Investigating roles of sustainable intensification practices in Ghana cropping systems using crop modelling

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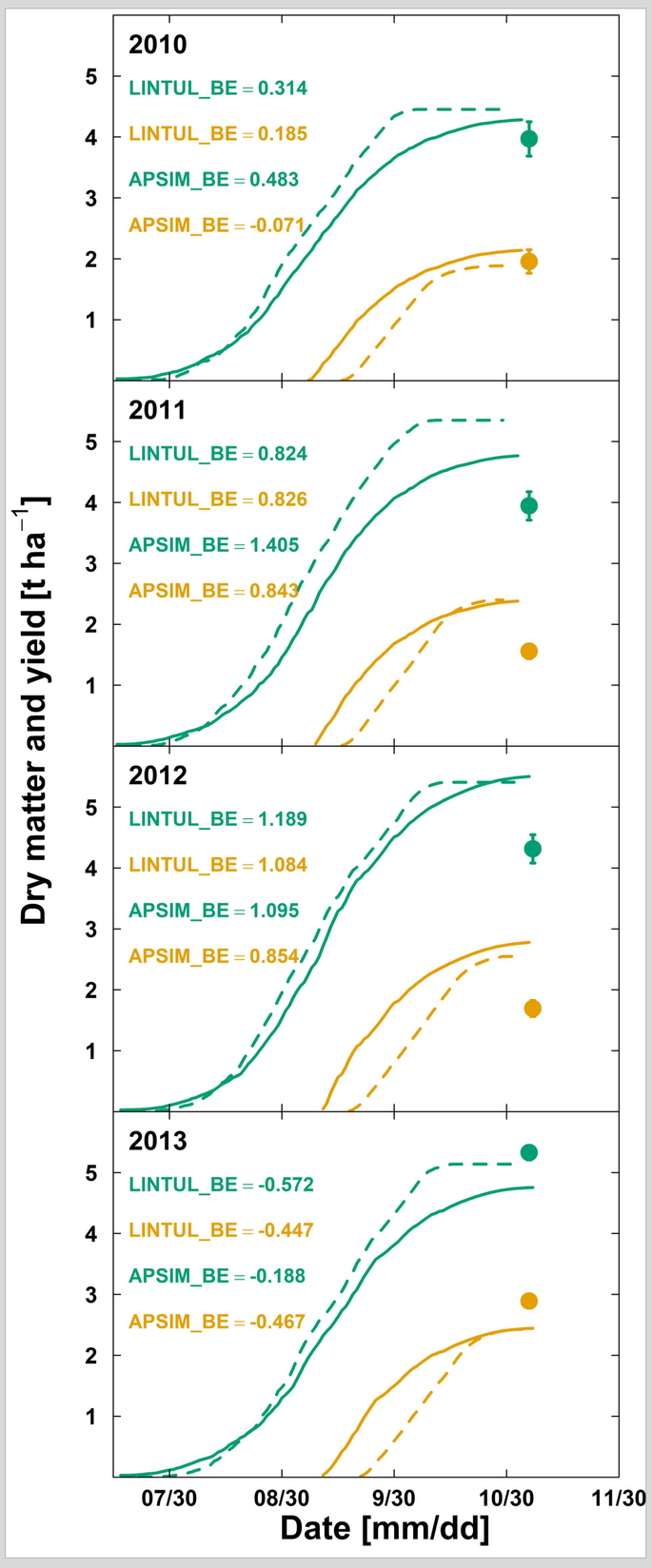
INTRODUCTION

- Highly spatial and temporal heterogeneity of soil, seasonal climatic characteristics, and local inputs
- Upscaling of sustainable intensification (SI) practices from specific locations to regional scales
- Comprehensive field trials which are often lacking in Africa
- Dynamic crop modeling systems incorporating SI practices [e.g. crop residue retention (R) or varied nitrogen (N) is used to investigate the effects of those SI practices on crop yield and soil nutrients

RESULTS

1. Modeling calibration

- Bias errors of yield were at 0.314 and 0.328 ton ha^{-1} for LINTUL5 and APSIM, respectively.



2. Modelling validation

- Two models overestimated biomass and yield in 2011 and 2012, with bias errors around 0.9 ton ha^{-1}, while underestimating grain yield by around 0.5 ton ha^{-1} in 2013.

