Methodology to quantify water, N and P interactions in crop production

Sjaak Conijn, Huib Hengsdijk, Joost Wolf, Katrien Descheemaeker & Ben Rutgers



WAGENINGEN UR
For quality of life

Kampala, 19-11-2013

Introduction

- *"Just enough N": how to get there?*

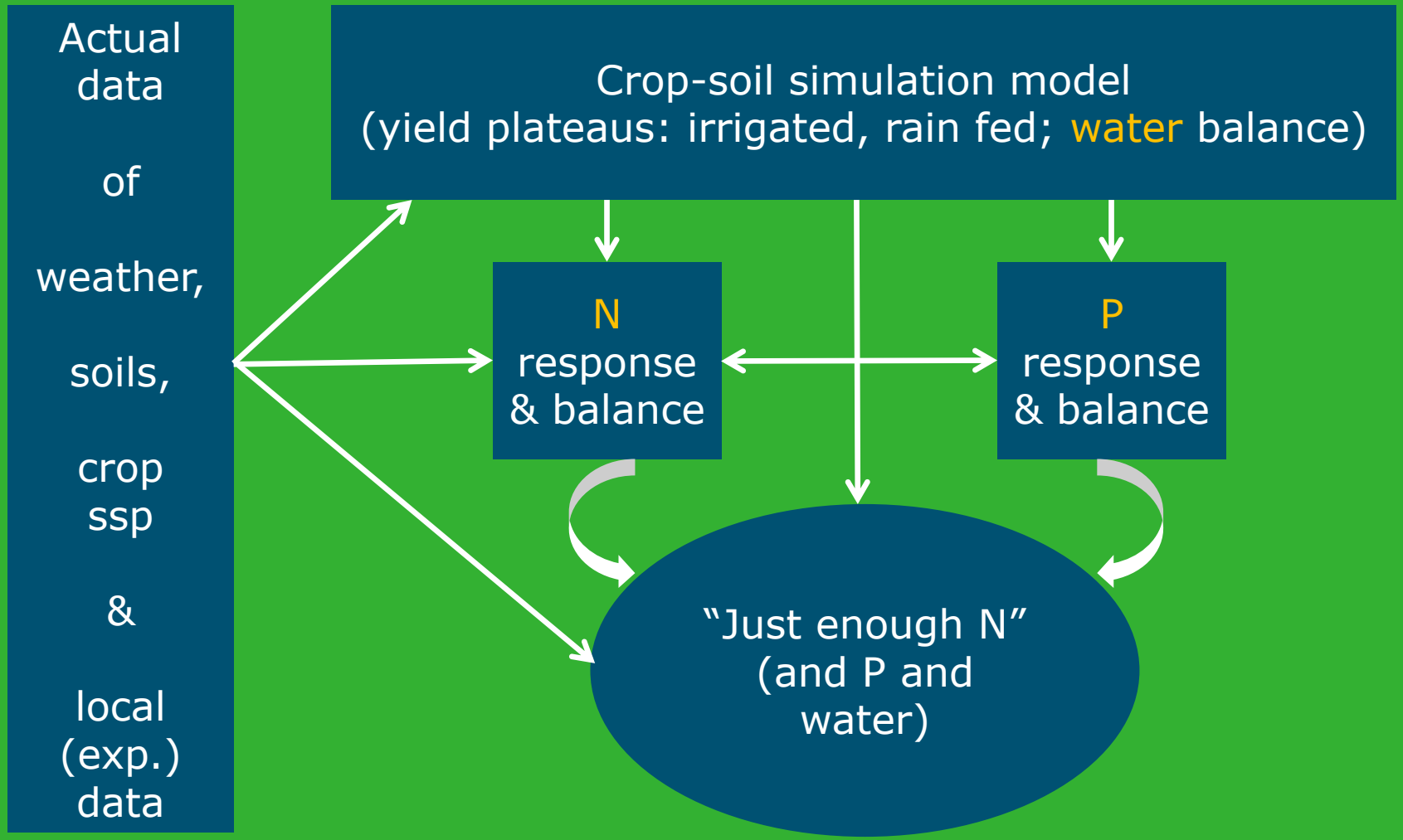
➢ One question leads to another .....

- ***How much do we need to produce?***
- Food demand => crop production goals => required N
- Target-oriented approach!

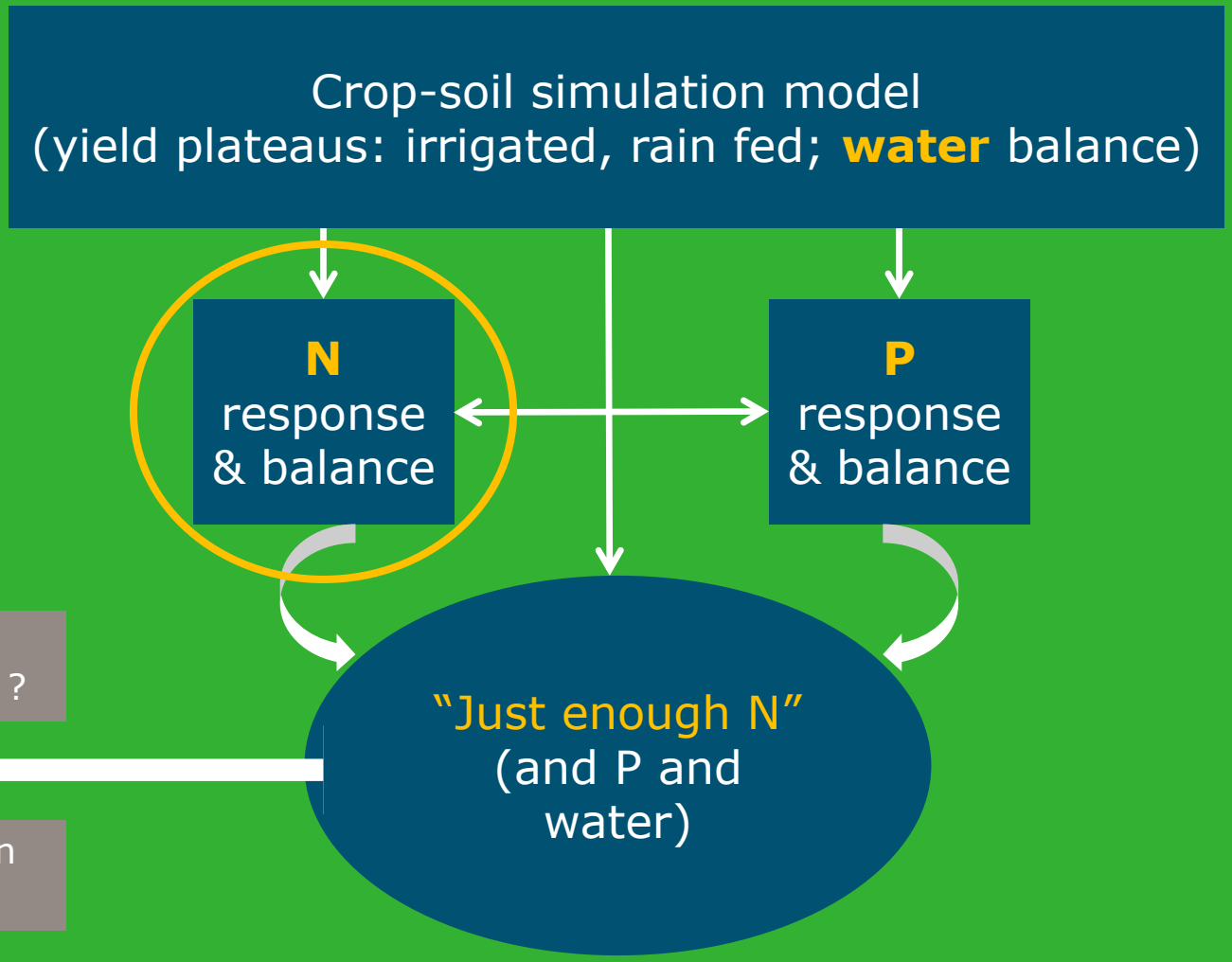
➢ and another .....

