Regional scale biophysical assessment of the potential for sustainable intensification

Madina Diancoumba, Chenzhi Wang, Thuy Huu Nguyen, Amit Kumar Srivastava, Jiali Cheng, Jonas Meier, Bright Salah Freduah, Dilys MacCarthy, Thomas Gaiser, Johannes Schuler, Heidi Webber

Introduction

- ❖ Climate shocks coupled with soil degradation are intensifying food insecurity and undermining agricultural sustainability in Sub-Saharan Africa (SSA), including **Ghana**.
- ❖ **Integrated Soil Fertility Management (ISFM)** offers a promising **path to sustainable intensification** by optimizing input use and enhancing the productivity of crops, such as maize.
- ❖ However, there is limited evidence on the **biophysical performance and risks of ISFM practices**, a gap this study addresses in northern Ghana.

Figure 1. Extent of the study site in red, located in northern Ghana, West Africa.

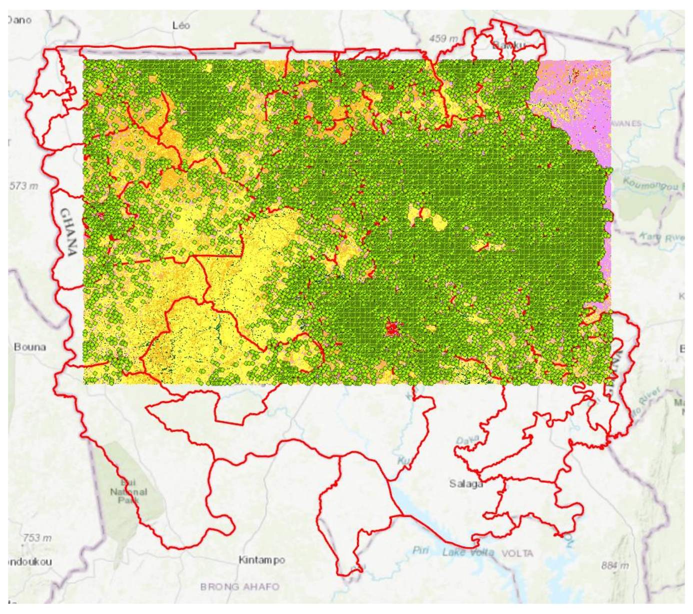
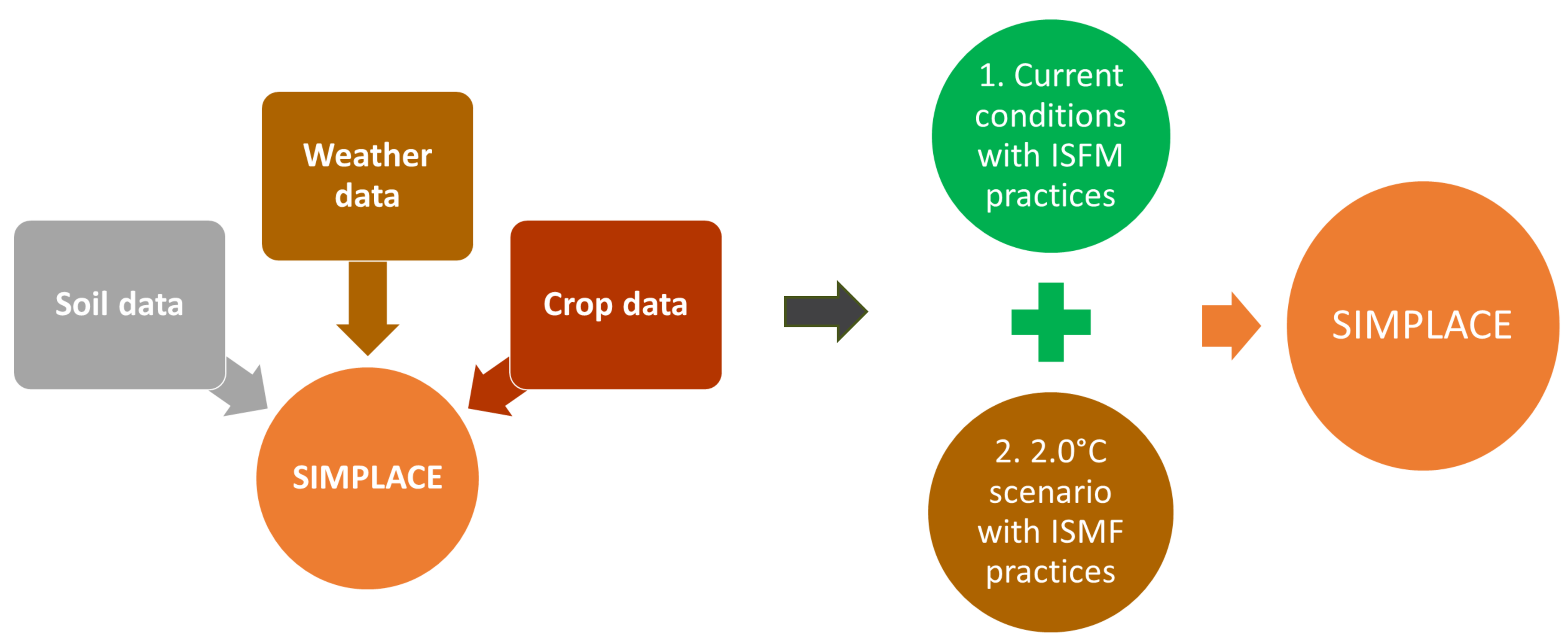


