DPRK Crop Monitoring and Forecasting: Challenges and Opportunities

DPRK Roundtable Conference, September 6, 2019
Seoul, South Korea

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Office of Global Analysis (OGA)

Foreign Agriculture Service (FAS)

United States Department of Agriculture (USDA)

USDA Foreign Agricultural Service
Office of Global Analysis
IPA Division

My Expectations

- **Goal #1**: Build partnerships with a network of experts to facilitate sharing of information
- **Goal #2**: Working with a network of experts to develop a common set of best practices, processes, and reporting about DPRK agricultural systems
- **Goal #3**: Develop a framework for assessing data quality across various sources (“working group”)

Presentation Outline

1. USDA Economic Information System
2. Challenges and Opportunities: DPRK Crop Monitoring and Forecasting
3. USDA's 2019 DPRK Crop Condition Assessment and Rice Area Identification-Mapping
4. Discussion-Questions-Comments

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USDA Agricultural Commodities Information System:
Commodity Balance Sheet

SUPPLY = DEMAND

Beginning Stocks + **Production** + Imports = Exports + Domestic Use + Ending Stocks

Beginning Stocks → Private (On-farm) (Pipeline), Government

Production → **Area x Yield**

Imports, Exports → Commercial, Concessional

Domestic Use → Feed, Residual, Food, Seed, Industrial

DPRK high degree of uncertainty

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Output: Reports and Production Supply and Distribution (PSD) database

- **Principal Federal Economic Indicators: WASDE, FAS and NASS**
- **PSD Online http://apps.fas.usda.gov/psdonline/psdhome.aspx**
- **Part of Data.gov http://www.data.gov/**

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World Agricultural Supply and Demand Estimates

United States Department of Agriculture

Office of the Chief Economist | Agricultural Marketing Service, Farm Service Agency | Economic Research Service, Foreign Agricultural Service

WASDE - 484 | Approved by the World Agricultural Outlook Board | July 9, 2010

NOTE: This report adopts U.S. area, yield, and production forecasts for winter wheat, durum, other spring wheat, barley, and oats released today by the National Agricultural Statistics Service (NASS). For rice, corn, sorghum, soybeans, and cotton, area estimates reflect the June 30 NASS *Acreage* report, and methods used to project yield are noted on each table. The first survey-based 2010 production forecasts for those crops will be reported by NASS on August 12 and will be included in that day's issue of this report.

WHEAT: U.S. wheat supplies for 2010/11 are raised this month on higher area, yields, and carryin. Beginning stocks are raised 43 million bushels based on the June 1 stocks estimate. Total wheat production is forecast 149 million bushels higher with higher forecast area and a forecast record yield of 45.9 bushels per acre. Winter wheat production is up 23 million bushels as higher Hard Red Winter wheat yields more than offset lower yields for Soft Red Winter wheat. Durum and other spring wheat production are forecast higher as abundant moisture and lack of heat stress in the Northern Plains support above trend yields. Feed and residual use is projected 20 million bushels lower as higher prices limit the competitiveness of wheat in livestock and poultry rations. Exports are projected 100 million bushels higher with lower expected production in several major exporting countries and strong early season export sales. Despite increased foreign demand for U.S. wheat, ending stocks for 2010/11 are projected 102 million bushels higher and remain at an expected 23-year high. The season-average farm price for all wheat is projected at $4.20 to $5.00 per bushel, up 20 cents on each end of the range as tighter world supplies and higher corn prices support wheat values.

This month's 2009/10 changes reflect the latest export and seed use data and reported June 1 stocks. Projected exports are lowered 20 million bushels and estimated seed use is lowered 3 million bushels. Based on these changes, June 1 stocks indicate feed and residual use 21 million bushels lower. The 2009/10 wheat farm price is estimated at $4.87 per bushel, up 2 cents from last month's projection.

Global wheat supplies for 2010/11 are reduced with world production projected 7.5 million tons lower as smaller crops in FSU-12, Canada, EU-27, India, and Turkey more than offset higher production in the United States and China. Production for Canada is lowered 4 million tons as persistent June rains limited seeding in the Western Prairies. Production is lowered 4.5 million tons and 3.0 million tons, respectively, for Russia and Kazakhstan as continued drought and high temperatures reduce yield prospects for spring wheat. EU-27 production is lowered 1.1 million tons reflecting early indications of lower-than-expected yields in northern Europe. India production is lowered 1.0 million tons on indications that heat during late grain fill reduced yields. Production is lowered 0.5 million tons for Turkey as early harvest results indicate disease has reduced expected yields. Production is raised 2.5 million tons for China where favorable June weather boosted harvested area and yields.

World wheat imports and exports are nearly unchanged for 2010/11, but substantial shifts are projected among the major exporting countries. Exports are reduced for Canada, Russia, Kazakhstan, and Turkey with lower production. Exports are raised for the United States, Australia, EU-27, and Ukraine. Global wheat consumption declines slightly with lower expected feeding in Canada, EU-27, Ukraine, and the United States mostly offset by increases for Russia and China. Global ending stocks are projected 6.9 million tons lower.

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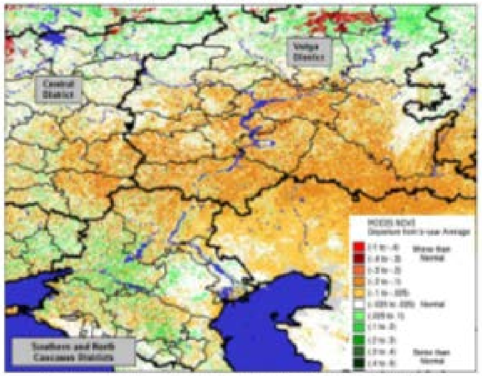
Circular Series WAP 07-10
July 2010

World Agricultural Production

Russian Volga District: Withering Drought Reduces Yield Prospects for Wheat



Vegetative indices (NDVI) derived from the MODIS satellite sensor indicate that crop conditions were significantly worse than average throughout the Volga District. The Volga District is one of Russia's key grain-production regions.

Russia Wheat: Severe Drought Reduces Production Prospects

The USDA forecasts Russia wheat production for 2010/11 at 53.0 million tons, down 4.5 million or 8 percent from last month and down 8.7 million or 14 percent from last year. Area is estimated at 26.8 million hectares, down 0.6 million from last month and down 1.9 million from last year. The decline in area is primarily due to higher estimated winterkill and lower reported spring wheat area. Yield is estimated at 1.98 tons per hectare, down 6 percent from last month and down 8 percent from last year. The reduction in estimated yield is attributed chiefly to withering drought in the Volga, Ural, and Siberian Districts, which together produce most of Russia's spring wheat.

Approved by the World Agricultural Outlook Board

USDA uses Satellite Earth-Observation Data as a cost-efficient-operational way of collecting necessary information to perform agricultural crops monitoring and crop yield forecasting. The Remote Sensing information provides independent measurements to support/complement yield forecasting systems/models that operate based on weather, soils and management data

Figure 1. NASA's current Earth-observing fleet includes 20 missions. Out of the 20 missions, 2 are payloads onboard the International Space Station (ISS)—the Rapid Scatterometer (RapidScat) and Clouds Aerosol Transport System (CATS) missions. This leaves 18 free-flying missions. Note: This diagram does not represent the actual orbital tracks of each mission or the actual groupings of satellites. * TCTE is a separate NOAA payload onboard the U.S. Air Force's Space Test Program Satellite (STPSat)-3 **Image credit:** NASA

DPRK Crop Monitoring and Forecasting:

Challenges and Opportunities

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Assessment of Crop Condition Characterization Drivers

Challenge 1: Incomplete characterization of crop productivity drivers to minimize uncertainty that can lead to over-or-under- estimates

Measurables

Precipitation:
- ✓ Wetness: wetter than average
- ✓ Dryness: drier than average

Temperature:
- ✓ Hot: Hotter than average
- ✓ Cold: Cooler than average or frost damage

Using the best and most reputable authoritative sources

Uncertainty

- ✓ Start-of-season
  optimal or delayed planting
- ✓ Varieties, Management (inputs), Pests and diseases
- ✓ Social-economic factors
  -policy changes,
  -agricultural subsidies,
  -government intervention,

Collection, Interpretation, and Integration of Field Data

Challenge 2: Incomplete Assessment System Infrastructure due to lack of integration of observed and verified measurements

Weather Data	Field Data
✓ **Precipitation**	✓ Crop Varieties
✓ **Temperature**	✓ Crop Calendars (regional)
✓ **Solar Radiation**	✓ Management practices
	✓ Soils

***more critical during water limited conditions**

Farming Systems Characterization

<u>Challenge 3</u>: Lack of operational knowledge of farming systems and farmers decision making

- How are crops grown/produced?
- What is the rate of technological improvement?