- ***How do other factors affect crop growth?***
- Weather, soil, crop variety, field history, other inputs
- Also focus on local production capabilities

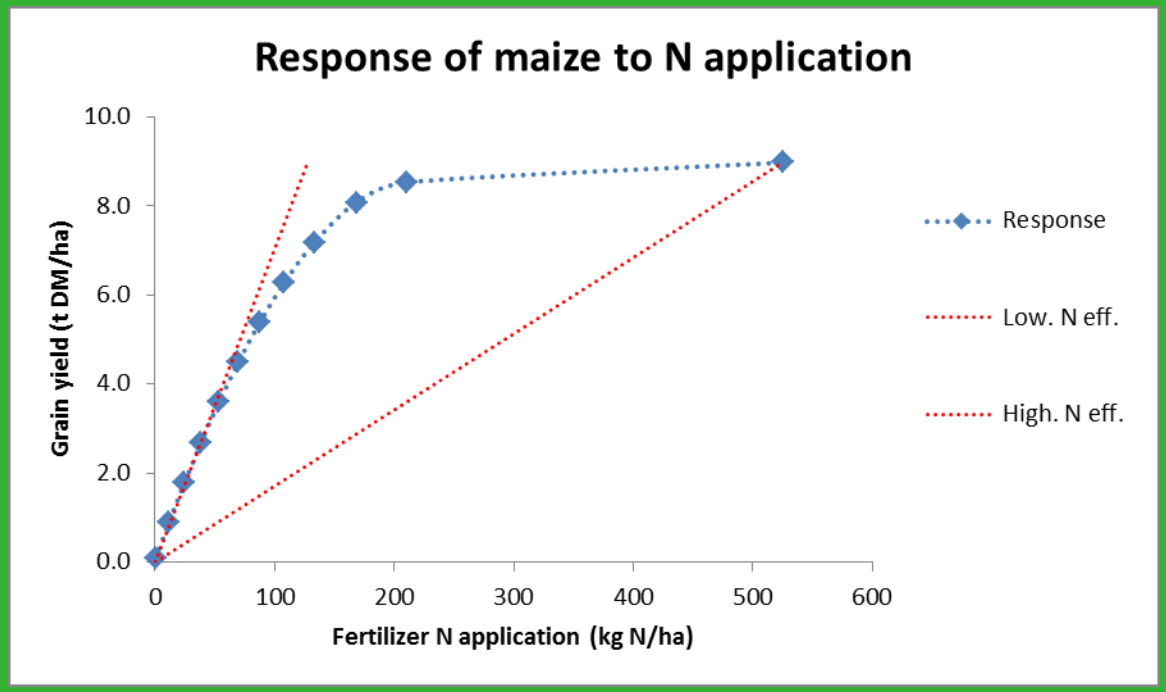
Generic methodology



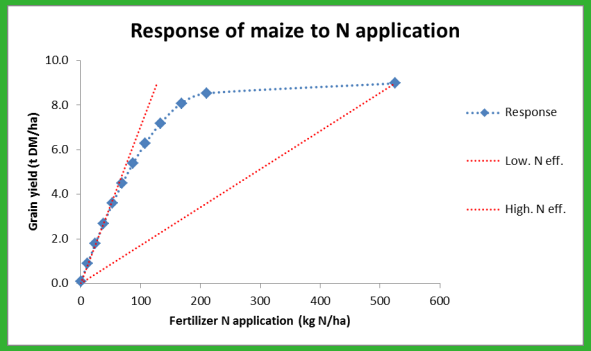
Generic methodology



N response curve



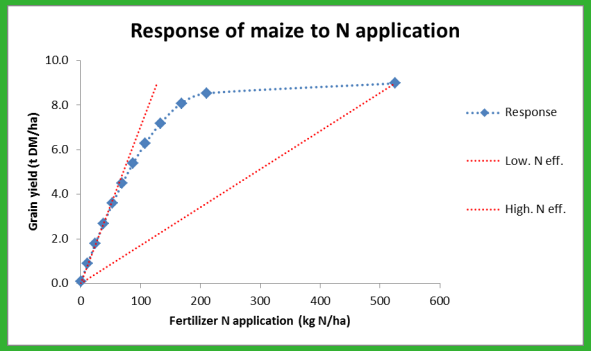
Break-down of the N response curve



Three main functions:

- N application => total N uptake
- Total N uptake => grain N yield
- Grain N yield => grain DM yield

Break-down of the N response curve



Three main functions:

- N application <= total N uptake
- Total N uptake <= grain N yield
- Grain N yield <= grain DM yield

Or the other way round!

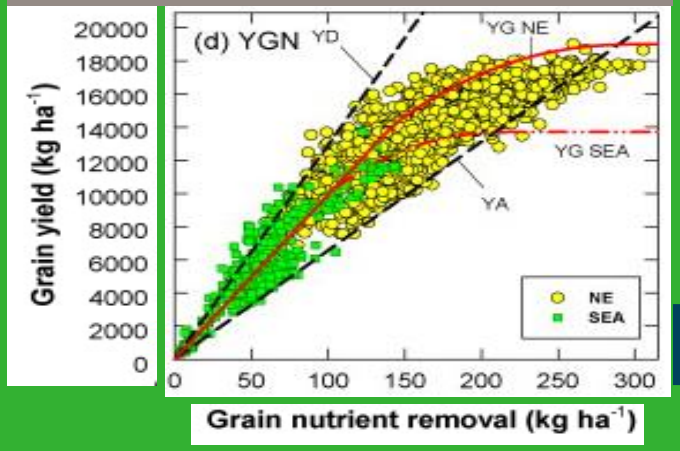
(start with grain DM yield and calculate N application)

A fourth function:

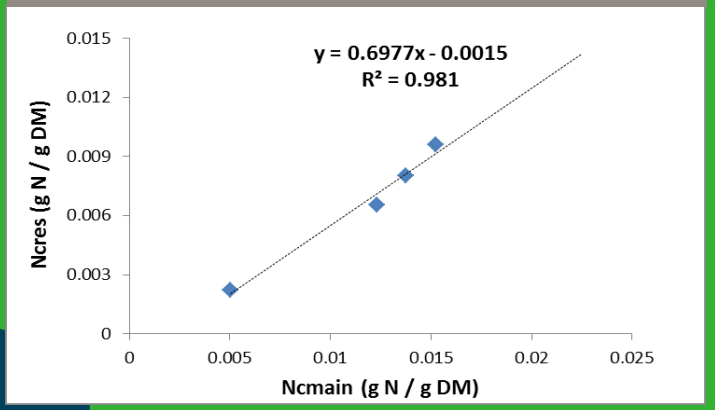
- N application => N losses

Components of the N response curve

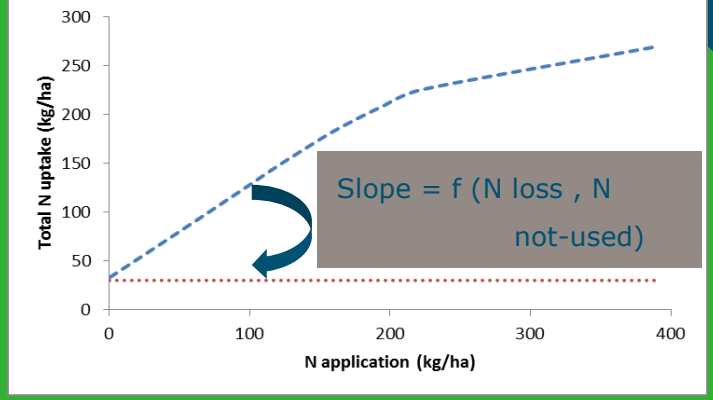
Grain DM yield vs. grain N yield



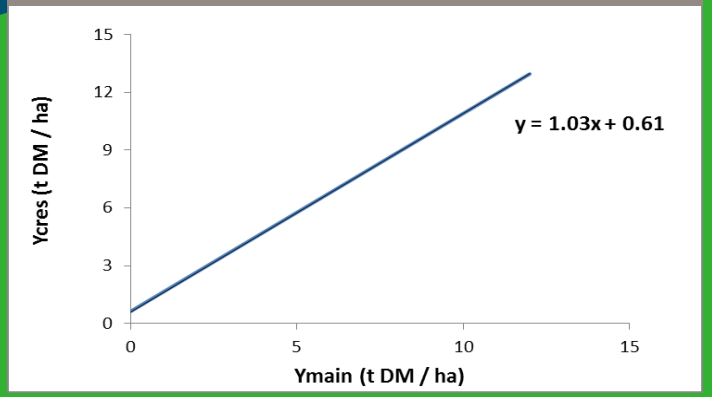
Crop residue Nconc. vs. grain Nconc.