MATERIALS AND METHODS

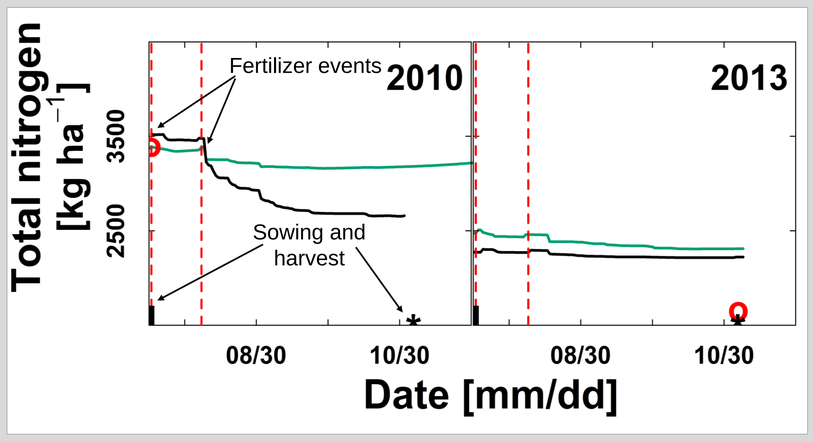
- **Experimental data:**
- Locations: Northern Ghana
- Field trial data: Naab et al., (2017)
- Cropping system: sole maize
- Growing season: 2010, 2011, 2012, 2013
- Soil types: Ferric soil
- **Crop models**:
- SIMPLACE <LINTUL5> and APSIM
- Crop practices scenarios: crop residue retention (R): 0, 25%, 75%, and 100% & chemical N: 0, 30, 60, and 90 kg N ha^{-1}

HIGHLIGHTS

- Comparison to N60-R100, adding or reducing 30 kg N ha^{-1} or reducing residue to soil do not have strong effects on grain yield for the selected trial.
- Modeling differences and uncertainty are high when lack of observed data.