- What is the seasonal crop cycle and planting/harvesting calendar?
- What are farmers choices/options when weather or prices are unfavorable?

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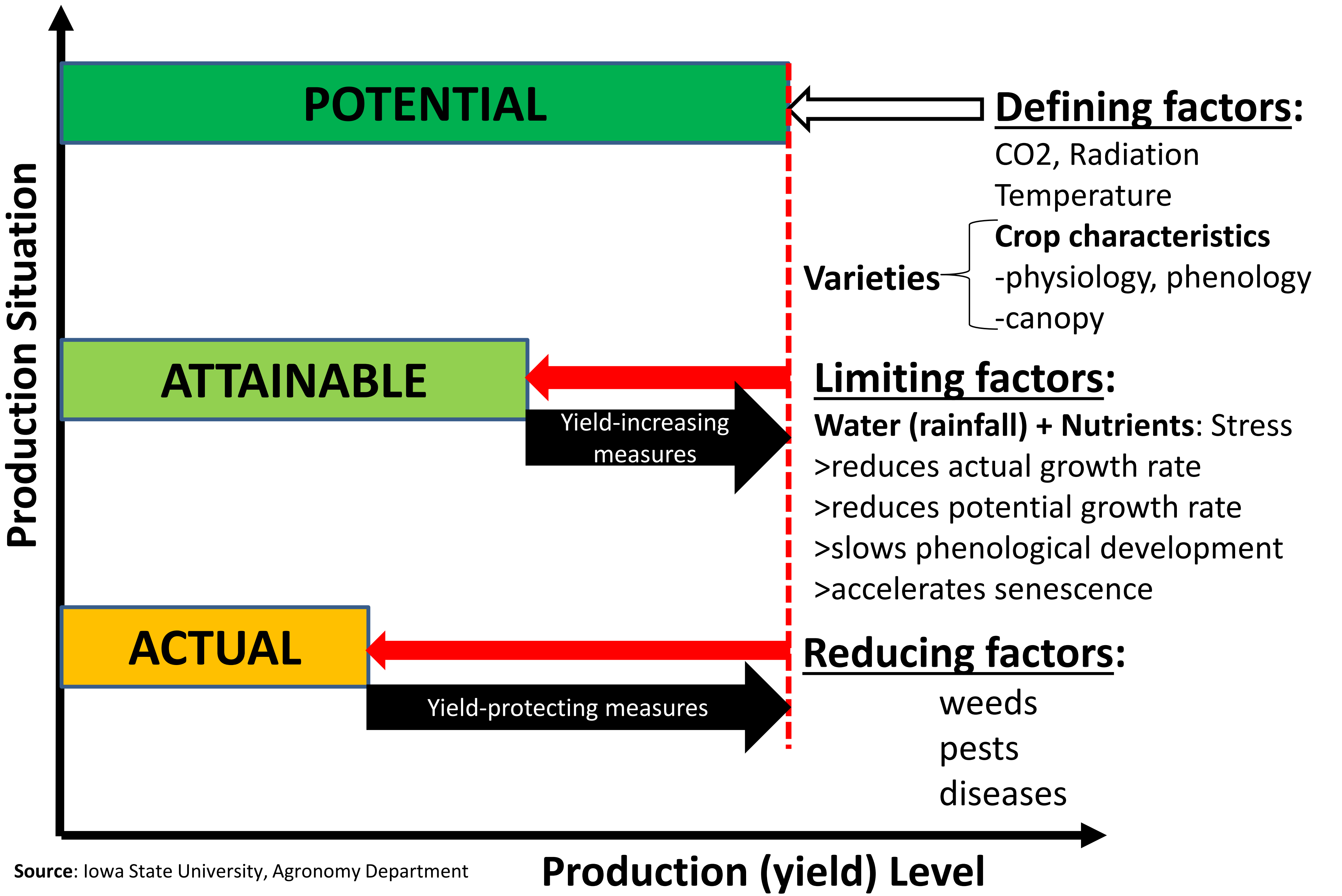
- What support programs or market signals skews planting decisions one way or another

Challenge 4: Lack of Yield Gap Data/Information



Source: Iowa State University, Agronomy Department

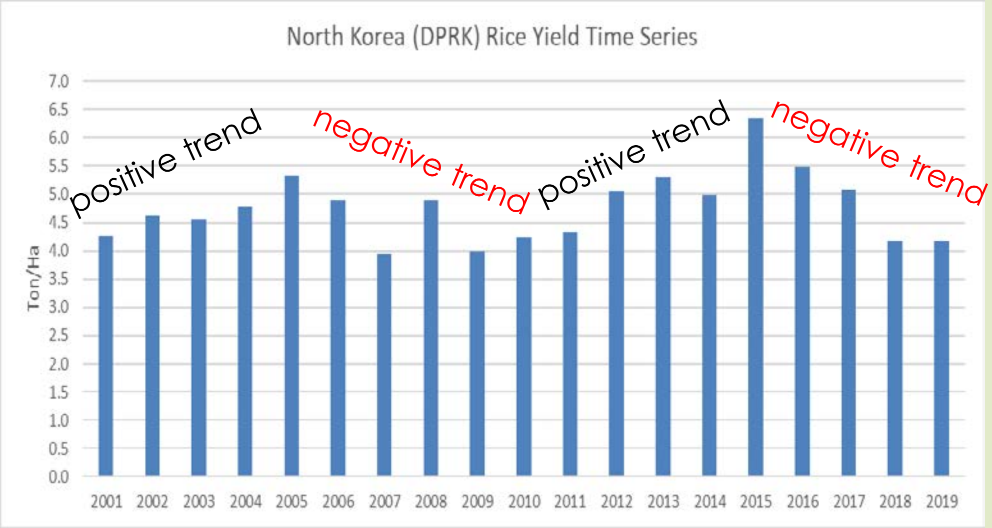
Lack of Yield Gap data: Primarily due to lack of understanding the various rice ecosystems; differences between potential yield (varieties); potential farm yield; actual farm yield (average yield realized by farmers); the best yield realized on farmers' fields and the average yield of the region

Unreliable Yield Index (ratios of actual yield to potentials)
Unreliable predictions of farm input levels and management practices

Challenge 5: Time Series Yield Variability: Understanding; Interpretation; Communication

- Due to variability in year-to-year yields, measurements of long-term yield decline or increase use statistical trend analysis (linear regression) to distinguish longer-term trends from short-term "noise"
- Simple linear regression are probably more useful when management remains the same over the estimated timeframe
- Assumption of unchanging management is more unrealistic. Yield at national level may not explain much.

Analysis of long-term trends is problematic. A regression fit may not be appropriate over the entire record due to reversed yield trends.