Total N uptake vs. N application



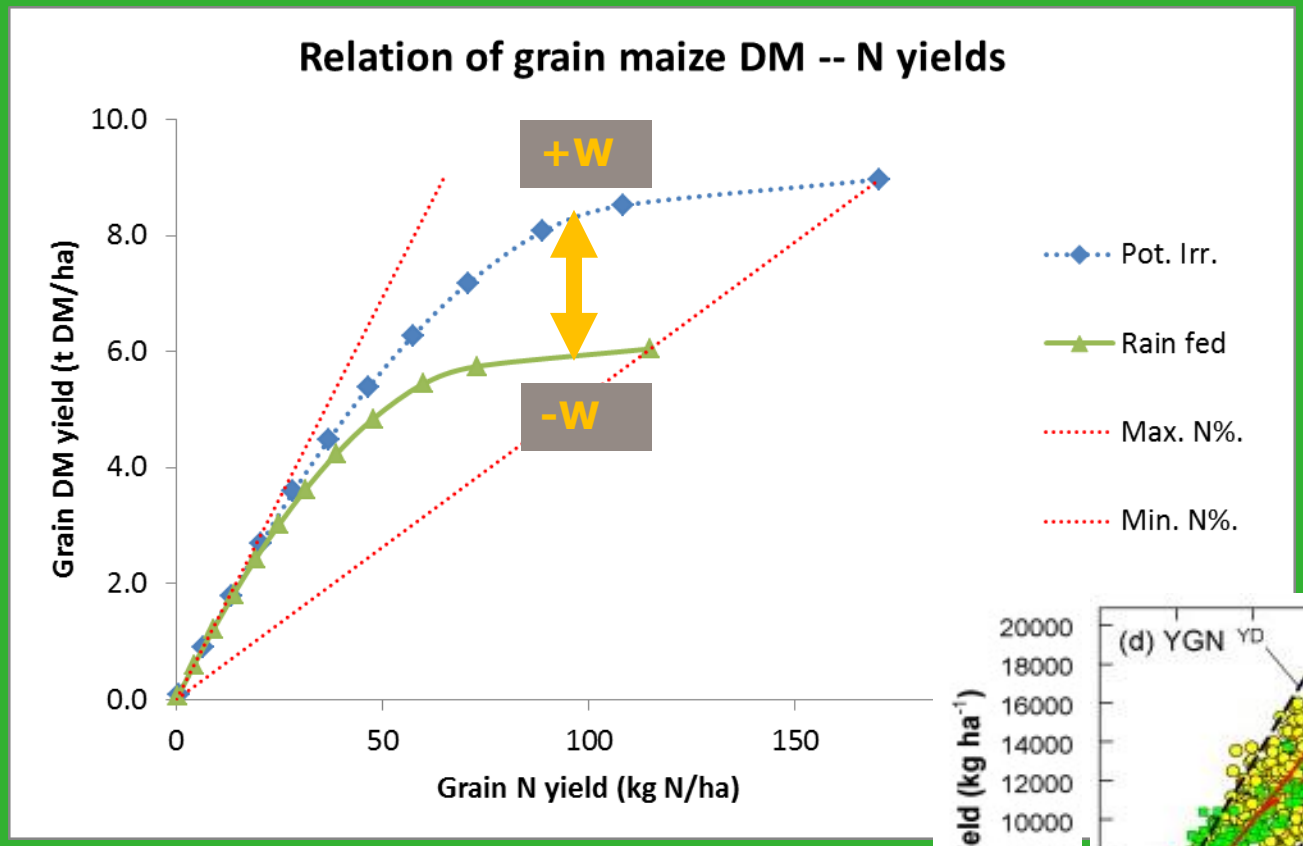
Crop residue yield vs. grain yield

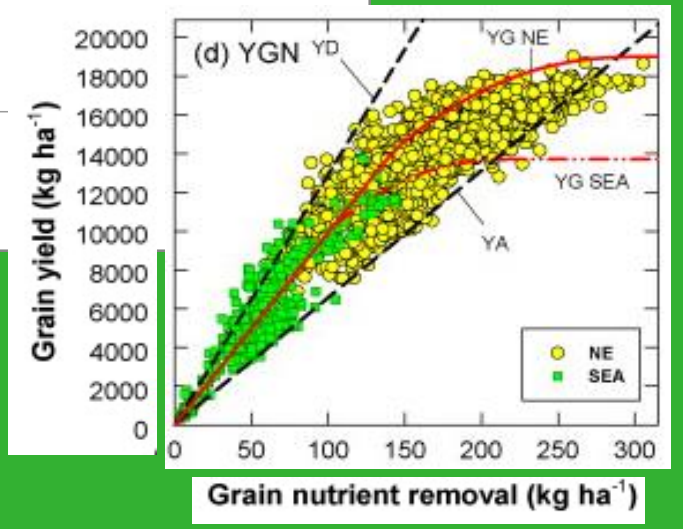


WAGENINGEN UR
For quality of life

Setiyono et al., FCR, Vol 118 (2009) ; IPCC (2006)

