Yield assessment using crop models

Felicitas Röhrig
Potsdam Institute for Climate Impact Research (PIK)
froehrig@pik-potsdam.de

IMC Dhaka, 07. November 2019
Outline

• Introduction: Yield loss assessment tool box

• Case study 1: India

• Caste study 2: Tanzania

• Summary and outlook
Yield loss assessment toolbox

- Ensemble of statistical and process-based crop models
- Integrate specific model strengths and different data types for higher precision in loss assessment
- Accurate yield estimation, even prior to harvest
- Reliable detection of yield variation, even under extreme events

**AMPLIFY:**
Agricultural Model for Production Loss Identification to Insure Failures of Yields

**Process-based crop models**
(SWIM, DSSAT, APSIM)

- Weather and climate data
- Remote sensing data
- Agricultural data

Felicitas Röhrig
**Statistical yield model**

AMPLIFY – Agricultural Model for Production Loss Identification to Insure Failures of Yields

- **Yields**
- **Weather**
- **Remote sensing**
- **Economy**

Crop calendar

Different statistical models:
- STSM, PDM, RCM

Transformation of the variables

Calculation of weather-related yield losses
Process-based eco-hydrological model
SWIM – Soil and Water Integrated Model

Climate inputs: Solar radiation, temperature & precipitation

Hydrosphere

- Glacier / Snow
- Soil profile
  - A
  - B
  - C
- Shallow groundwater
- Deep groundwater

Pedosphere

- Nitrogen cycle
  - NO₃⁻ N
  - NH₄⁺ N
  - N_e + N
  - N_eff
- Carbon cycle
  - C_POM
  - C_AOM
  - C_soil
- Phosphorus cycle
  - P_abc
  - P_m,sc
  - P_m,se

Vegetation

- LAI
- Biomass
- Roots
- Wetland module
- Crop module
- Forest module

Management: land use pattern, land management & water management

- Reservoir module
- Water abstraction & irrigation
- Point sources & fertilizers
- Crop rotation

Felicitas Röhrig
Case study 1: Rice in India
Model performance: spatial coverage of rice yields

Felicitas Röhrig

Arumugam et al. (forthcoming): Geospatial near-real-time biophysical rice modeling via big data analytics to support crop insurance in India.
Around 60% (68%) of the districts obtained a rRMSE of less than 20% (25%) after calibration.
Model results: Simulated yield loss in 2016 and 2017

Simulated yield loss (%) (Kharif - 2016)

Simulated yield loss (%) (Kharif - 2017)

Yield loss (%)
- 100%
- 90 to 100%
- 80 to 90%
- 70 to 80%
- 60 to 70%
- 50 to 60%
- 40 to 50%
- 30 to 40%
- 15 to 30%
- 0 to 15%
- No Loss

Arumugam et al. (forthcoming): Geospatial near-real-time biophysical rice modeling via big data analytics to support crop insurance in India.
Case study 2: Maize in Tanzania
Spatial coverage of maize yields by SWIM

Time period 2003-2010

Observed

avg = 1.3t ha$^{-1}$

SWIM

avg = 1.3t ha$^{-1}$

$r = 0.57^{NS}$

Felicitas Röhrig

Gornott, Hattermann, Wechsung, under review
Explained spatial and temporal yield variability

PM + SM

\( r = 0.05^{NS} \)
**Combined model approach to improve model performance**

**SWIM**  
(Soil and Water Integrated Model, process based)

**AMPLIFY**  
(Agricultural Model for Production Loss Identification to Insure Failures of Yields; semi-empirical, statistical model)

- Combination improves yield assessment accuracy, models complement each other
- Promising calibration and validation results for Tanzania
- Extreme yield losses are captured by our crop model
Correlation (r) of observed and modeled yields
Comparison between a precipitation index and combined model approach

Pearson’s r of observed maize yields and combined model approach (right) or a precipitation index (left)

Not used by us!
Ability to separate weather-related and non-weather related factors influencing yield loss

In Tanzania, only 27% of the yield variability is attributable to weather.

The range is 4 – 57%.
Summary

- Our crop models are able to capture yield loss at time of harvest and at fine resolution over large geographic area.
- Reliable detection of yield variation, even under extreme events.
- Integration of process-based and statistical models allows accurate yield loss assessment even in context of data scarcity.
- Ability to separate weather- and management factors driving yield loss.
In these regions, we have already successfully applied single and joint models for yield estimation and/or forecast.
Thank you!
froehrig@pik-potsdam.de