DPRK Crop Monitoring and Forecasting: Challenges and Opportunities

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Seoul, South Korea

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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
USDA Agricultural Commodities Information System: Commodity Balance Sheet

SUPPLY = DEMAND

Beginning Stocks + Production (Area x Yield) + Imports = Exports + Domestic Use + Ending Stocks

Private (On-farm) (Pipeline) Government

Commercial Concessional

Feed Residual Food, Seed, Industrial

DPRK high degree of uncertainty
Output: Reports and Production Supply and Distribution (PSD) database

- Principal Federal Economic Indicators: WASDE, FAS and NASS

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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 - 2019
Approved by the World Agricultural Outlook Board
July 9, 2019

**NOTE:** This report adopts U.S. area, yield, and production forecasts for winter wheat, barley, sorghum, and oats made recently by the National Agricultural Statistics Service (NASS). For rice, corn, soybeans, soybeans, and cotton, area estimates reflect the June 30, 2020, Acreage report, and estimated yield projections are projected by each report and are not re-calculated as the new projections in this report.

**WHEAT:** U.S. wheat supplies for 2010/11 are raised this month on higher area, yields, and carry. Spring wheat production is forecast 148 million bushels higher with a forecast area and a forecast yield of 148 million 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 crops limit the competitiveness of wheat in livestock and poultry ration. Exports are projected 100 million bushels higher with lower expected production in several major export countries and strong early season export sales. Despite increased foreign demand for U.S. wheat, ending stocks for 2010/11 are projected 10 million bushels higher and remain at an expected 25-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 yields. Production for Turkey 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 the grain filling reduced yields. Production is lowered 0.5 million tons for the United States. The 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 6.8 million tons lower.
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.
DPRK Crop Monitoring and Forecasting: Challenges and Opportunities
**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

<table>
<thead>
<tr>
<th>Precipitation:</th>
<th>Temperature:</th>
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<tbody>
<tr>
<td>✓ Wetness: wetter than average</td>
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<td>✓ Dryness: drier than average</td>
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<td>✓ Hot: Hotter than average</td>
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<td>✓ Cold: Cooler than average or frost damage</td>
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**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

<table>
<thead>
<tr>
<th>Weather Data</th>
<th>Field Data</th>
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<tr>
<td>✓ Precipitation</td>
<td>✓ Crop Varieties</td>
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<tr>
<td>✓ Temperature</td>
<td>✓ Crop Calendars (regional)</td>
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<td>✓ Solar Radiation</td>
<td>✓ Management practices</td>
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<td>✓ Soils</td>
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*more critical during water limited conditions*
Farming Systems Characterization

**Challenge 3:** 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?
- What support programs or market signals skews planting decisions one way or another?
Challenge 4: Lack of Yield Gap Data/Information

Production Situation

- **POTENTIAL**
  - Defining factors:
    - CO2, Radiation
    - Temperature
  - Crop characteristics
    - physiology, phenology
    - canopy

- **ATTAINABLE**
  - Limiting factors:
    - Water (rainfall) + Nutrients: Stress
      - reduces actual growth rate
      - reduces potential growth rate
      - slows phenological development
      - accelerates senescence
  - Yield-increasing measures

- **ACTUAL**
  - Reducing factors:
    - weeds
    - pests
    - diseases
  - Yield-protecting measures

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.

Focus areas: plains + moderate slopes

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**
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.

North Korea
Crop Calendar

Barley (Spring)
Barley (Winter)
Corn
Millet
Rice
Sorghum
Soybean
Wheat (Spring)
Wheat (Winter)

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<tr>
<th>Month</th>
<th>Barley (Spring)</th>
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<th>Rice</th>
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Weather (Precipitation and Temperature) has significant effect on crop performance, accounts for most of the inter-annual yield variability. 

\[ \text{GDD} = \frac{(\text{Tmax} + \text{Tmin})}{2} - \text{Tbase} \]
Weather (Precipitation and Temperature) has significant effect on crop performance, accounts for most of the inter-annual yield variability. 

\[
GDD = \frac{(T_{\text{Max}} + T_{\text{Min}})}{2} - T_{\text{Base}}
\]
North Korea/DPRK
2019 Rice Cropland Classification

Data required for complete mapping:
- Satellite data itself
- Ground-truthed data or other base/reference map to estimate the accuracy

Without ground-truthed data, remotely-sensed data is of limited value.
MARS ASAP Crop Mask (Area Fraction)
GlobeLand30 2010 NGCC, China

Hwangwe 2019 Rice Area
Sentinel Imagery Classification

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

- Cultivated Land
- Forest
- Grassland
- Shrubland
- Wetland
- Water Bodies
- Tundra
- Artificial Surfaces
- Bare Land
- Permanent Ice and Snow
Rice cultivated area identification and mapping using water areal extent as “reference map” 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)
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
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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