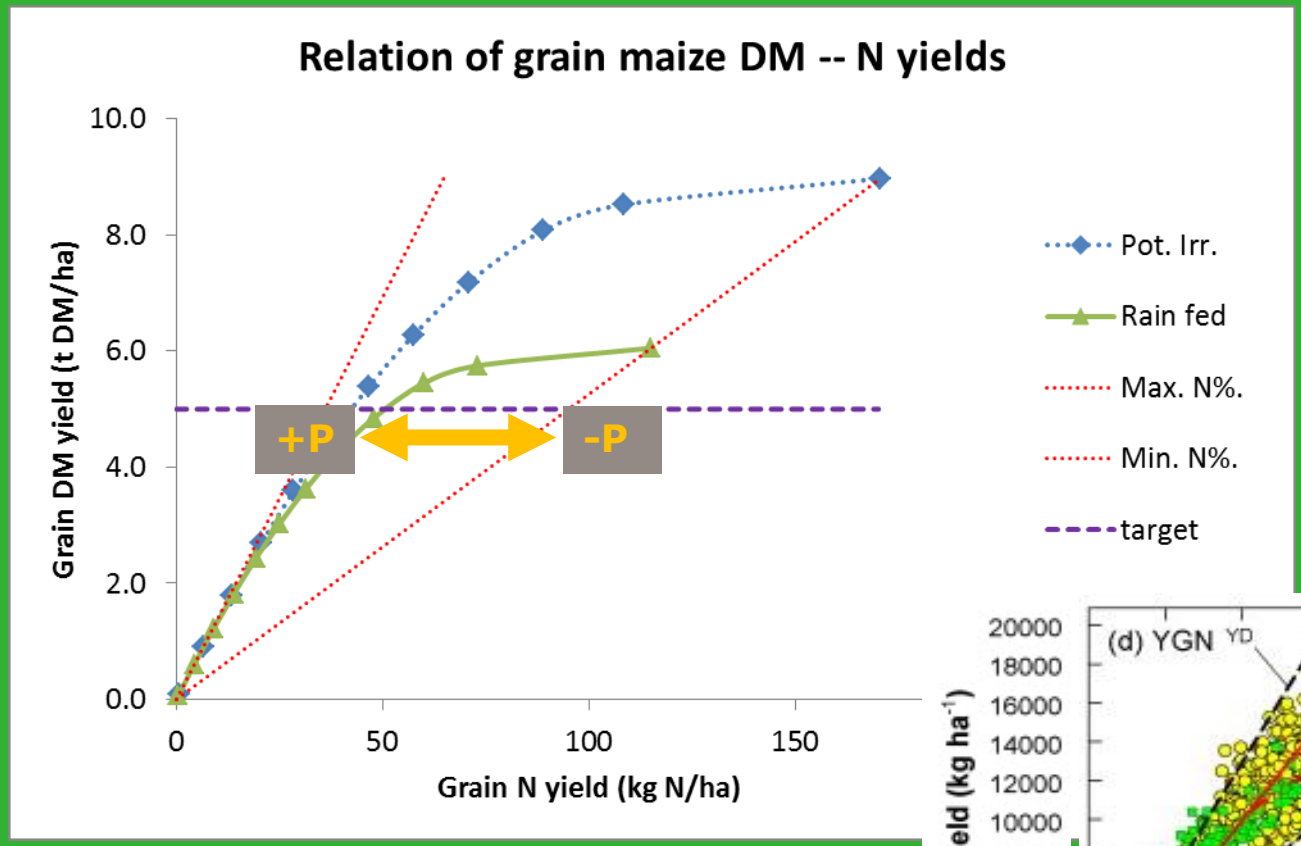
Interactions: water and N

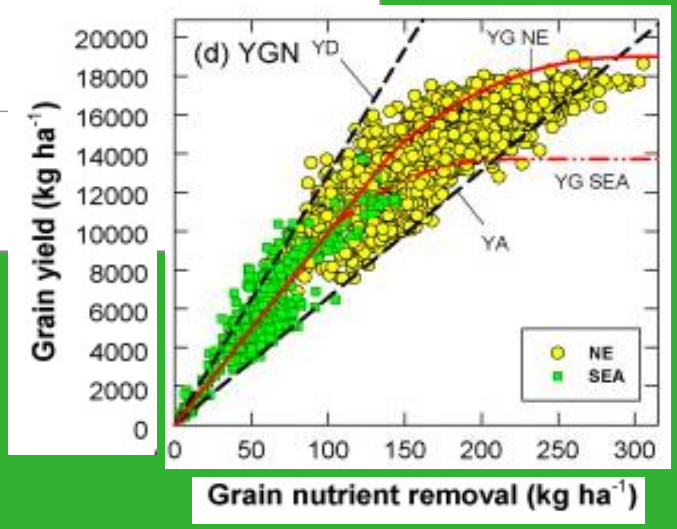




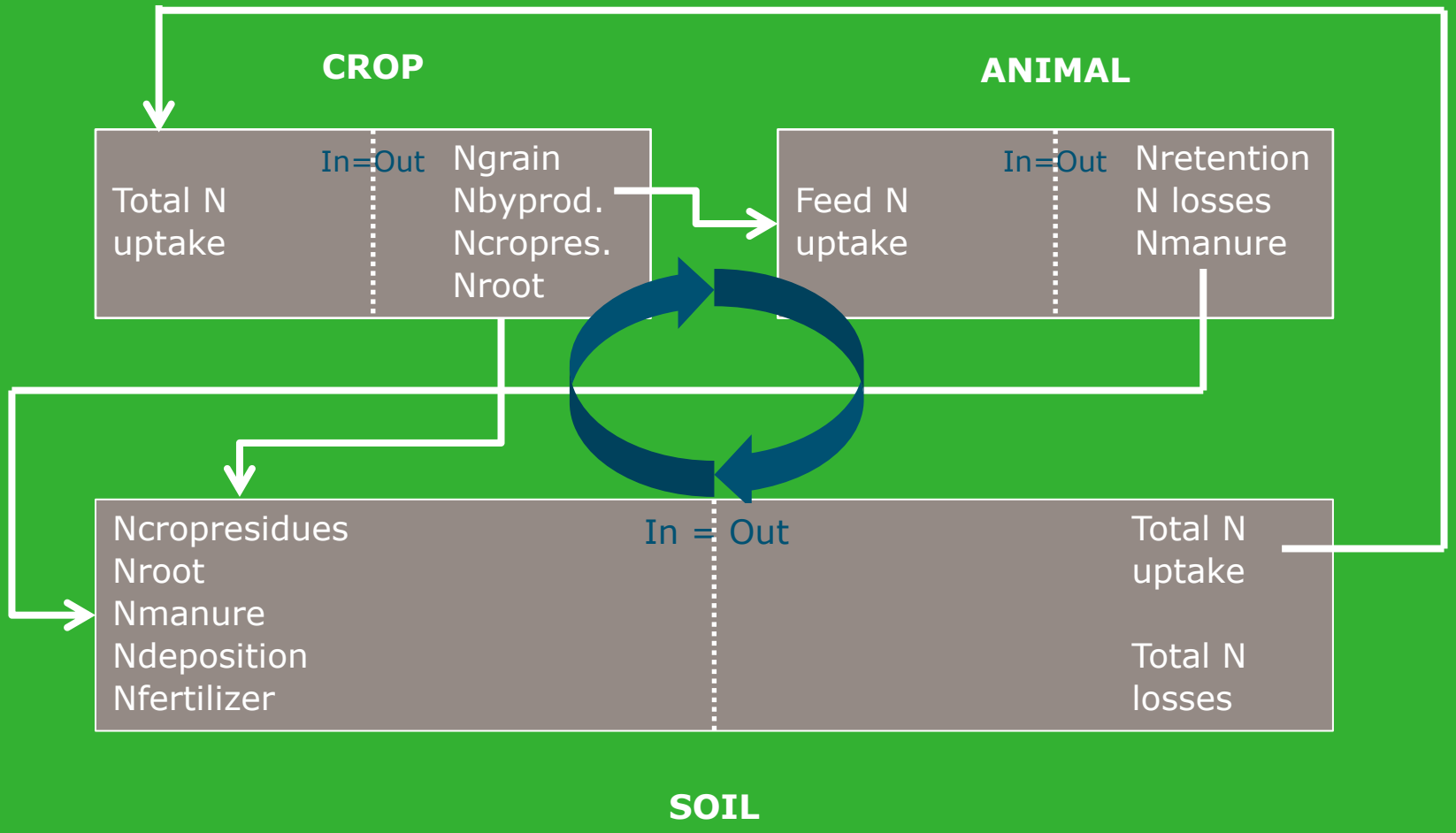
WAGENINGEN UR
For quality of life

Interactions: P and N





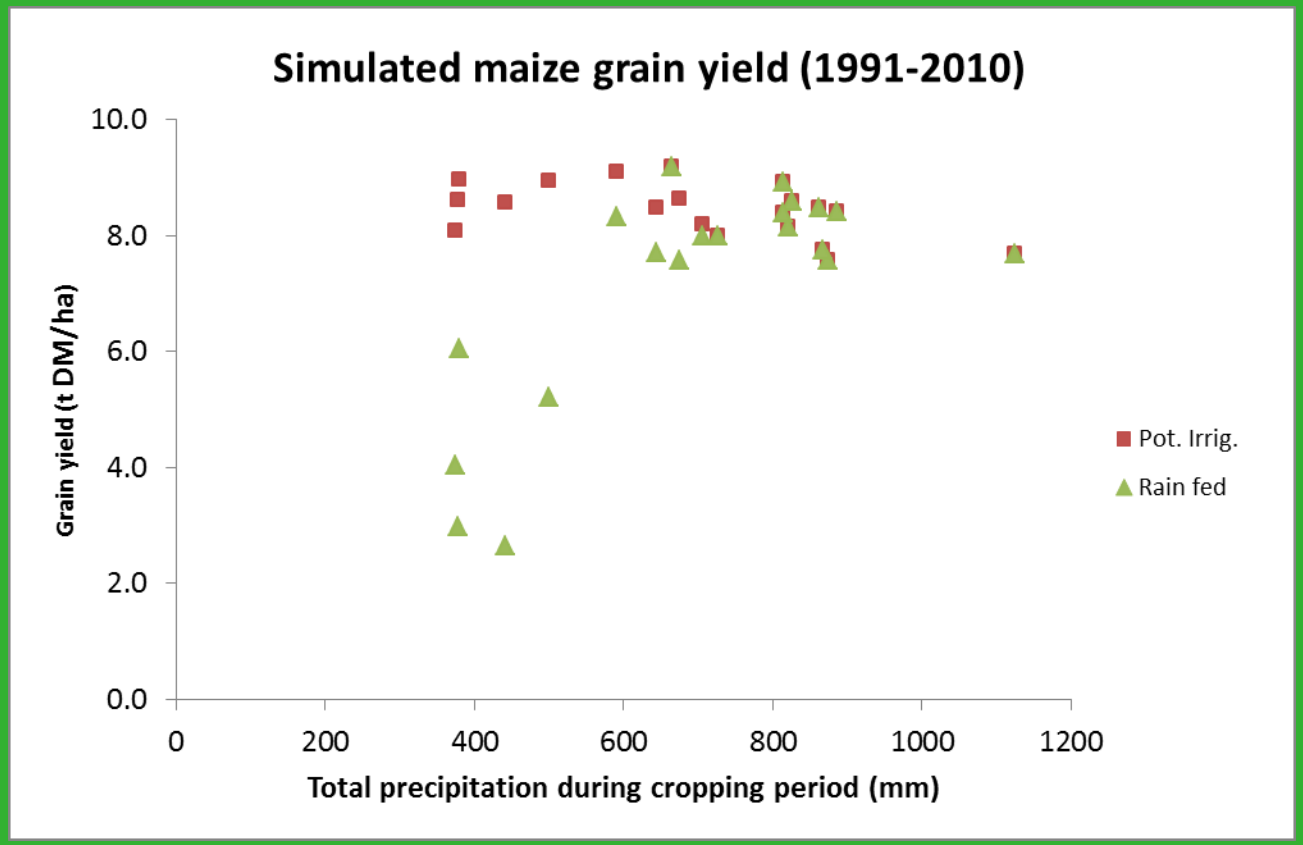
N system balance => soil N availability



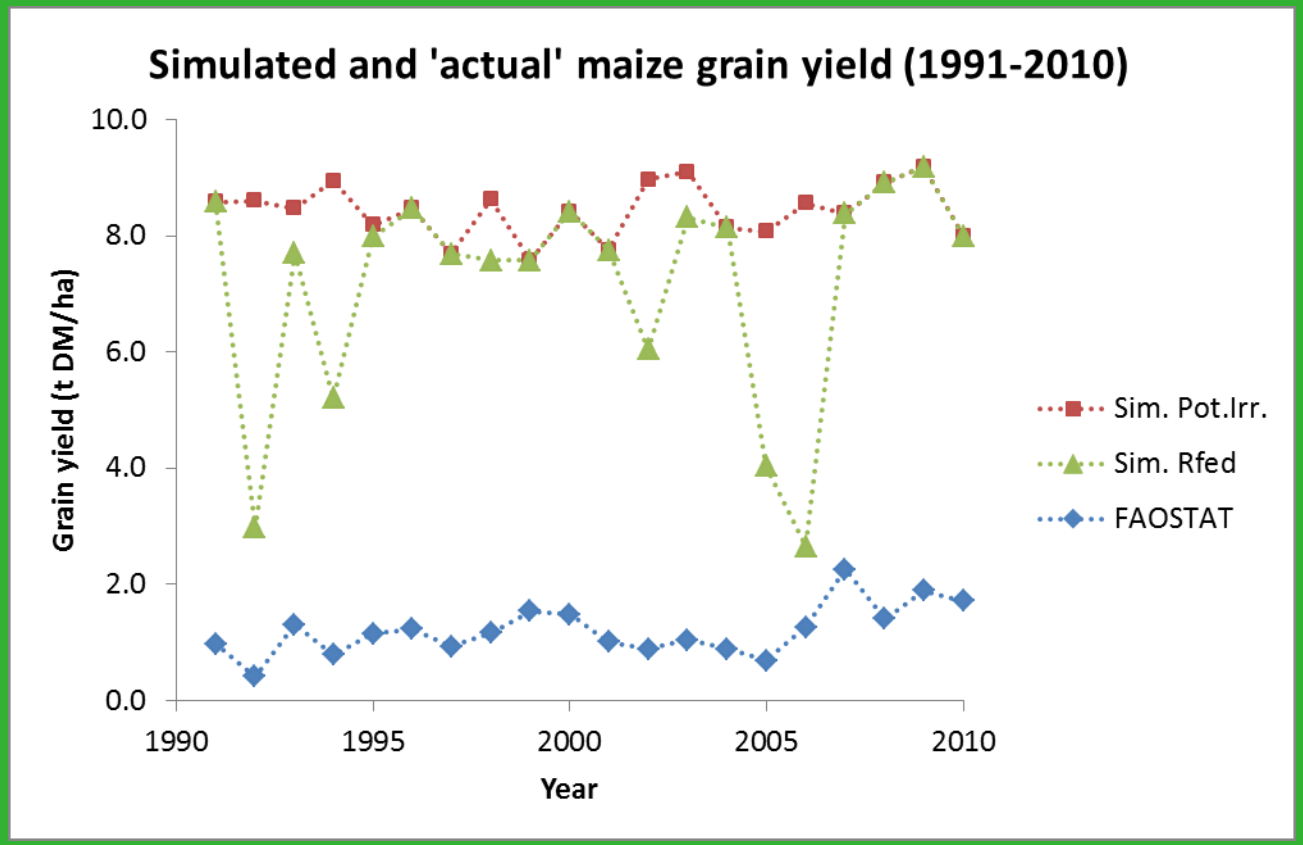
Summarizing our methodology

- Aim: calculating minimum N fertilizer requirements for target crop yields
  - Target-oriented and input-oriented approach
  - Field-based
