Crop Monitoring and Forecasting:

Satellite based technology for rice crop monitoring, yield forecasting and crop damage assessment

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Approaches and Methodologies for Crop Monitoring and Production Forecasting
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Background

IRRI and partners are using remote sensing, crop modeling, smartphone-based surveys, and cloud computing to map and estimate:

- Planting dates
- Rice area and yield
- Flood/drought / pest damages

Timely, detailed and accurate information in the hands of stakeholders.
Integrated remote sensing, crop modeling, smartphone-based surveys, and cloud computing allowing us answering three basic questions related with rice production

• Where
• When
• How much

countries where field sizes are < 1 ha, with diverse management, varieties and climate.

Provide assessment and estimates at higher spatial and temporal resolutions.
The **RIICE** project provides **accurate and timely information on rice** using satellite remote-sensing, crop modeling, and other technology.

** RIICE: Remote sensing based Information and Insurance for Crops in emerging Economies **

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RIICE Project Sites

Phase 1 (2012 - 2015)
1.65M ha rice in 13 sites in 6 countries

RIICE Project

• The RIICE project has demonstrated that rice can be mapped with high accuracy across different seasons, different crop and water management practices and different maturities.

• Rice area accurately mapped at sub hectare resolution in over 1.6m ha across 13 sites in Thailand, India, Vietnam, Cambodia, Indonesia and the Philippines.

• Potential to replicate in other rice growing countries.
Radar (SAR) images vs. optical images
Scaling up...

Sentinel-1A
- Launched April 2014 by ESA
- 12 day repeat frequency
- 20m resolution
- Free and open access
- SAR sensor – perfect for rice

Sentinel-1B
- Launched in April 2016
- 6 day repeat frequency

Sentinel-1C & 1D
- To be launched in 2021 ensuring continuity
Changes in these images over time are used to map where rice is grown, when it is grown and how much rice is harvested.
Rice Has Distinctive Temporal Features
Planting Dates and Seasonality

- reveals heterogeneity in planting
- showing season is early or delayed
- may reveal areas where there are constraints
Planting Dates

Red River and Mekong River Delta, Vietnam 2013

Accuracy ± 11 days

Accuracy ± 15 days
Rice map classification accuracy (%) is based on comparison against 100 ground truth points per footprint. Consistently above 85% in all 13 RIICE sites.
Yield Estimation Process
Using remote sensing and crop modeling

MAPscape-RICE (sarmap)

ORYZA (IRRI)

Meteo
Variety
Management
Field results

Field results
MAPScape-Rice
Raw SAR data -> Rice SAR Products

- Rice Area Map
- Planting Dates Map
- LAI Maps
In-Season Rice Yield Forecasting

Linking SAR-based remote sensing data (CSK-LAI) with ORYZA Crop Growth Model

Forecast without RS = 6.2 t/ha

LAI estimate from RS 55 days before harvest Corrects the forecast & get closer to actual yield of 5.2 t/ha
Yield Forecasts and Estimates

Nueva Ecija, Philippines

1\textsuperscript{st} forecast:
Sep 2014 = \textbf{5.60 t/ha}

2\textsuperscript{nd} forecast:
Oct 2014 = \textbf{5.40 t/ha}

PSA-BAS forecast:
Oct 2014 = \textbf{5.48 t/ha}

End-of-season estimate:
Nov 2014 = \textbf{5.30 t/ha}

PSA-BAS estimate (by province):
Mar 2015 = \textbf{5.31 t/ha}

Accuracy = 86% (based on crop cuts)
Yield 2015 Wet Season Central Plain Thailand

Forecast Yield Data Available: Sep 2015 Agreement: 82%*

End of Season Data Available: Dec 2015 Agreement: 85%*

OAE Preliminary Data Available: Mar 2016

Wet season, 2015
Yield (kg/ha)

- < 2000 kg/rai
- 2000 - 3000 kg/rai
- 3000 - 4000 kg/rai
- 4000 - 5000 kg/rai
- 5000 - 6000 kg/rai
- > 6000 kg/rai

*Accessed based on initial data from DOAE for Suphanburi province.
Multi-Country Model Yield Validation

Year: 2013-2015
Season: WS, DS
Ecosystem: Irrigated, Rainfed

Agreement: 81-93%

Modeled Yield (kg/ha)
Reported Yield (kg/ha)
Philippines
Vietnam
India
Thailand
Cambodia
Oct 2013 – severe flooding in Nakhon Ratchasima and Buri Ram was captured in our SAR imagery and provided within days to DOAE. 9,103 ha on Oct 6th, of which 7,138 ha were rice 1,576 ha on Oct 10th, of which 1,423 ha were rice
Detailed maps of flood affected rice areas can show which fields were flooded, when and for how long.

CSK images provided by GISTDA. CSK images processed by sarmap. Fieldwork/observations by Thai RD. Coordination by IRRI
Conclusions

Incorporation of remote sensing products (SAR) into crop model improves yield estimation:

• Captures the response of rice plants to environmental conditions over large areas
• Includes rice phenology to initialize the model
• Tested in 6 countries with at least 85% accuracies for end of season yield estimates

Involvement of national partners is crucial:

• The only way to sustain, promote and validate an operational crop monitoring system
• Data collection for calibration and validation & provision of knowledge on rice types and practices that are essential for product generation
Thank You

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