Is the observed change in trend due to:

1. **Environmental conditions**
2. **Agronomic/soil problems**
3. **Economic problems**
4. **Changes in management practices**

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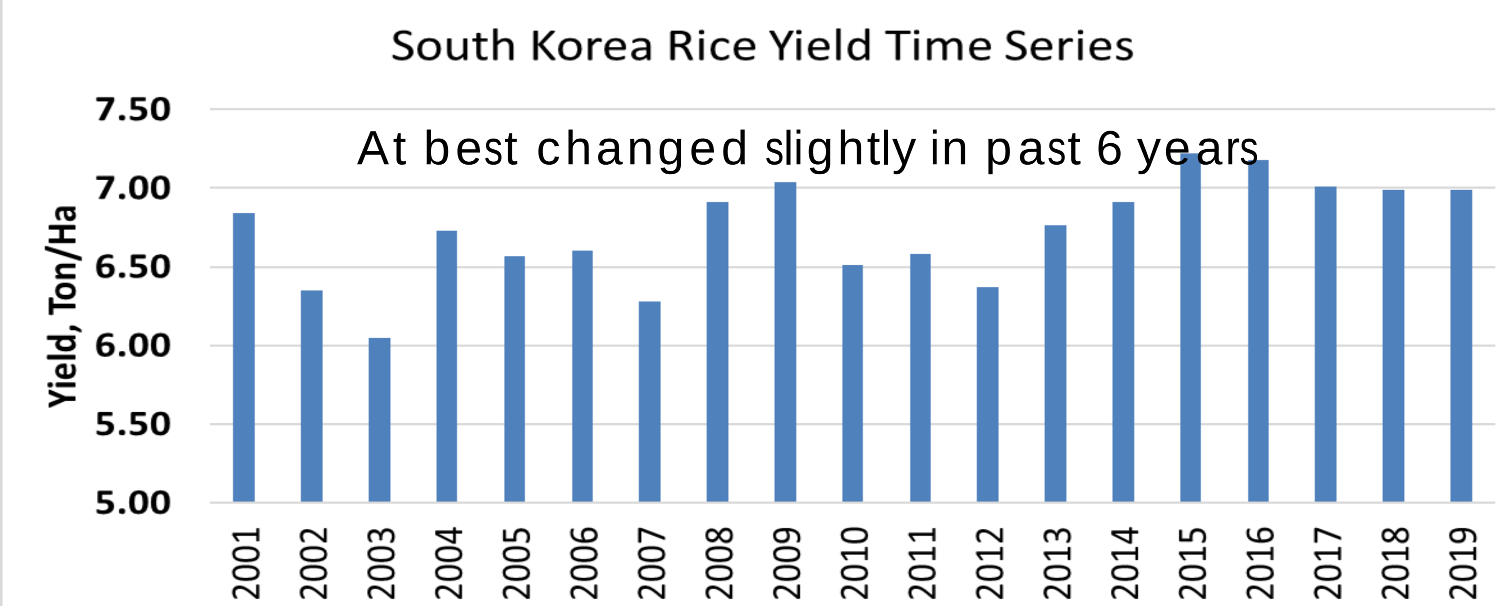
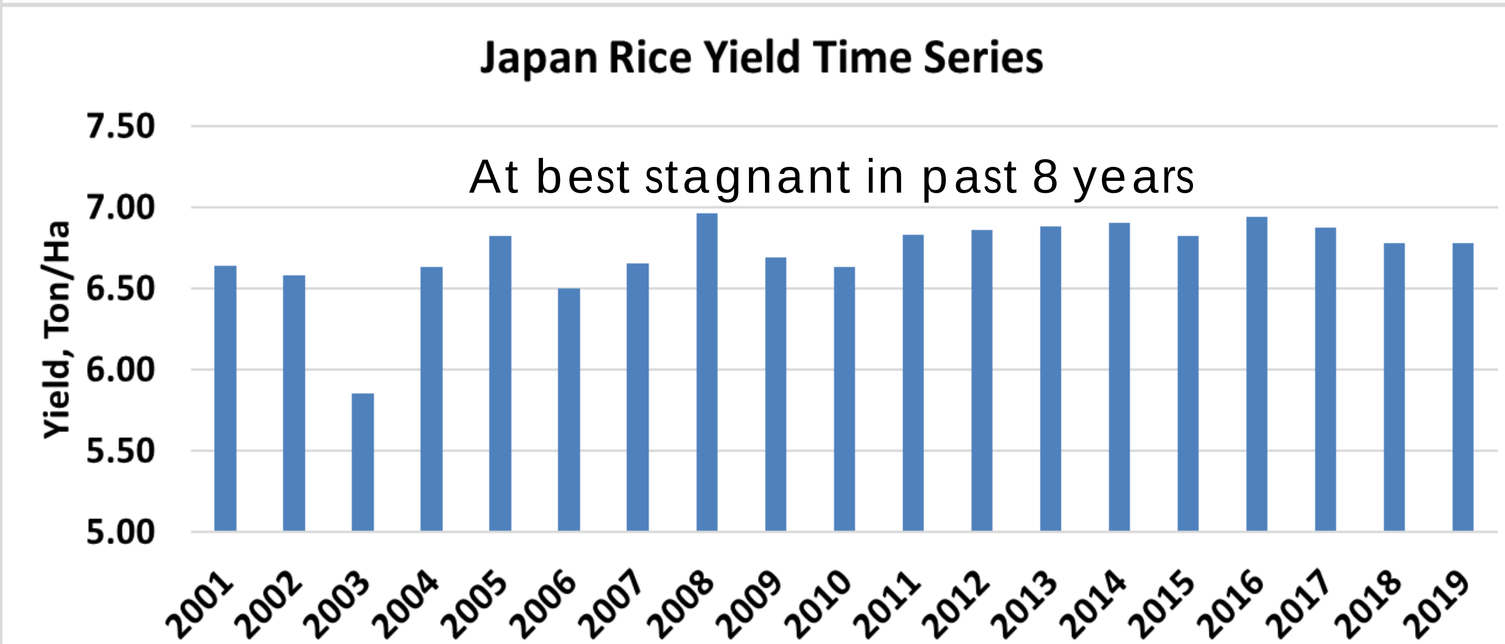


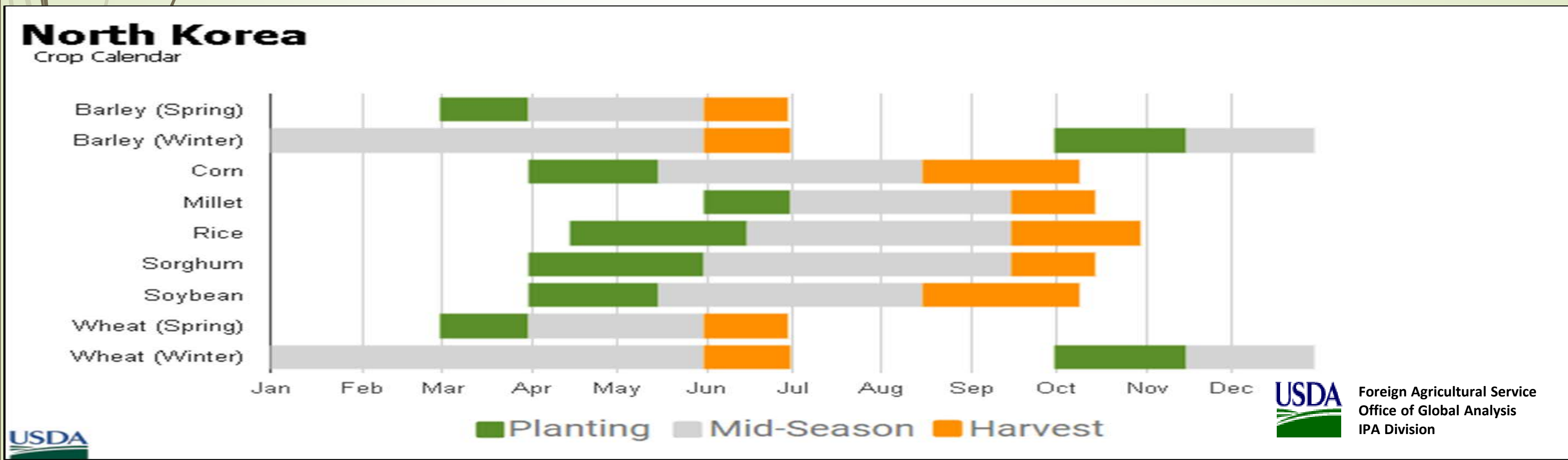


For Japan and South Korea, these are dynamic economies and may be due to high level of economic development and industrialization discouraging farmers from rice production in favor of profitable alternative enterprises. This makes regional extrapolation of yield growth rates unrealistic