Figure 2. 1950 grid cells covering maize production area in northern Ghana

Materials and methods

- ❖ Daily climate data from **large ensemble HAPPI simulations** were used. **Two climate scenarios** were considered: the current conditions and the 2.0°C scenario, which is 2.0°C warmer than preindustrial conditions.
- ❖ **SoilGrids (1km) data** were used for a total of 1950 grids (Fig. 2).
- ❖ **Obatanpa maize variety,** commonly grown in the region, was used.

1. Data compilation and model setup
2. Model simulations for 2 scenarios



3. Assessment of each scenario using key indicators

ISFM components	Key indicators
1. Organic resources (2.5t/ha, 5t/ha)	Grain yield
	+
	Biomass yield
2. Inorganic fertilizer (30kg N/ha, 60kg N/ha, 90kg N/ha)	+
	SOC at 30 cm depth
	+
3. Combination (2.5 t/ha+ 30kg N/ha; 2.5t/ha +60kg N/ha)	N leaching
	+
	N uptake

4. Risk assessment

Bad years are identified as those where yields fall within the bottom 10th percentile for the baseline treatment.

Figure 3. Steps followed for the biophysical assessment

- ❖ To evaluate treatment sustainability, all indicator values were normalized to a 0-1 scale using the min–max scaling.