  - Location- and crop-specific parameters
  - Water, N and P interactions
  - Equilibrium conditions , maintaining soil fertility
  - N losses within and outside cropping period
  - Theoretical best input use efficiencies
  - For now: single cropping situations
  - Example: maize in Malawi (Lat: -15.25; Long: 34.75)

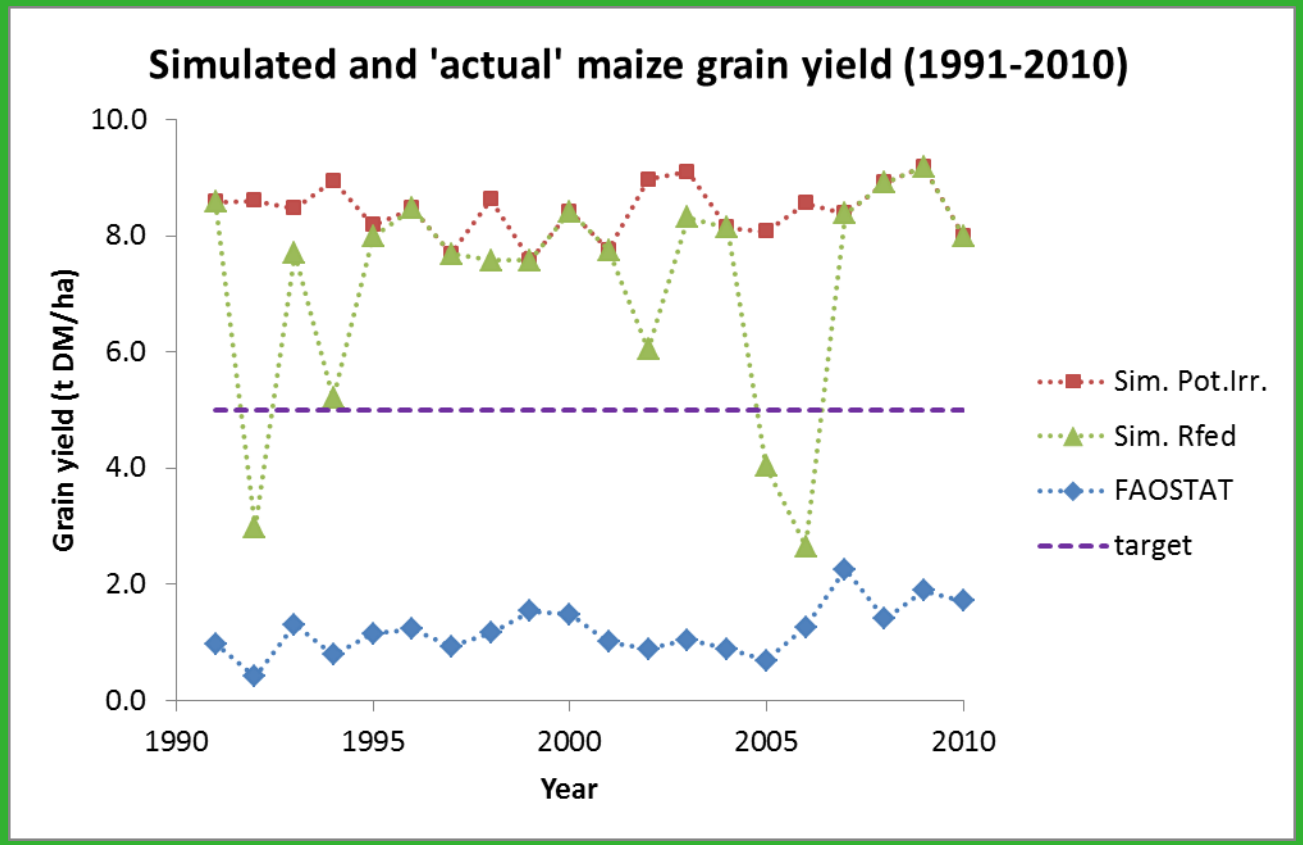
Results from the crop-soil model (1)



Results from the crop-soil model (2a)



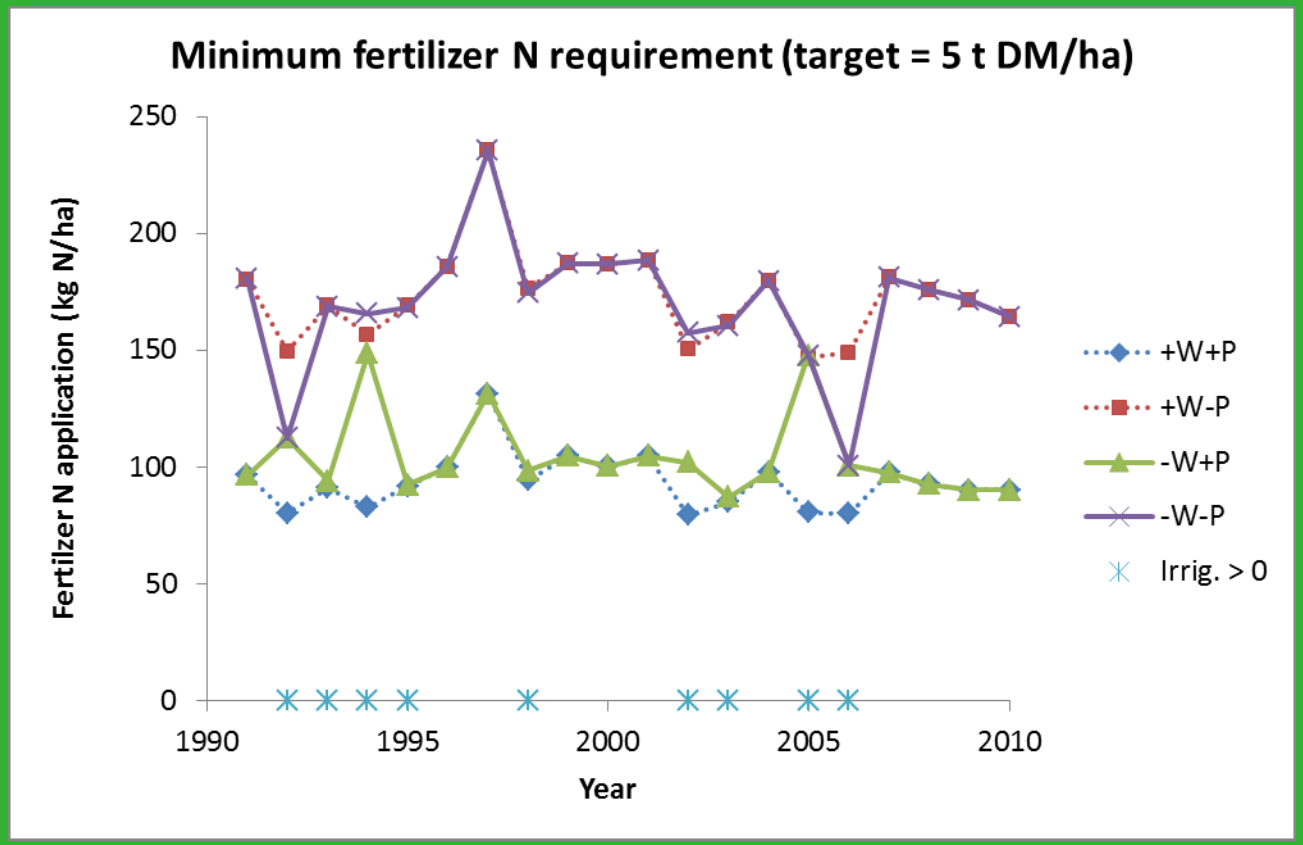
Results from the crop-soil model (2b)