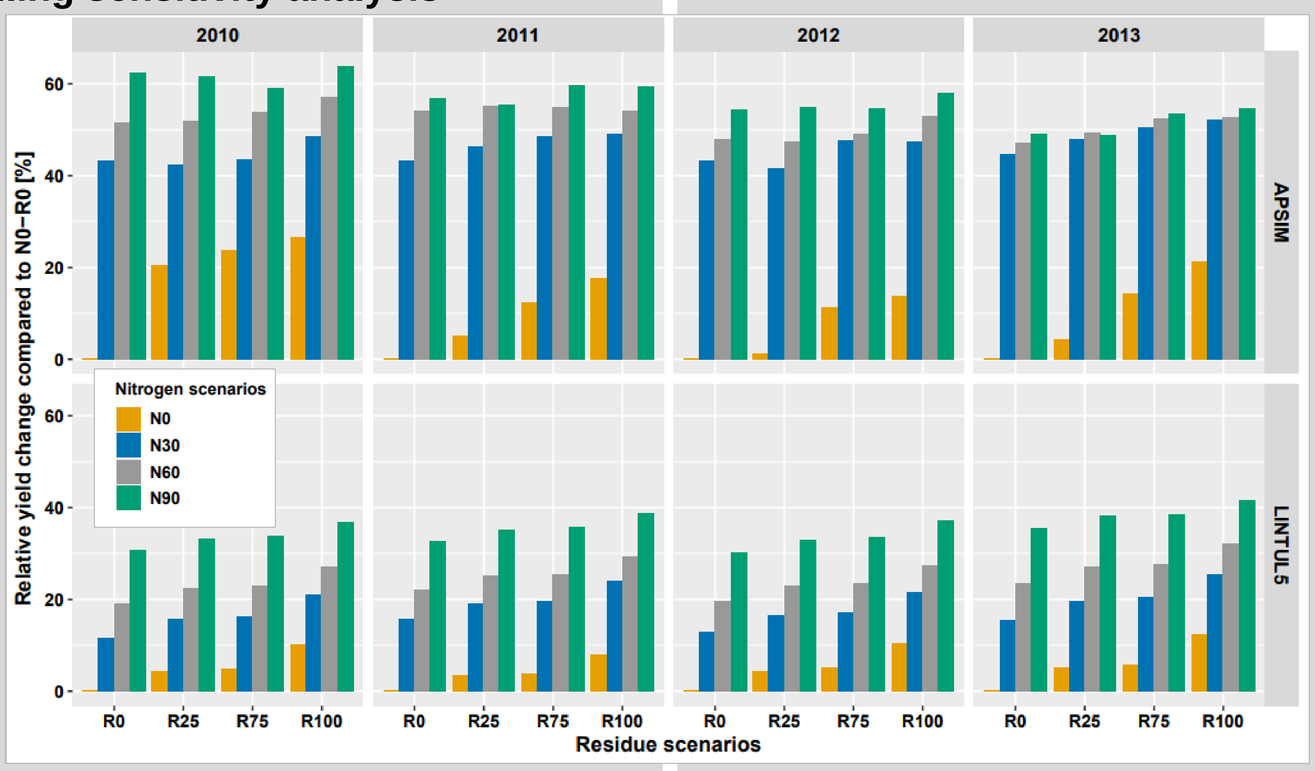
RESULTS

2. Modelling validation (continued)



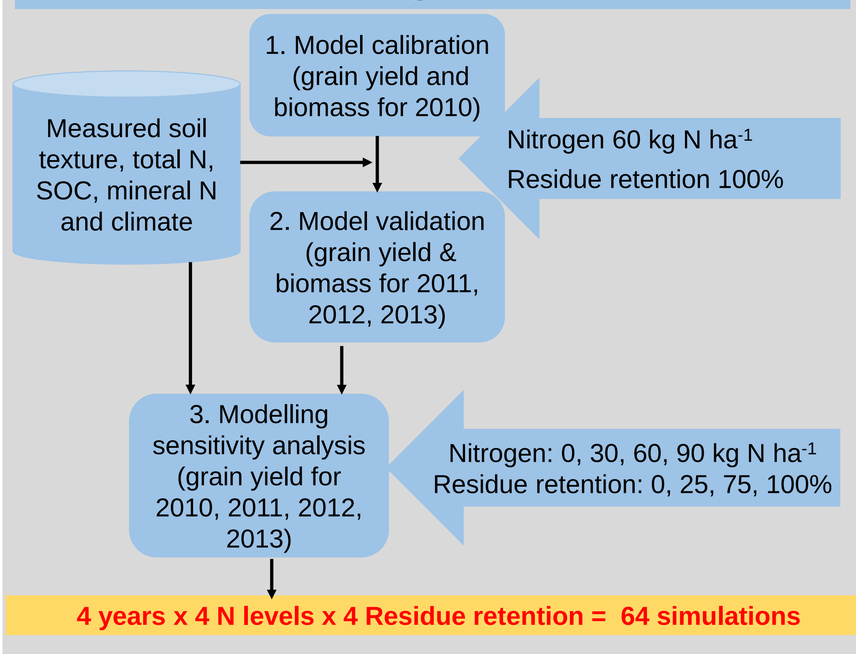
Depletion of total N after 04 seasons was high. Two models overestimated total N in 2013.

3. Modelling sensitivity analysis



- Relative yield change (RYC) due to chemical N input was larger than due to residue retention.
- RYC simulated by APSIM was higher (10-20%) than simulated RYC by LINTUL5.
- Adding chemical N input (90 kg) increased 30-60% grain yield compared to N0-R0.

Modelling workflow



RESULTS

Average RYC compated to N60-R100 (considred as current SI practices in farmer fields) of different residue retention scenarios in 2012

Model	Scenario N (kg ha-1)	RYC (%)
APSIM	N0	-98
	N30	-17
	N60	-8
	N90	6
LINTUL5	N0	-31
	N30	-14
	N60	-6
	N90	8

- Comparing N60-R100 with N0-R0, yield was reduced by average of 31% (LINTUL5) and almost 98% (APSIM).
- Compared to N60-R100, RYC was not much when increase/decrease of 30 kg N ha^{-1}.
- Difference of APSIM and LINTUL5 models was due to differrence in initial set-up for N60-R100.

OUTLOOK

- Needs to add more sensitivity analysis with different soil types, P fertilizer levels, cropping systems (maize-soybean rotation, intercropping etc…)

References:

Naab et al., (2017); Ender et al., (2023)
Probert et al., (1997); Thorburn et al., (2010)

Project: COINS — co-developing innovations for sustainable land management in West African smallholder farming systems

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