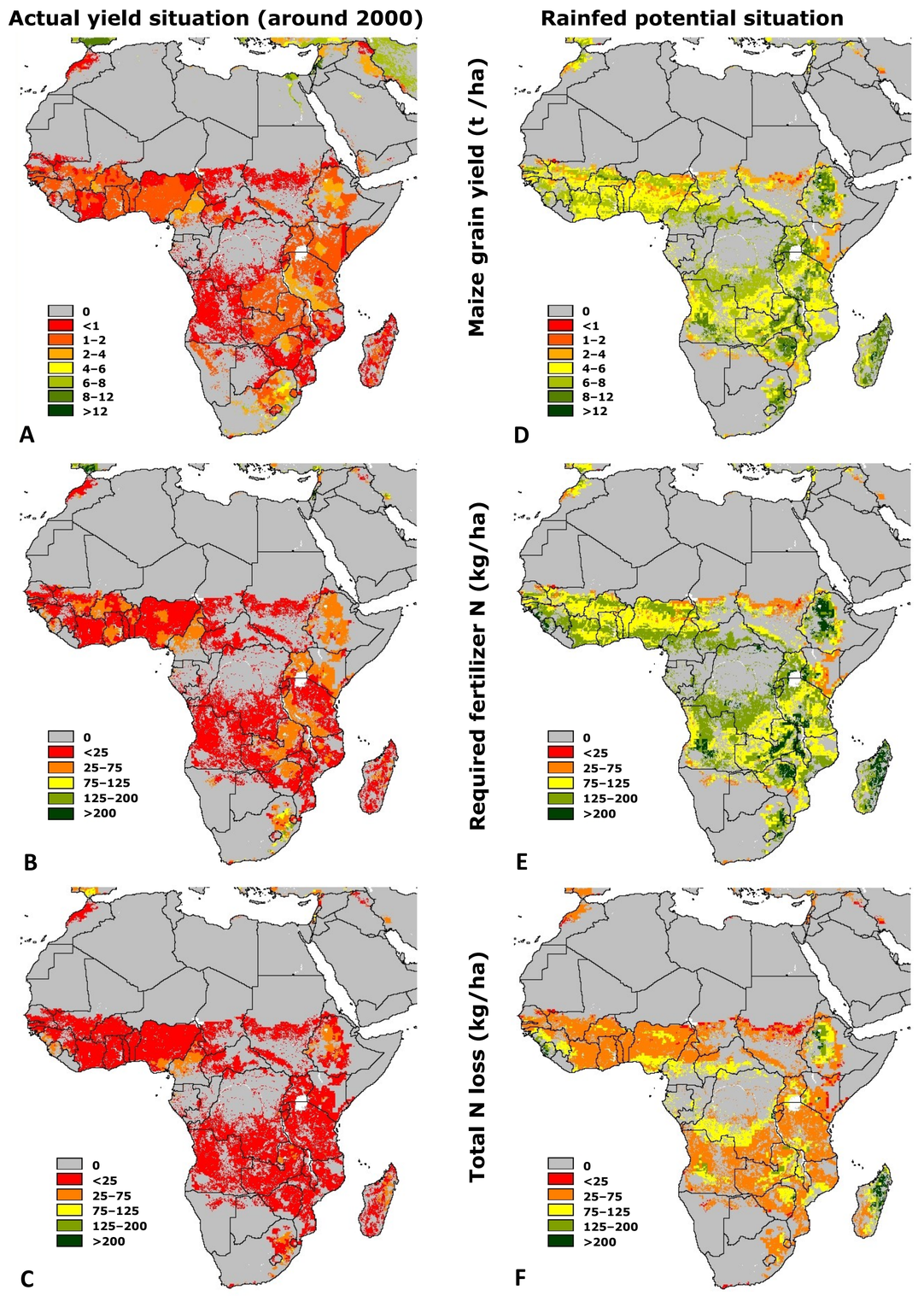


Figure 1a-f. Actual yields, minimum required fertilizer N and total annual N loss calculated for actual yields (a-c); simulated rainfed potential yields, minimum required fertilizer N and total annual N loss calculated for 80% of rainfed potential yields (d-f) for maize harvested areas on a 5*5 arc-minute grid (around 2000; Monfreda *et al*. 2008).

Discussion

Due to lack of data on actual N fertilizer use we could not calculate N fertilizer input gaps for maize in Africa. Presented results (Fig. 1) can be used as first approximation of additional fertilizer N required to increase yields to 80% of rainfed potential and the associated increased N loss.

Interaction with P availability and the calculation of minimum fertilizer P requirement will be incorporated, including the effects of weather variability, management and previous crops. Calculation of the effects of soil water balance on N losses will be improved.

We seek collaboration for further development, calibration and validation of the methodology and for local datasets of weather, soils, crop yields and management.

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