Target = 5 t grain DM/ha
= 70% of Sim. Rfed (on average)
= 3x average Faostat (last 5 y)
=> ca. 100 kg fertilizer N required

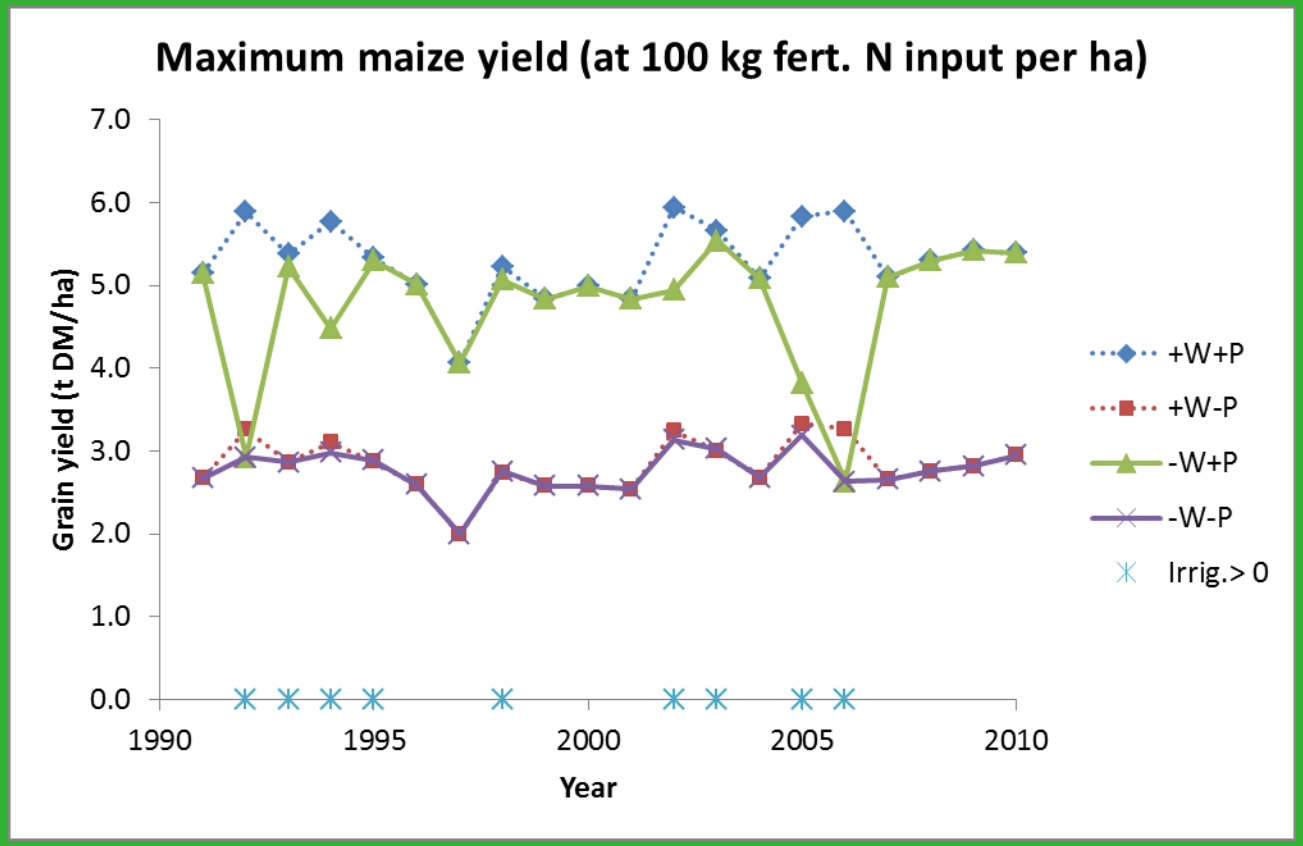
WAGENINGEN UR
For quality of life

Results from N requirement calculations



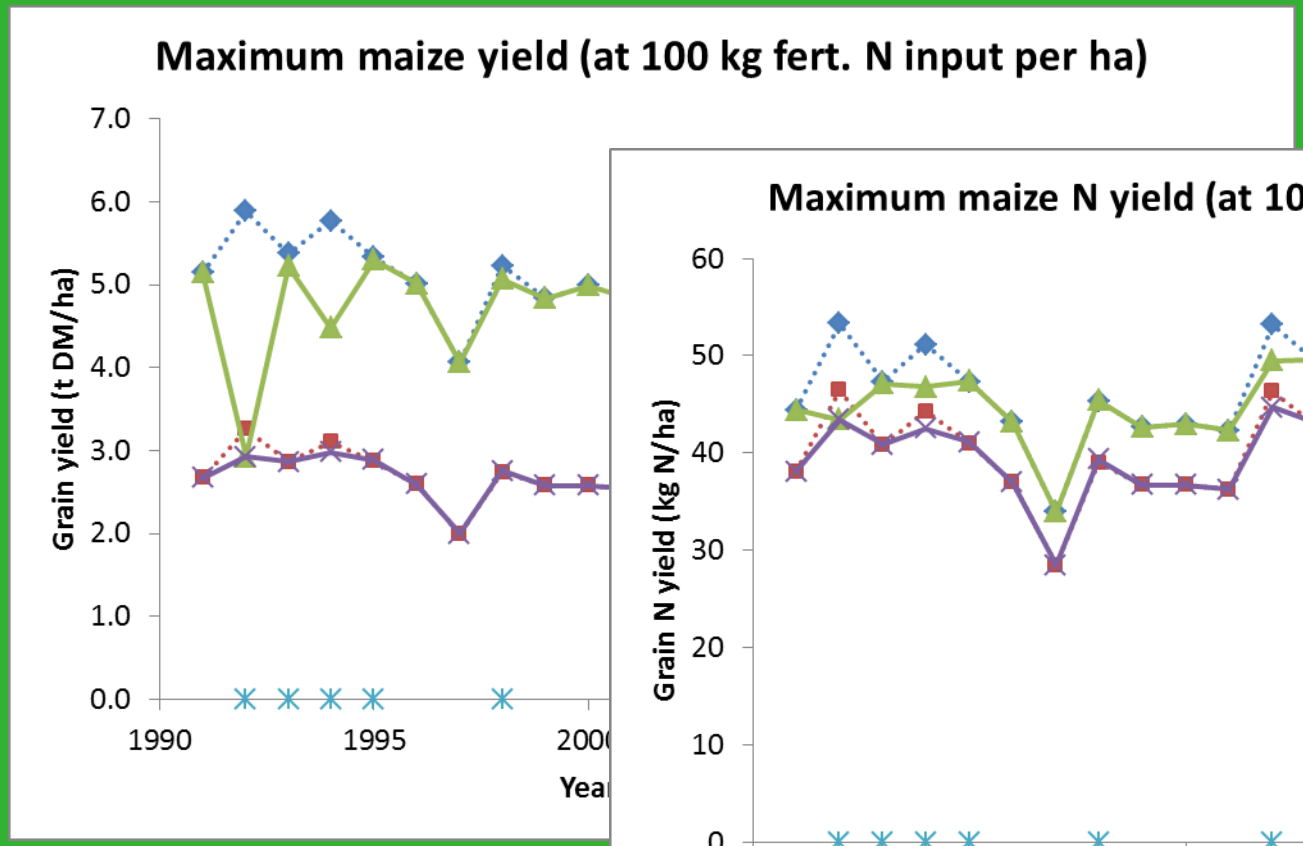
Blue (+W+P)	= 94 kg fert. N/ha
Green (-W+P)	= 104 kg fert. N/ha
Red (+W-P)	= 173 kg fert. N/ha
Purple (-W-P)	= 170 kg fert. N/ha