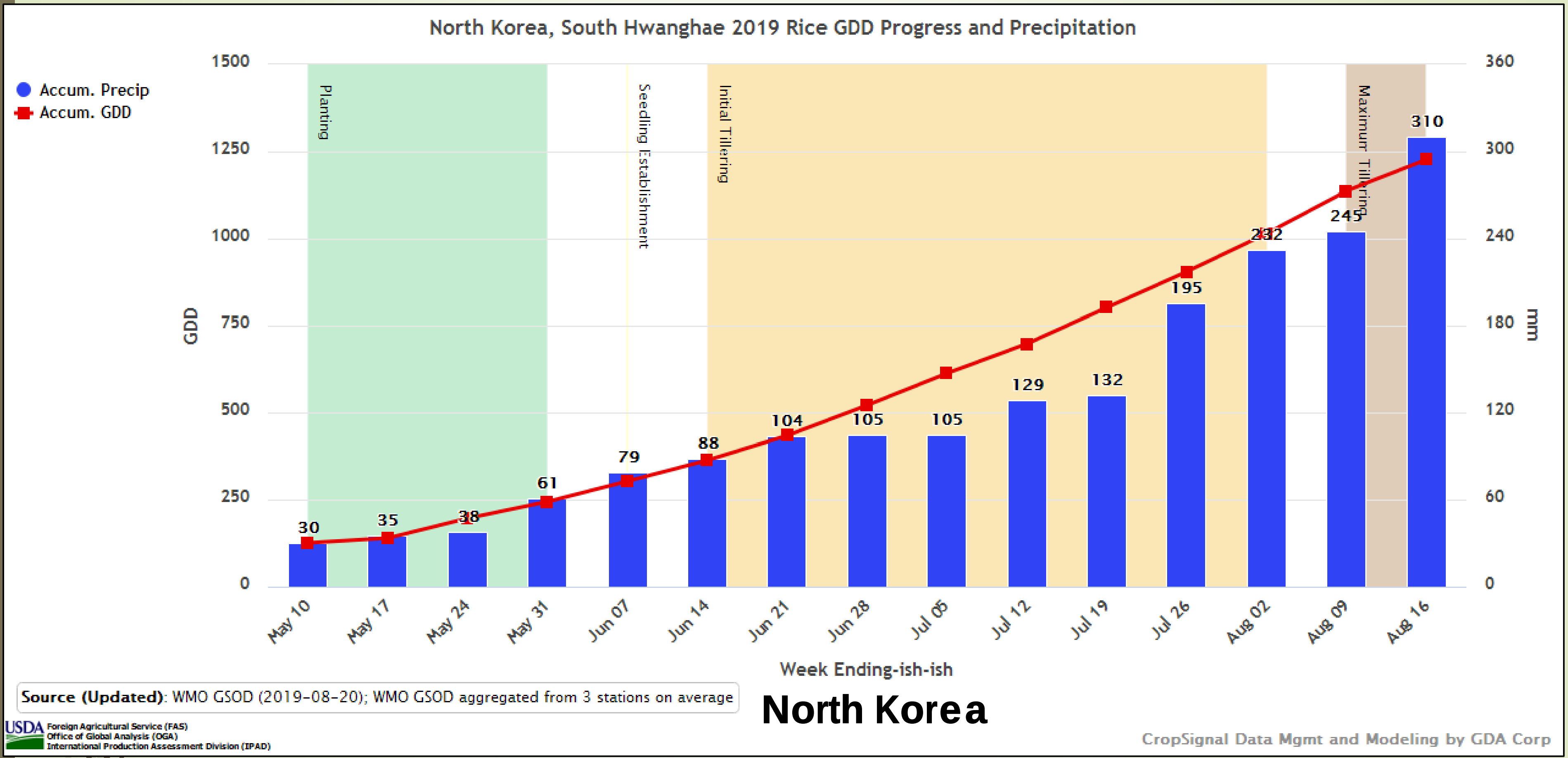
Challenge 6:
Usefulness and Reliability of Generalized Crop Calendars

- Impact of excess rain at sowing
- Droughts during vegetative growth
- Frost at emergence
- Rain at flowering
- Dry spells at grain filling
- Heat stress before/during maturity
- Rain at harvest

Timing is crucial for systematic examination and interpretation of the impact of various conditions on crop growth-development



Importance of Crop Calendars and Optimal Planting Time for Model Initiation

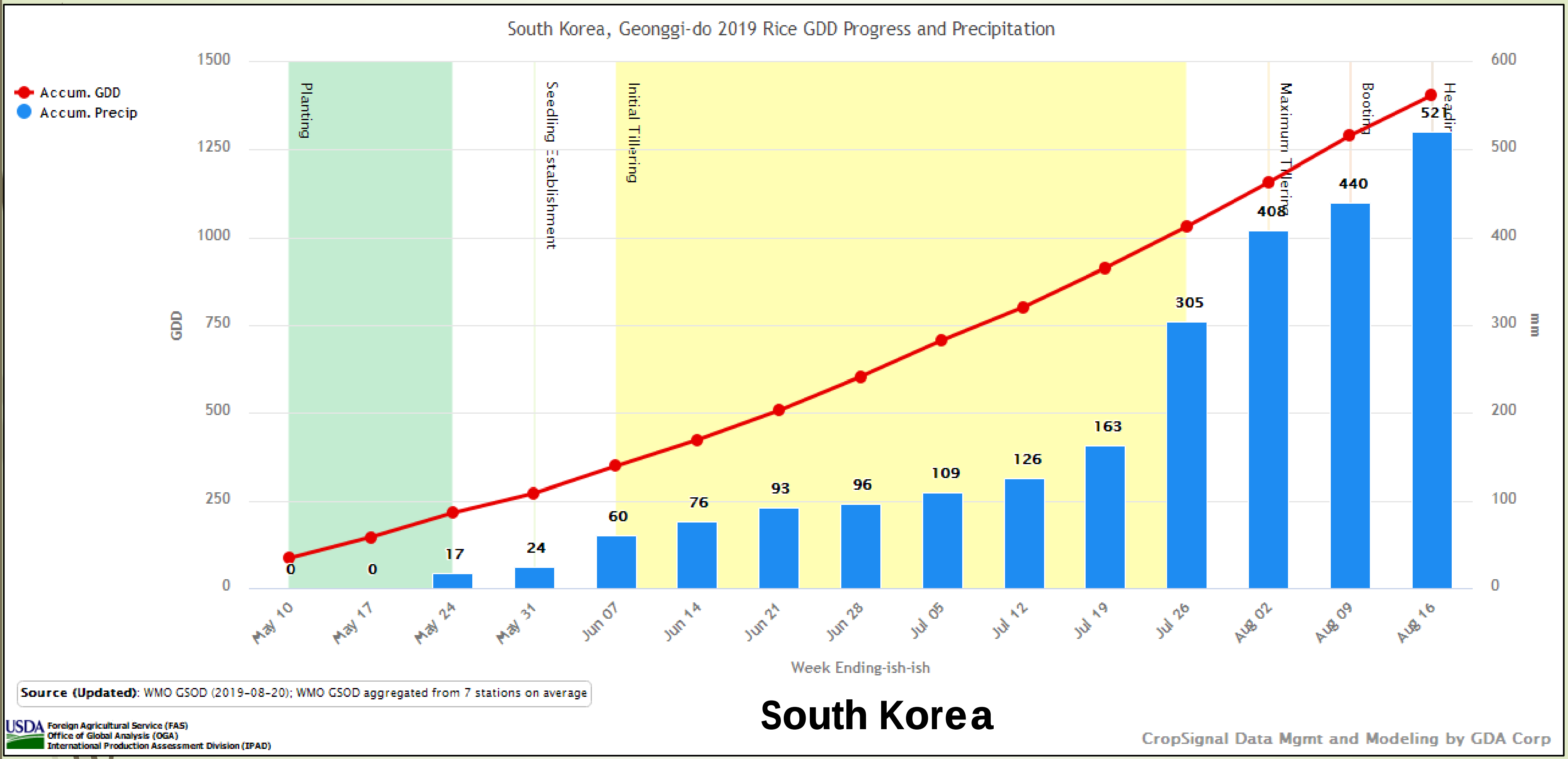


North Korea

Weather (Precipitation and Temperature) has significant effect on crop performance, accounts for most of the inter-annual yield variability

