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Crop systems evaluation for strategic investment decisions

J. Koo, S. Wood, Z. Guo
International Food Policy Research Institute, 2033 K St., NW, Washington, DC 20006, USA
Contact: j.koo@cgiar.org

Introduction

Investors in development and policymakers have a growing need for data and tools to help them target and prioritize interventions so as to achieve the greatest possible food security impacts in cost-effective ways. Although crop systems modelling has been used successfully as a cross-disciplinary decision support tool, many crop models have been developed for use on comparatively small unit areas, which are typically assumed to be homogeneous in crop growth, environmental conditions, and management regimes. However, typical investment or policy-making decision covers large areas with significant heterogeneity in crop growth conditions and thus crop responses to potential interventions. Potential benefits and pitfalls of increasing the spatial resolution in crop systems modelling studies of large areas have been discussed and tested, but the choices of models and scenarios in these studies have been relatively simple and limited in scope, due to incomplete spatially-explicit knowledge of the crop systems attributes, a lack of sufficiently high-resolution data at regional or global scales required to evaluate such models and results, and the computational cost of running these models over a large area at a high resolution under multiple scenarios. Despite many challenges, a Sub-Saharan Africa (SSA) and South Asia (SA) region-wide decision-support platform employing crop systems models at its core is being developed by a network of crop modellers facilitated by the HarvestChoice project (http://HarvestChoice.org) to help meet the demand for a large scale analytical research platform with accompanying data. The platform is being developed to assess the spatially-explicit likely-changes in crop yield and biomass production and regional resource and market implications of technology and management innovations, under different scenarios of changes in crop management practices and agricultural policy at a grid-based regional scale. This paper discusses the platform development process, and presents a series of use-cases describing potential analytical uses of the platform for the high-spatial-resolution regional estimation of: (1) crop calendar, (2) baseline crop productivity level, and (3) impacts of biotic and abiotic stresses on crop production, under a range of management and climate change scenarios.

Methods

The analytical crop systems modelling platform is being developed by focusing on following issues: (1) characterizing cropping systems based on a blend of macro and micro data, (2) compiling/developing regional-scale crop model input data layers in a standard format, including climate/weather, soil properties, pest and disease prevalence, and model evaluation datasets, (3) developing a set of regional-scale scenarios of potential changes in R&D investment, technology and market access, and farm-scale adoption, (4) developing a database of spatially-explicit pre-run crop systems model results that allow users to assess the potential impacts of scenarios of changes based on the user-defined baseline, and (5) developing a suite of tools to provide an easy interface for running crop growth models in a grid-based regional context with pre-loaded yet modifiable datasets and user-defined scenarios.

Based on the preliminary version of the datasets and tools being compiled and developed, a spatially-explicit database of model results based on following use-cases was developed:

1. Crop- and site-specific length of growing period (LGP) and cropping calendar and their comparison with existing regional databases developed using rule-based systems and observations;

2. Baseline production under a range of supplementary nutrient and water management practices for two representative varieties for each crop, under current and future climate, with:
    a. Impacts of drought on growth stage-specific water stress and yield,
    b. Pest infestation based on the surveyed and simulated pest prevalence data and estimated damage,
    c. Drought and pest infestation occurring simultaneously.

Each case used DSSAT v4.02 (Jones *et al*., 2003) model for maize and groundnut at a 5 arc-minute (approximately 10 km) grid in SSA. For current and future climate, 30 years of daily weather for each grid cell was simulated using WeatherMan (Hoogenboom *et al*., 2006), MarkSim (Jones & Thornton, 2000), and WorldClim (Hijmans *et al*., 2005). Representative soil profiles for major soils in each grid cell were compiled using the Harmonized World Soil Database 1.0 (FAO, IIASA, ISRIC, ISSCAS, JRC, 2008) and the ISRIC-WISE 1.1 (Batjes, 2002). Crop yield in each grid cell was estimated as a weighted average based on the relative area of each soil type.

Results and discussion

Overall outputs of the use-cases showed that location-specific information on the potential changes of crop production under a wide range of scenarios can be useful to help set investment priorities and indentify efficient technology development and adaptation strategies. These outputs will be integrated with an economic evaluation to provide insights into the potential spatial and socio-economic patterns of impact under simulated investment, policy, and environmental change scenarios at regional and global scales.

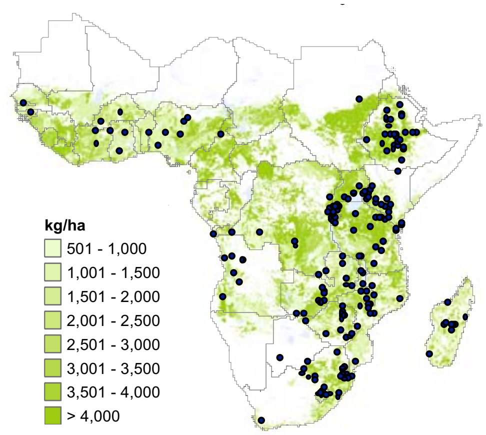

Figure 1. Simulated rainfed/low-input maize yield potential in Sub-Saharan Africa and CIMMYT maize field trial locations (dots).

The performance of crop systems models can be compromised if the environmental or production conditions of interest greatly differ from those used during model development and evaluation, and the risk can be relatively higher in the regional-scale application. As part of the analytical platform development, a set of field measurement data are being compiled from multiple sources (e.g., CGIAR field trial database, national/sub-national agricultural census data) for use as modelling control points. Rigorous efforts on model evaluation will be critical in gaining the confidence of scientists, analysts, investors, and policymakers.

References

Batjes, N.H., 2002. A Homogenized Soil Profile Data Set for Global and Regional Environmental Research (WISE, version 1.1) 2002/01. International Soil Reference and Information Centre, Wageningen, The Netherlands.

FAO, IIASA, ISRIC, ISSCAS, and JRC, 2008. Harmonized World Soil Database [Online]. Available by FAO (Rome, Italy) and IIASA, Laxenburg, Austria.

Hijmans, R.J., *et al.*, 2005. Int. J. Climatol. 25: 1965-1978.

Jones, J.W., *et al*., 2003. Eur. J. Agron. 18: 235-265.

Jones, P.G. & P.K. Thornton, 2000. Agron. J. 92: 445-453.

Hoogeboom, G., *et al*., 2006. Weatherman. Release 4.0.2.0. Univ. of Hawaii, Honolulu, HI.