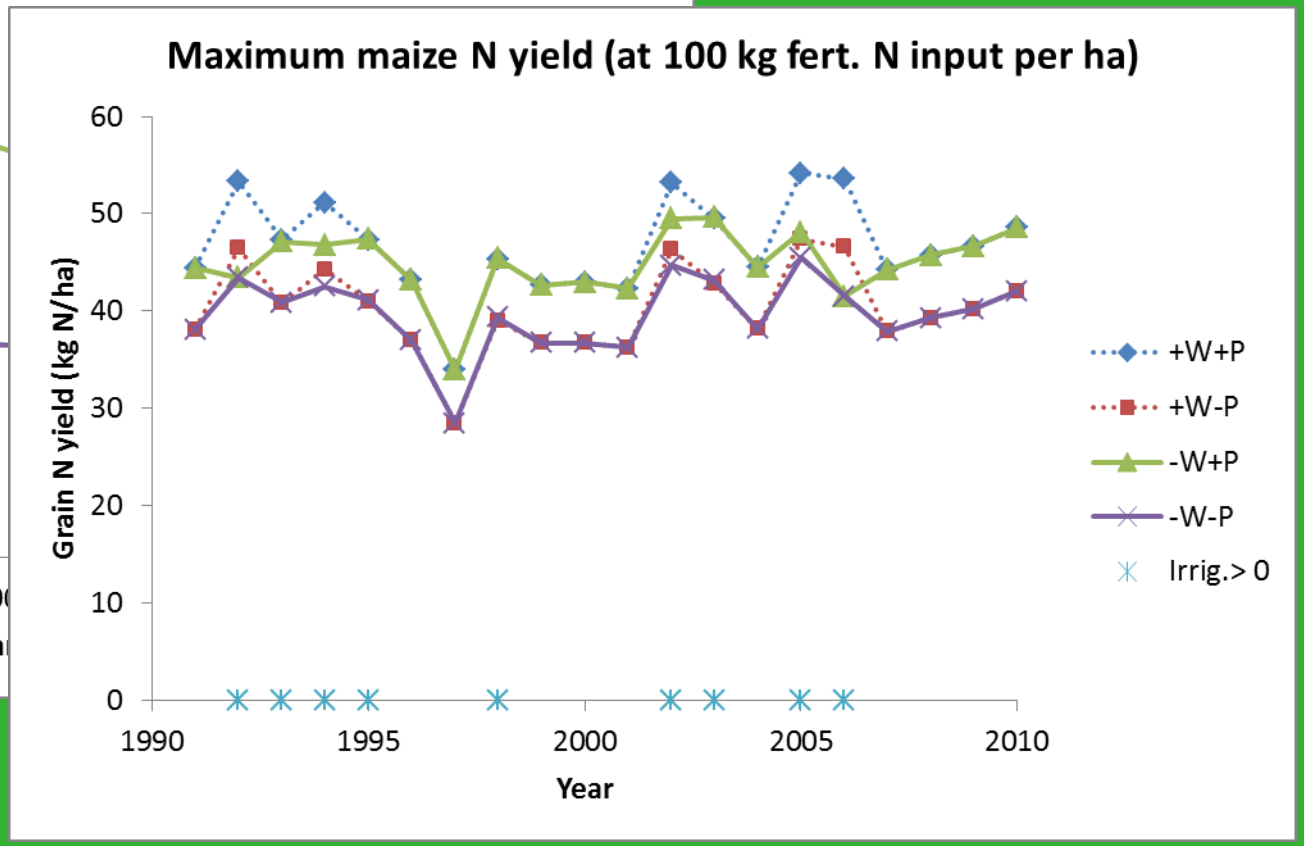
Results from N requirement calculations



Blue (+W+P)	= 5.3 t grain DM/ha
Green (-W+P)	= 4.8 t grain DM/ha
Red (+W-P)	= 2.8 t grain DM/ha
Purple (-W-P)	= 2.8 t grain DM/ha