GDD = (Tmax + Tmin)/2 - Tbase

Importance of Crop Calendars and Optimal Planting Time for Model Initiation

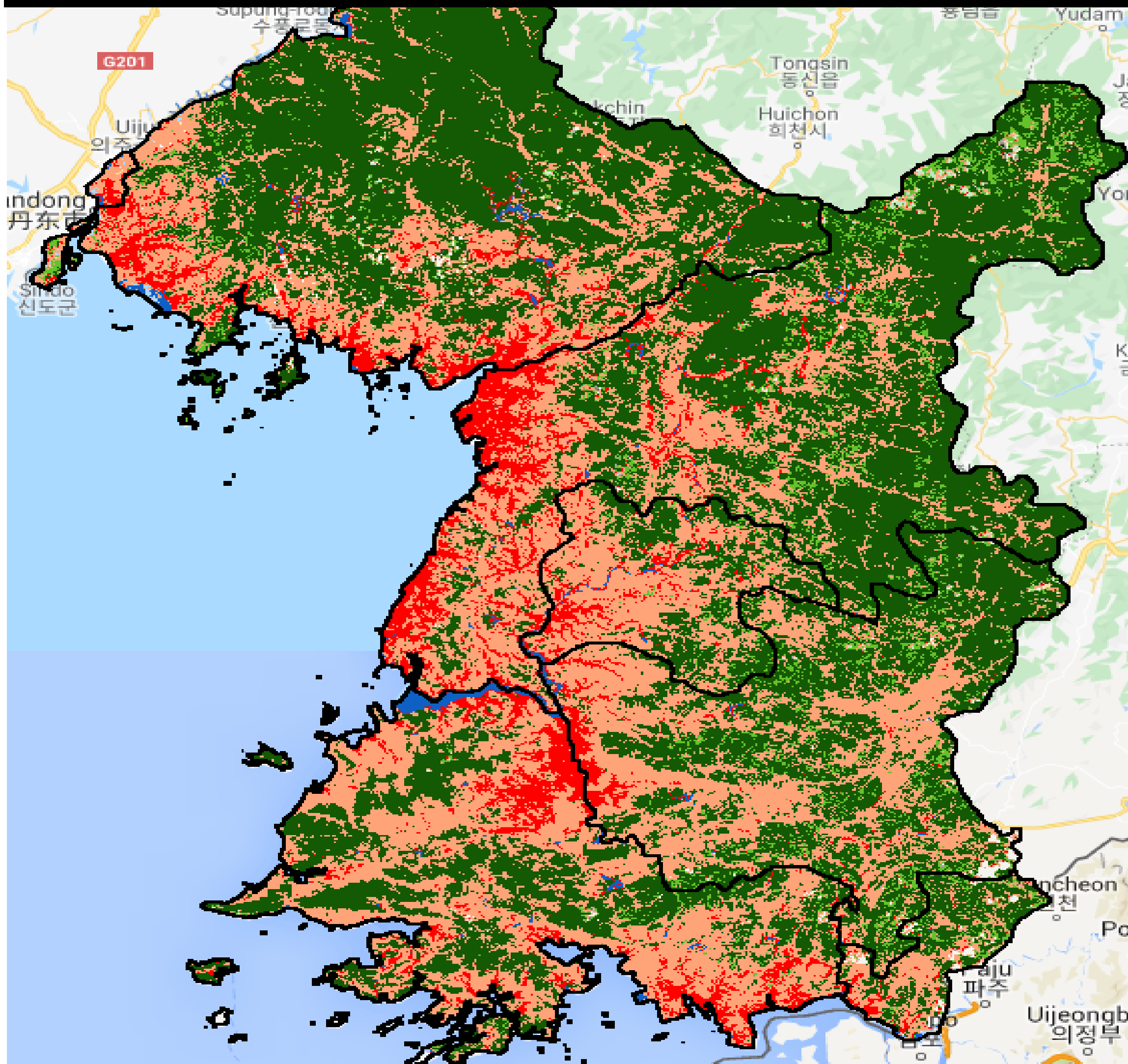


Weather (Precipitation and Temperature) has significant effect on crop performance, accounts for most of the inter-annual yield variability

GDD = (Tmax + Tmin)/2 - Tbase

Challenge 7a: Using satellite (remotely-sensed) derivatives without ground-truth observations for verification

Sentinel-2 imagery, Jun 25 – July 16, 2019



Without ground-truthed data, remotely-sensed data is of limited value.

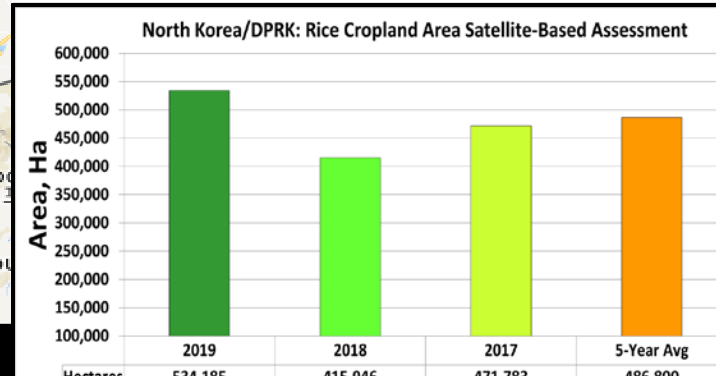
North Korea/DPRK 2019 Rice Cropland Classification

- Rice
- Cultivated land/Built-up
- Forest
- Thin Vegetation
- Water

Data required for complete mapping:

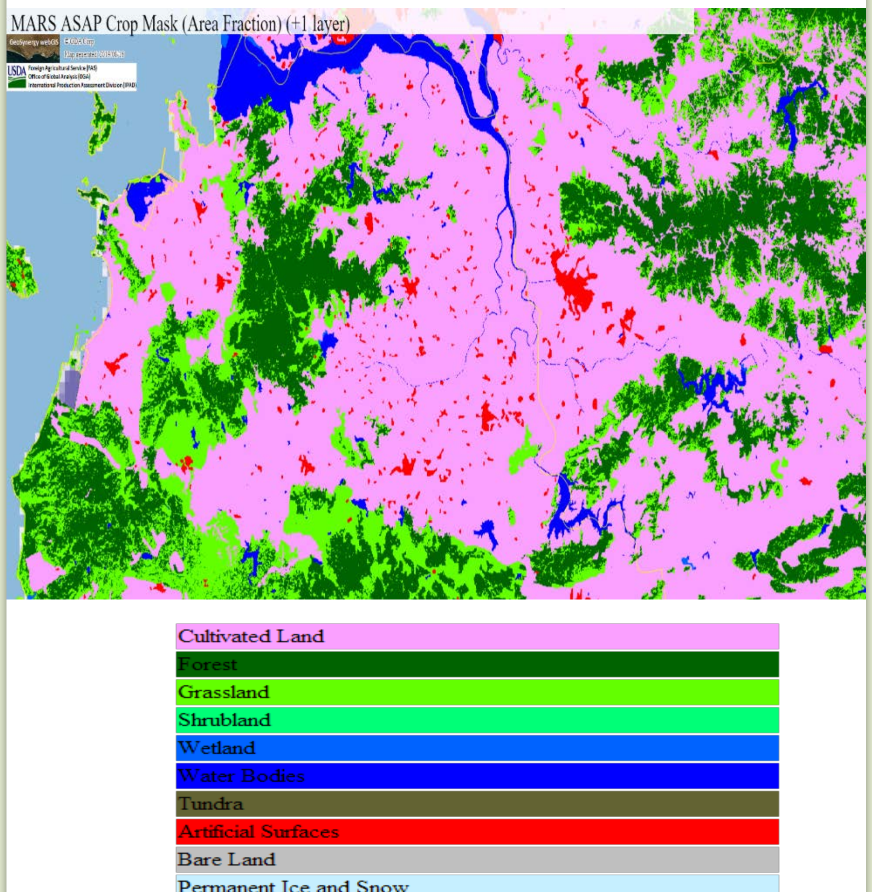
✓ **Satellite data itself**

➢ **Ground-truthed data or other base/reference map to estimate the accuracy**

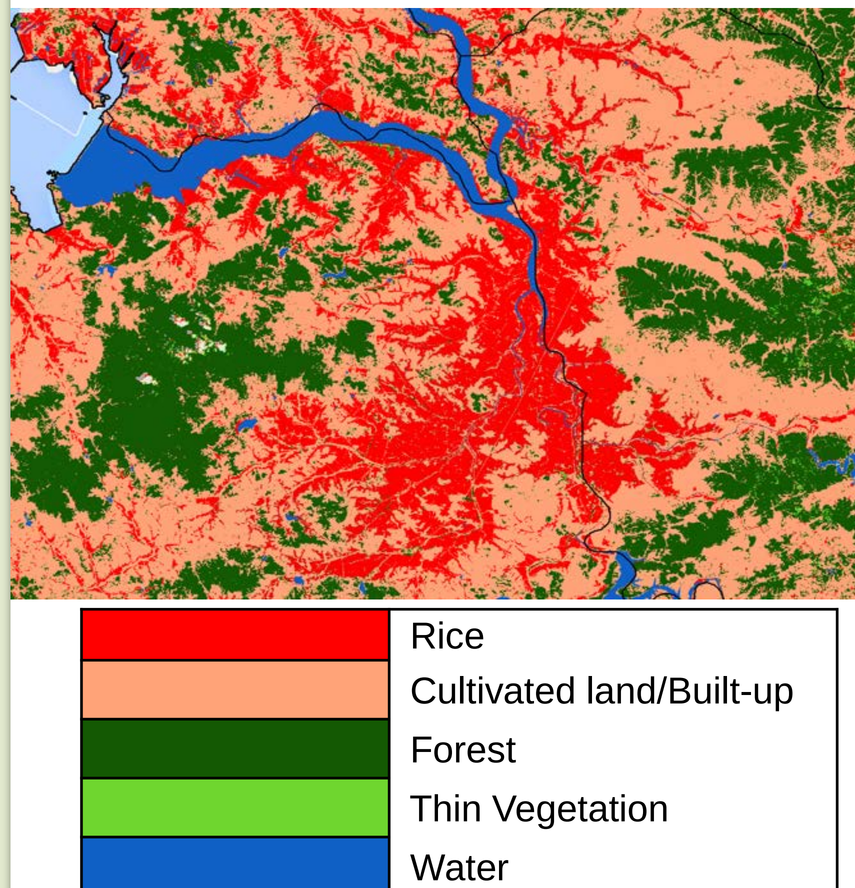


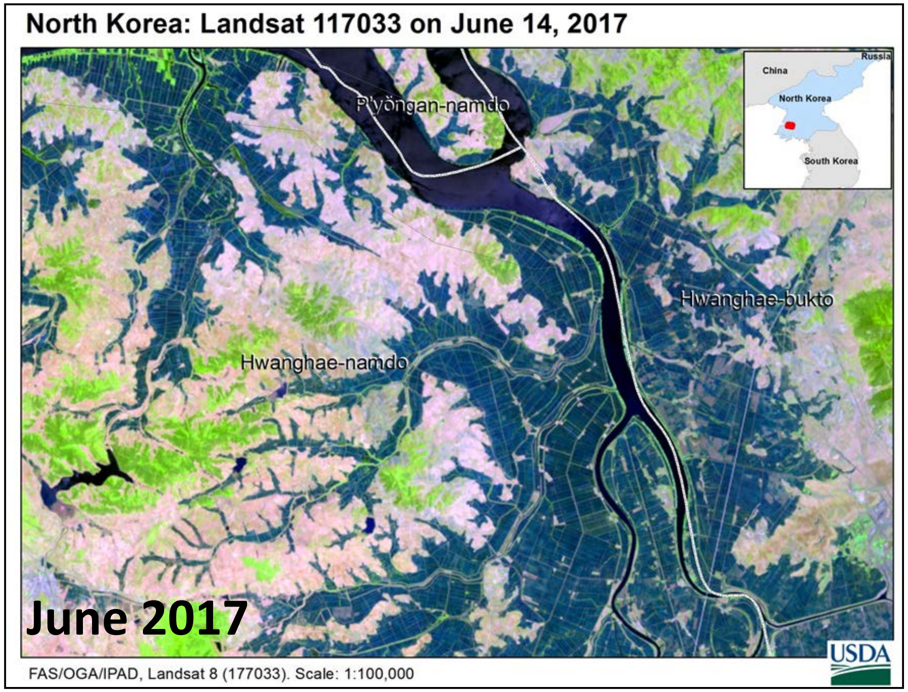
	2019	2018	2017	5-Year Avg
Hectares	534,185	415,046	471,783	486,800

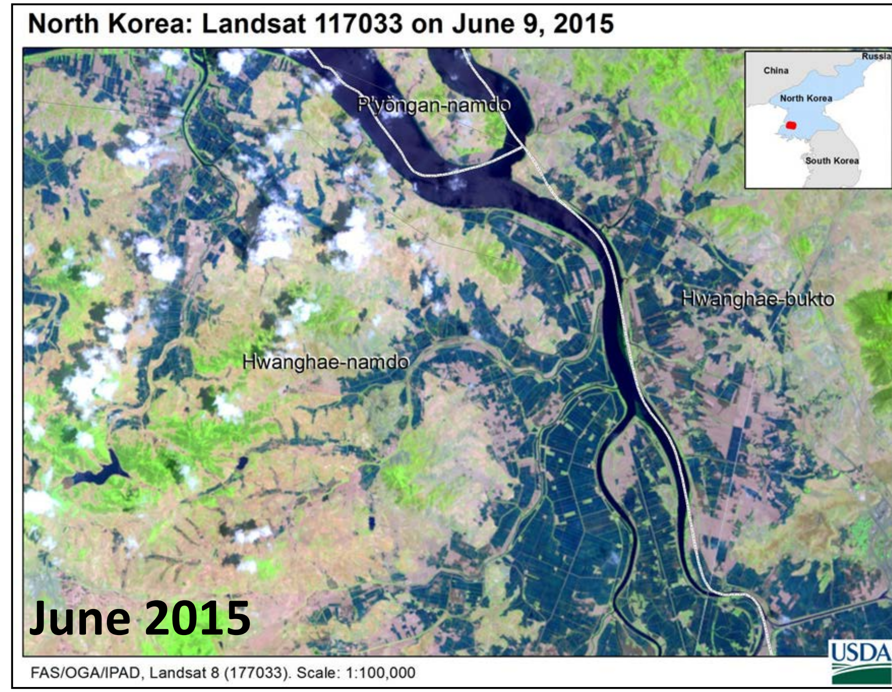
MARS ASAP Crop Mask (Area Fraction)
GlobeLand30 2010 NGCC, China



Hwangwe 2019 Rice Area
Sentinel Imagery Classification





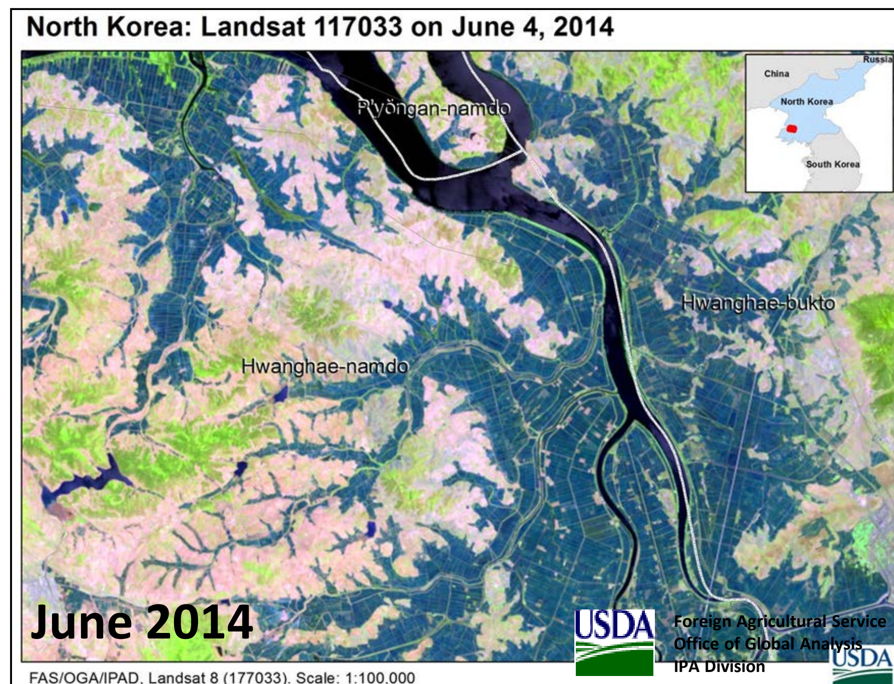


<u>Rice cultivated area identification and mapping using water areal extent as "reference map"</u>

Landsat 8 Satellite Images show rice/paddy fields (*shades of dark*), based on identification of pre-planting flooding of fields.