Results

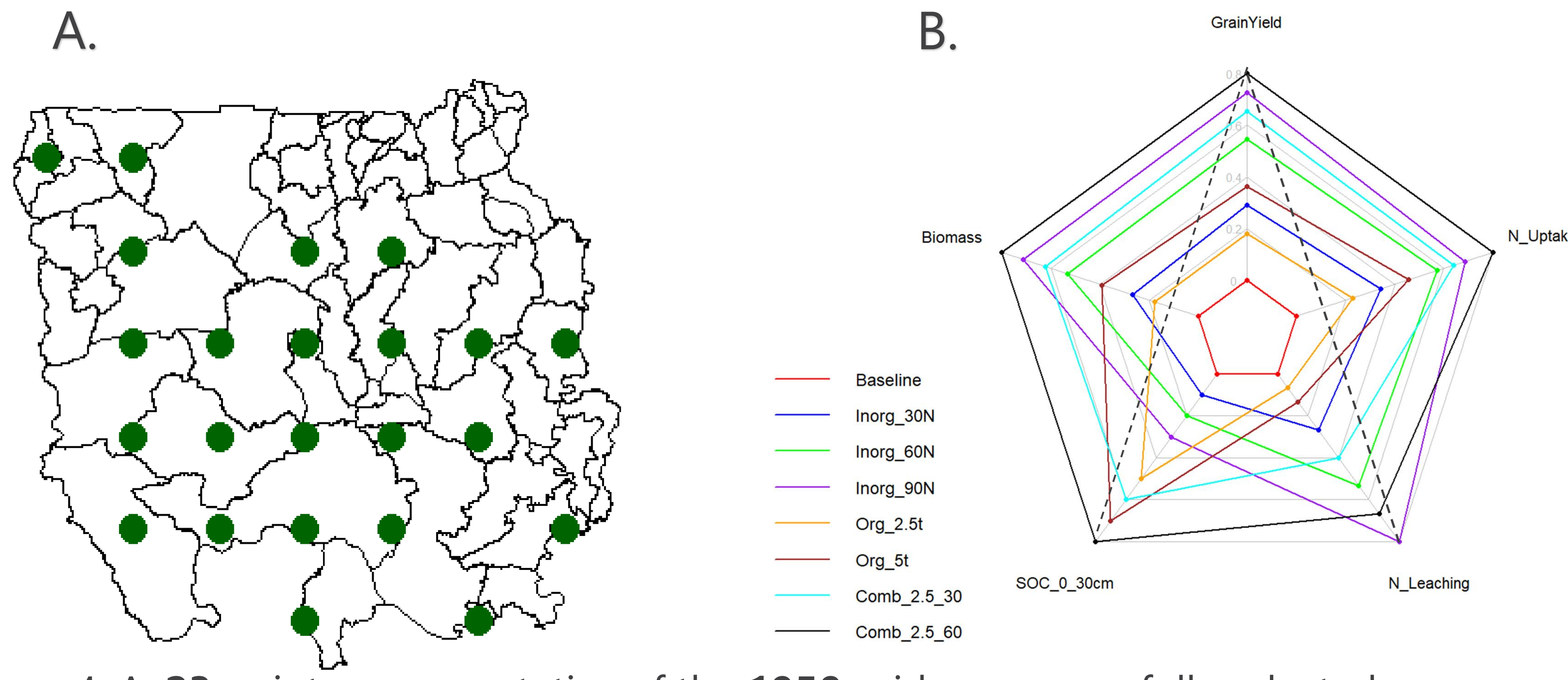


Figure 4. A. **23** points, representative of the **1950** grids, were carefully selected.
B. Pentagon diagram showing the scores for each key indicator and the ISM practices compared with the baseline under current conditions. The dashed lines subdivide the pentagon into 3 triangles.

- ❖ Results reported include only the **first three steps described** below (Fig. 3) and the current conditions.
- ❖ The combined fertilizer treatments resulted in greater grain and biomass yield.
- ❖ N leaching was more pronounced when only inorganic fertilizer was applied.
- ❖ Organic treatments resulted in higher SOC stored in the first 30cm of the soil.

- ❖ **SIMPLACE simulation framework** was used to assess i) current conditions with ISFM practices; ii) the 2.0°C scenario with ISFM practices; iii) the risks associated with ISFM under all conditions.
- ❖ A **subset** of representative data points was selected to conduct a **preliminary analysis**, enabling an **initial exploration** given the high computational cost associated with the full-scale simulation.

Further steps

- ❖ Extend the analysis to the full-scale simulation.
- ❖ Identify the risk of crop failure under current and 2.0°C scenarios for each ISFM

References:
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Leibniz Centre for Agricultural Landscape Research (ZALF) | Eberswalder Straße 84 | 15374 Müncheberg | Germany
Contact: madina.diancoumba@zalf.de
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