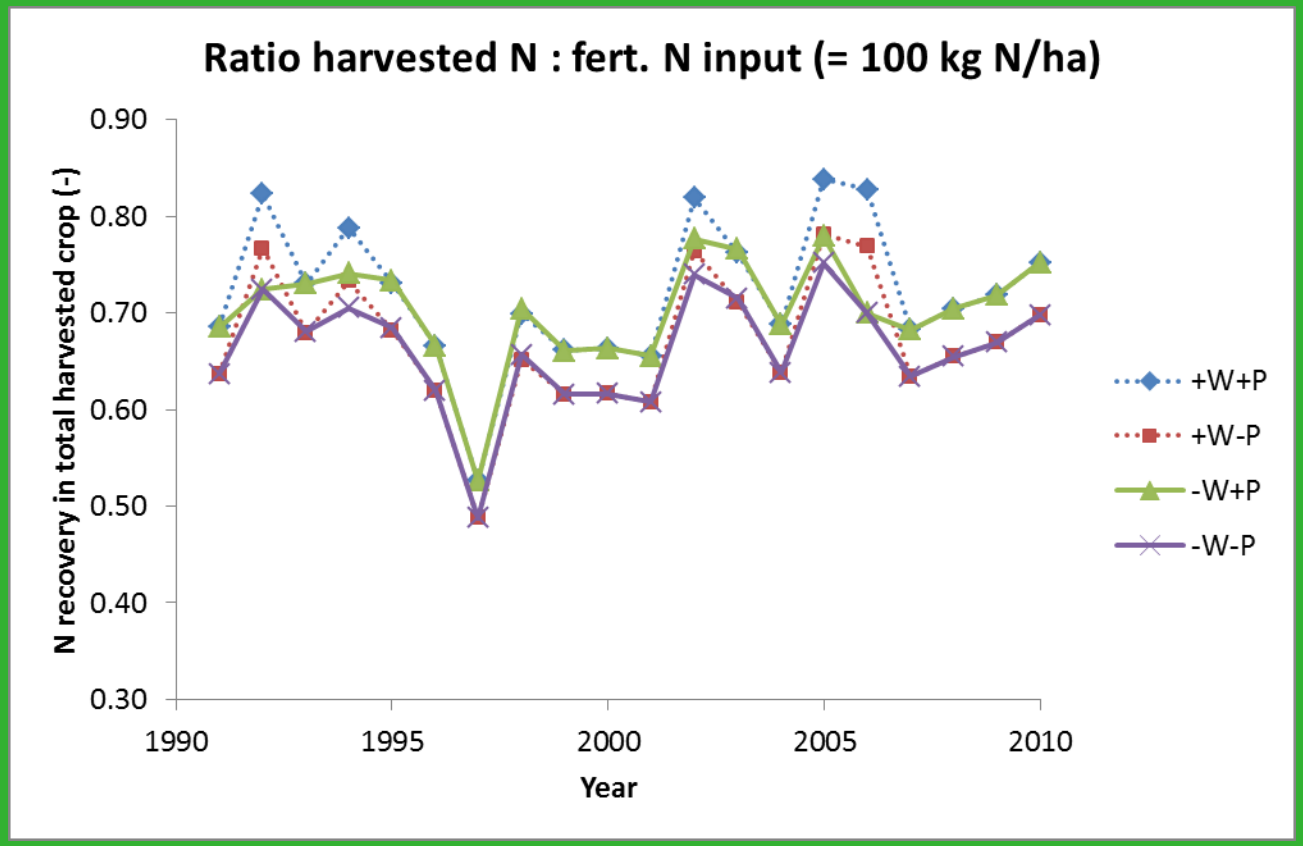
Results from N requirement calculations





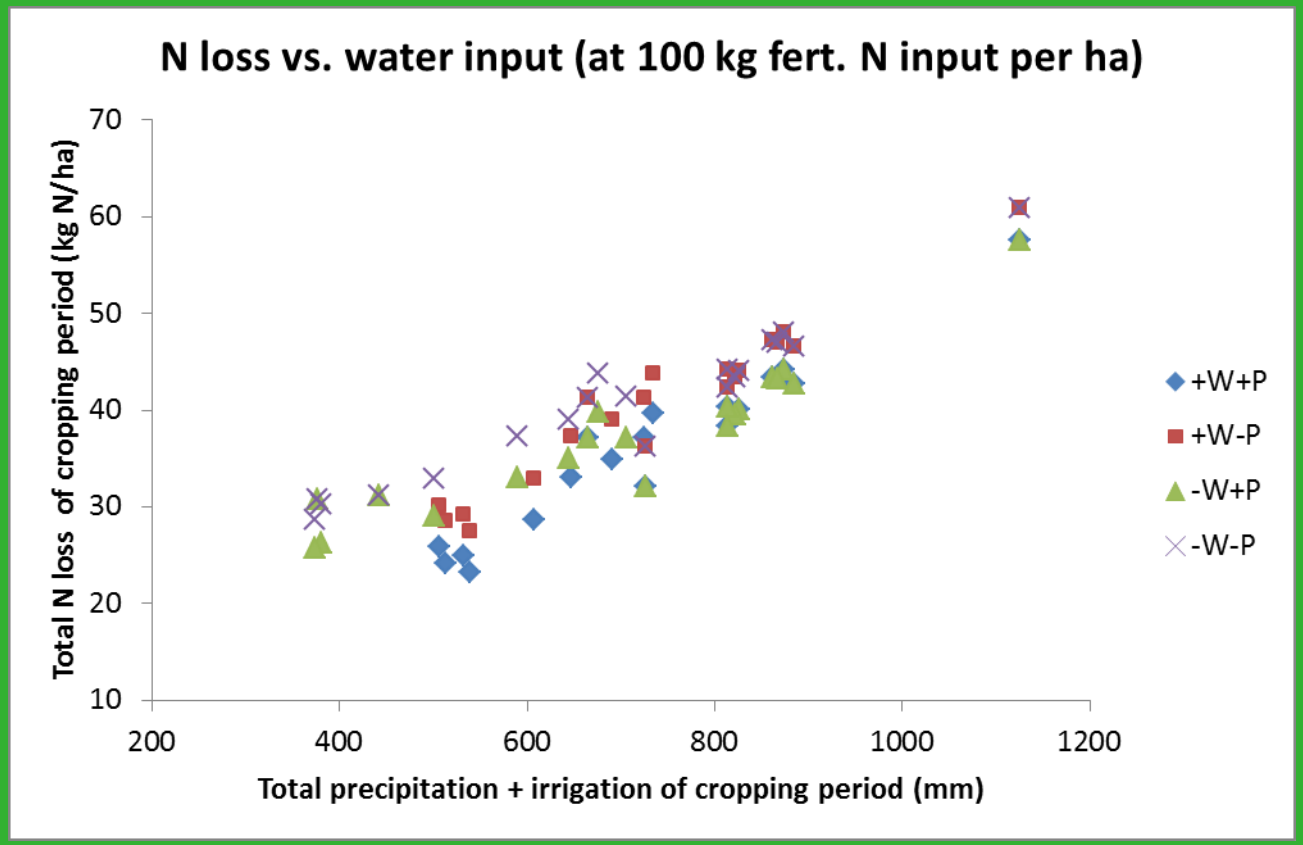
WAGENINGEN UR
For quality of life

Results from N requirement calculations

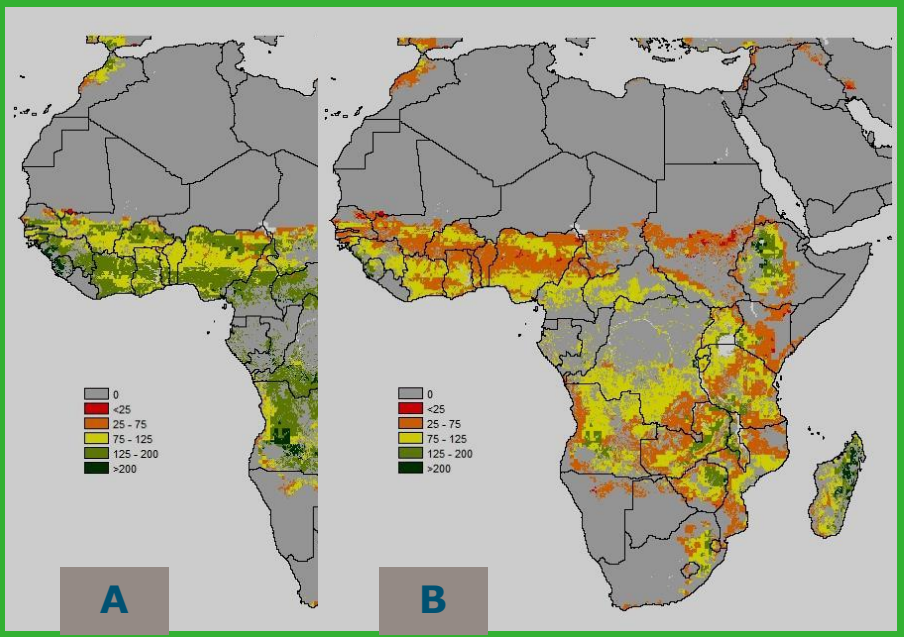


Blue (+W+P)	= 0.72
Green (-W+P)	= 0.70
Red (+W-P)	= 0.67
Purple (-W-P)	= 0.66

Results from N requirement calculations

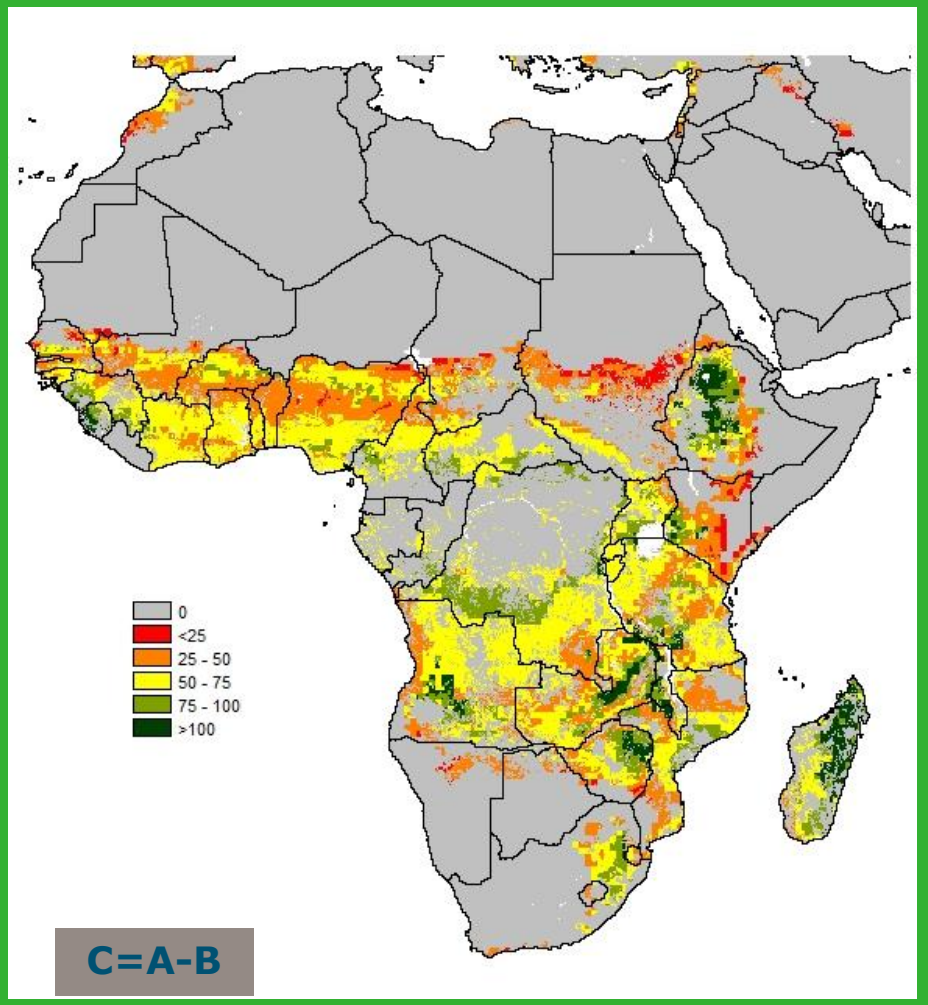


Fertilizer N requirement maps



A: N requirement at low P (high N levels)
B: N requirement at high P (low N levels)
C: difference between A and B
(extra N required due to low P conditions)

Target: 70% of rain fed maize yield level
Resolution: ca. 9x9 km2 at the equator



WAGENINGEN UR
For quality of life

Improvements, discussion & conclusions

Planned improvements

- N loss equation(s)
- Feedback of mulch/SOM on water balance: runoff
- Testing with field data (2014; *suitable datasets?*)

Discussions/conclusions

- N congress, P congress, water congress, climate congress, and so forth: is that smart?
- Methodology is useful to benchmark crop yields and optimal input use of water, nitrogen and phosphorus.
- N requirements are strongly affected by water and P availability and are essential for answering

"Just enough N and how to get there?"

The end

Thank you for
your attention



and thanks to the
Wageningen UR Program:
“Sustainable Intensification”

http://www.wageningenur.nl/en/basis

WAGENINGEN UR
For quality of life