The 2017 and 2014 images show similar flooding pattern (rice planting area extent) compared to 2015 (less area, drought year)

- ✓ general agreement may still present inaccuracies in terms of locational or site-specific water errors; may not be 1:1 relationship (water : rice presence/absence)



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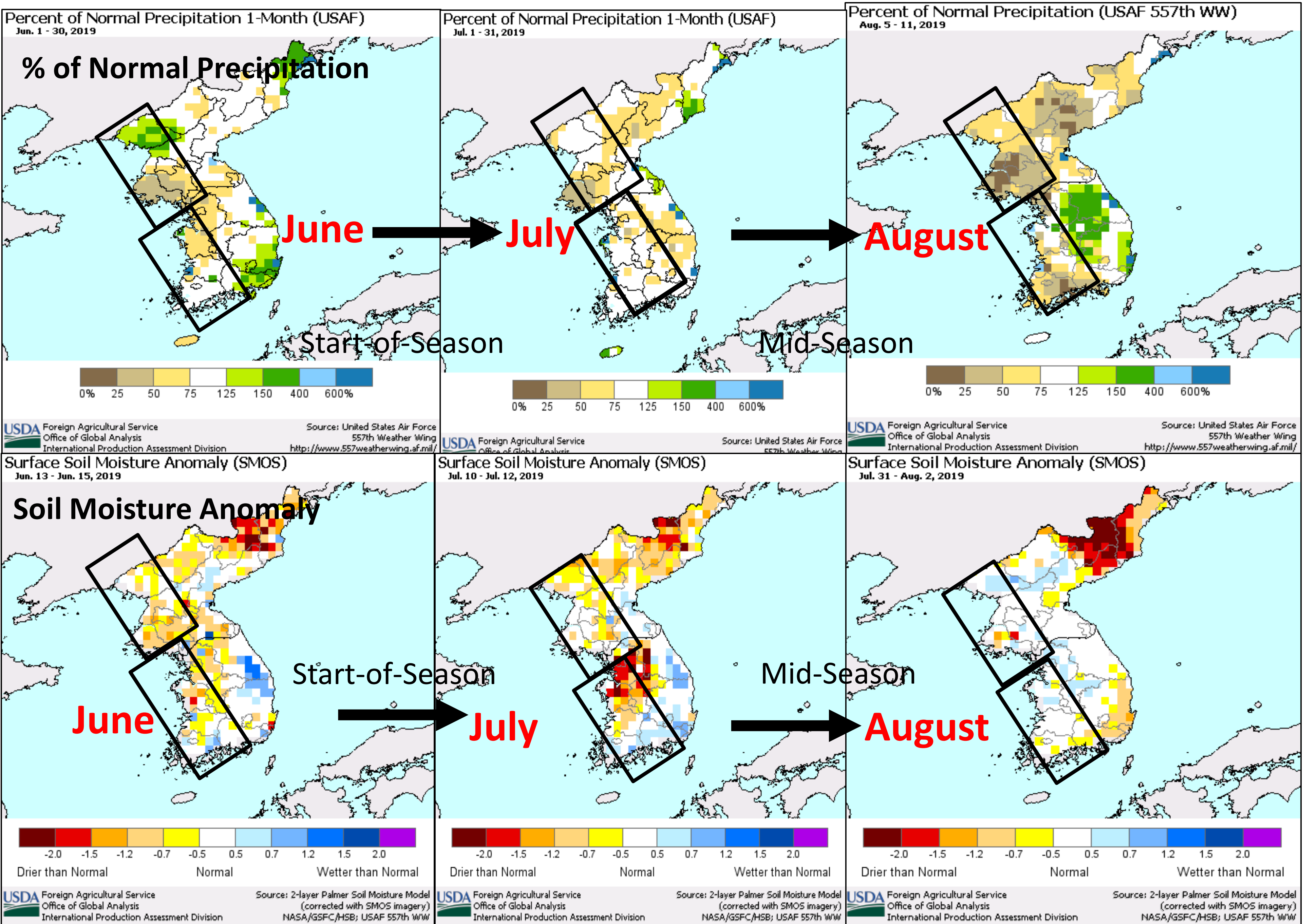
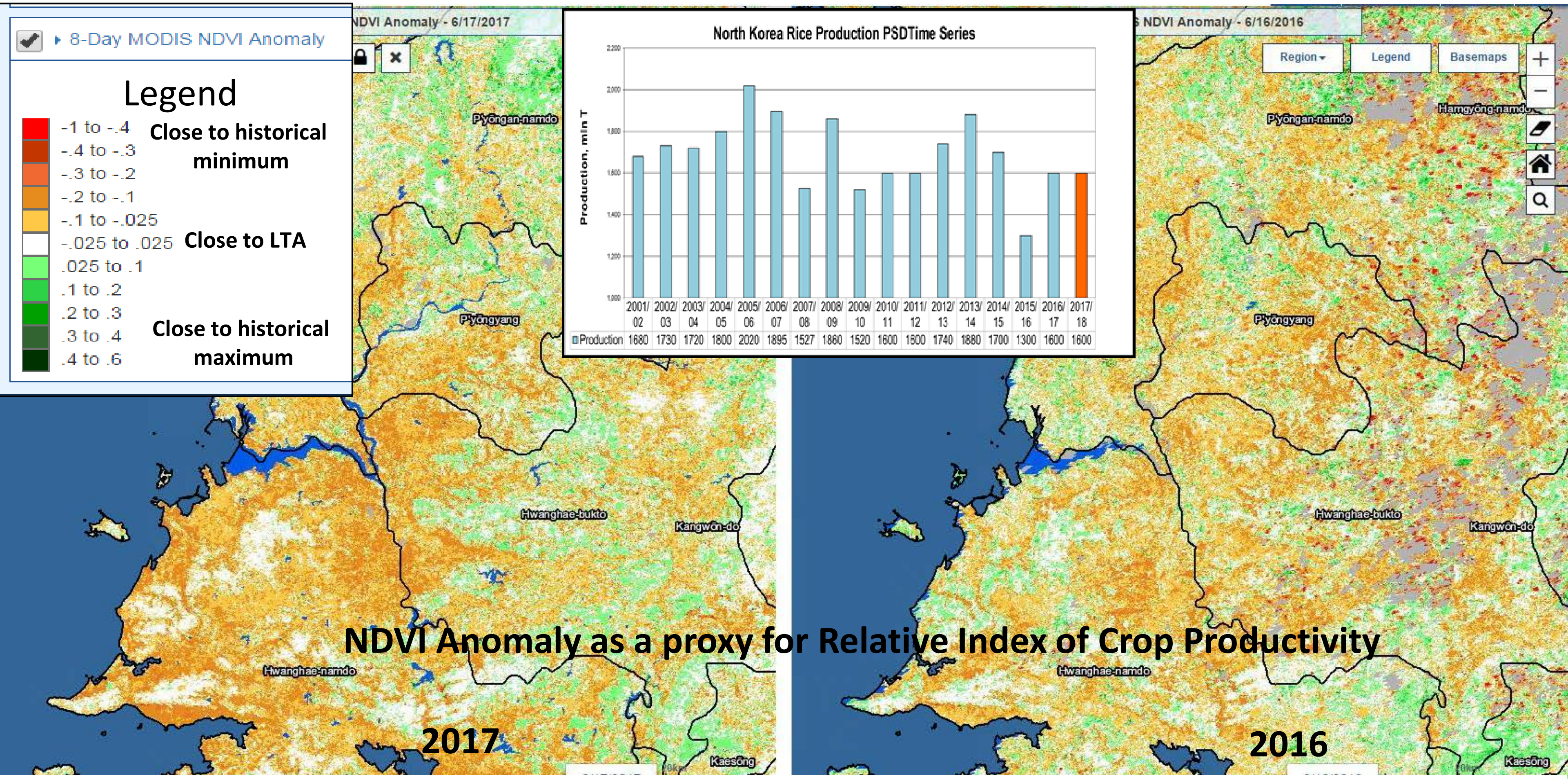
Challenge 7d: Using satellite data derivatives without corresponding ground observations



Challenge 7b: Using satellite (remotely-sensed) derivatives without corresponding reliable ground observations, survey/census statistics



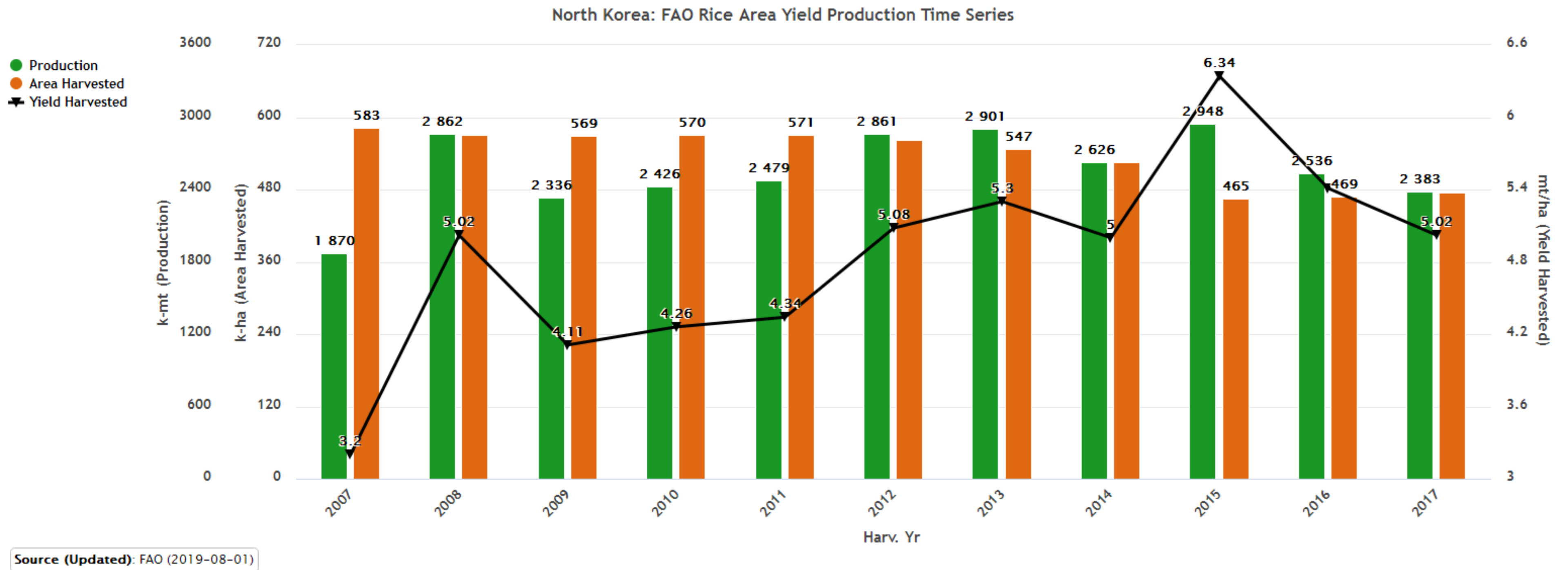
The best way forward requires more quantitative model-based approaches Using Systematic Observations (Ground verification, Survey/Census Statistics).

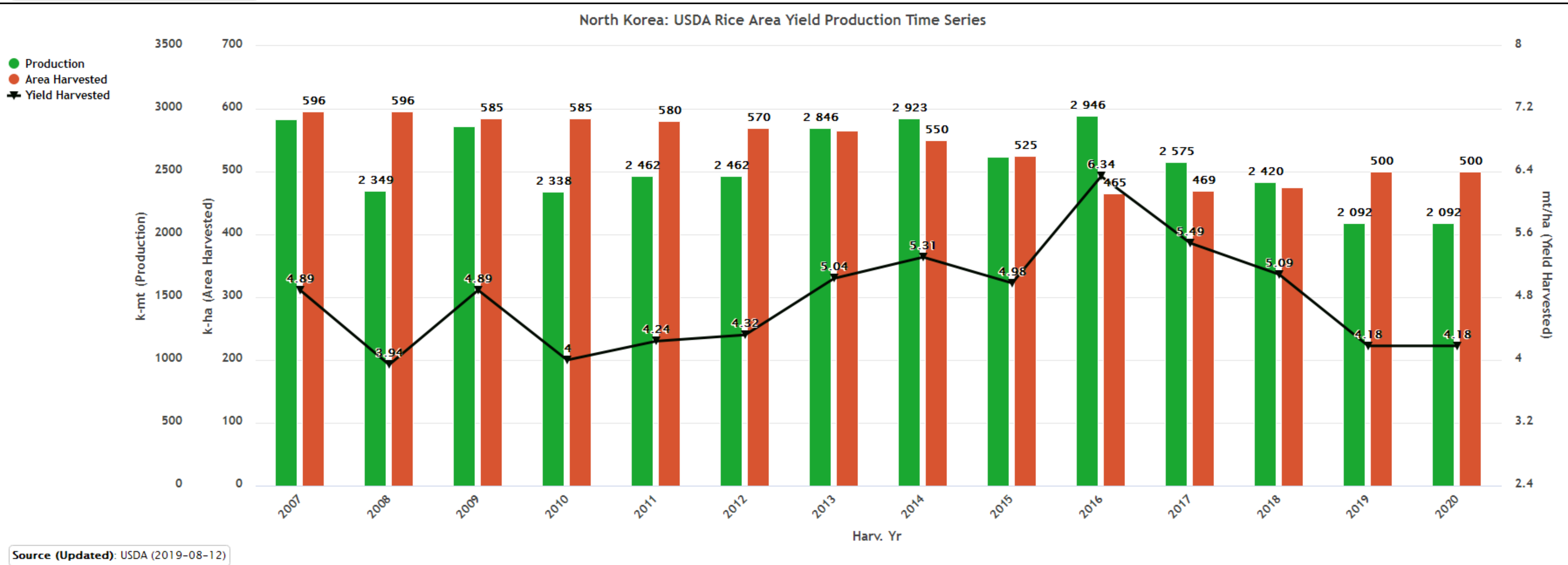
National-level yield data may not necessarily be sufficient evidence for yield trends.

Challenge 8: Discrepancies Among Limited Data Sources

- Limited data sources (often inconsistent) include Min. Agric; World Food Program (WFP); UN-FAO; GIEWS

- **Significant discrepancies among data sources, sometimes difficult to reconcile**





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CropSignal Data Mgmt and Modeling by GDA Corp

Summary: Challenges and Opportunities

- **Challenge 1**: Minimizing uncertainty due to introduction/propagation errors leading to: Over/Under Estimate

- **Challenge 2**: Incomplete system infrastructure due to Insufficient Integration of Field Data *more critical during water limited conditions

- **Challenge 3**: Lack of Yield Gap Data/Information. Primarily due to lack of understanding the various ecosystems; differences between potential yield (varieties); potential farm yield; actual farm yield (average yield realized by farmers); the best yield realized on farmers' fields and the average yield of the region

- **Challenge 4**: Understanding; Interpretation; Communication of Time Series Yield Variability

- **Challenge 5**: Usefulness and Reliability of Generalized Crop Calendars

- **Challenge 6**: Using satellite derivatives independent of reliable observed statistics, NDVI Anomaly as a proxy for Relative Index of Crop Productivity

- **Challenge 7**: Apparent significant discrepancies among data sources, sometimes difficult to reconcile

#Thanks...........

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