Agriculture and Agri-Food Sector in Canada

- Agriculture and Agri-Food sector employs 2.1 million people, accounts for 8% GDP
- Export focused: $40.3 billion per year
- Canada’s agricultural land mass large and sparsely populated
Earth Observation & Market Transparency

- Earth Observation was identified by Canadian Industry and Government as an important tool that should be further incorporated into market analysis and forecasting by the Grains Value Chain Roundtable and subsequently by a Multi-Commodity forum.

- The consultation processes interviewed key industry stakeholders from the agricultural value chain that would use market information (farmers, medium and large exporters, market information providers, farm managers, provincial and federal governments)

- The industry identified the need for market information to be delivered in a shorter time frame with improved accuracy

**Earth observation viewed as a potential way to improve timeliness and accuracy of market information**
Earth Observation Science at AAFC

• In light of these trends, AAFC geospatial science has been moved outside of the research domain into operational application.

• New geospatial technology offers opportunities to improve the timeliness, scope, accuracy and integration of science, bringing more relevance to AAFC science and more science to AAFC’s policies and programs.

• Earth observation-based decision support that integrates airborne, satellite, in situ, and ground data collection networks are some of the geospatial technological keys to this future.

The Centre for Agroclimate, Geomatics and Earth Observation (ACGEO) works across the research, development and technology transfer continuum to bring timely, accurate information to users, and work with users to understand their needs.
In Season Crop Monitoring

- Use a mix of earth observation, modelling and observation networks to produce quantitative and qualitative information about crops during the growing season.
- Forecasts, bulletins and early warning all based on integration of the best available information, with data open and transparent.
National-Scale Operational Monitoring at AAFC

EO-Based Information Products

- Circa 2000 National Land Cover Monitoring;
- Annual National Crop Inventory Monitoring (2009-);
- Agricultural Land Use Change Indicators;
- Passive and Active Microwave Soil Moisture Estimation;
- Near Real Time Weekly Crop Condition Assessment (250m);
- Crop Zones and Densities;
- Interpolated Crop Yield and its Variability.

EO-Integrated Information Products

- Canadian Crop Yield Forecaster (CCYF);
- Climate Production Risk Committee
- Canadian Drought Monitor
- Canadian Vegetation Drought Response Index (CanVegDRI);
- Crop Specific Soil Suitability Ratings (LSRS);
- National Soil Databases.
Canadian Crop Yield Forecast (CCYF)

- Uses a combination of earth observation data (Normalized Difference Vegetation Index – NDVI) and climate station information to forecast current crop yield for key commodities at intervals starting at the end of June.
- Model based forecasts are currently internal to AAFC.
- Work with Sector Development and Analysis Directorate to provide forecasts in advance of the monthly Outlook for Principle Field Crops Report (which are released publicly).
Probability Forecast: Yield Distributions

Probability distribution accounts for the uncertainty in the expected yield.
Integration into National Statistics

- In 2015, Statistics Canada replaced its September Farm Survey with the model developed at AAFC.

- This builds on their earlier work on the Crop Condition Assessment Program to link historical crop yield data to real-time remote sensing.

- AAFC continues to provide guidance on model development, introduction of new data sets and methods; Statistics Canada provides official crop yield estimates.
Comparison of National Yield Estimates From AAFC and STC (Yields are in Bu/Ac)

### Graph 1: AAFC Model (July 18) vs STC (No release)
- Spring Wheat
- Canola
- Durum Wheat
- Barley
- Oats
- Soybeans

### Graph 2: AAFC Model (August 15) vs STC Survey (August 23)
- Spring Wheat
- Canola
- Durum Wheat
- Barley
- Oats
- Soybeans

### Graph 3: AAFC Model (September 15) vs STC Model (September 20)
- Spring Wheat
- Canola
- Durum Wheat
- Barley
- Oats
- Soybeans

### Graph 4: AAFC Model (October 13) vs STC (no release)
- Soybeans
Transparency: Data to Information

Data

Maps

Information

Geomatics Applications
Putting More EO data in the Hands of Users

- Drought Severity
- Accumulated Heat
- Accumulated Precipitation
- Satellite Vegetation Condition
- Grasshopper Risk
- Crop Yield

- Application team is working with MISB, Programs Branch, Statistics Canada and others to develop tools that will directly allow these users to explore latest data and information to better serve their client’s needs.
Canadian Drought Monitor

- A consolidation of indices and indicators into one comprehensive drought map - addressing the fact that there is no single definition of drought.
- The North America Drought Monitor is a cooperative effort between drought experts in Canada, Mexico and the United States to monitor drought across the continent on an ongoing basis.

Climate-Related Production Risks Committee

- Integrates multiple AAFC geospatial datasets and regional expertise to report bi-weekly on 17 climate-related risks to production.
- Used for biweekly interdepartmental market information meetings, program planning.
- CRPRC reports are the basis of Canada's international reporting to FAO AMIS.
Ongoing Research in Earth Observation

Space-Based Crop Inventory
- Development of methods and workflows for more accurate landscape classification (DUAP-CSA).

Land Use Change Indicators

An Agricultural Monitoring Framework for Canada
- Development of a monitoring framework appropriate to meet the needs of Canadian ag sector (GRIP-CSA).
- Development of methodologies to estimate crop acreages within-season.

Crop Phenology Metrics
- Development and application of algorithms to extract phenological metrics from EO time series.

Integration of EO in the CCYF
- Affects of integrating EO data into the Canadian Crop Yield Forecaster.

Soil Moisture Monitoring in NRT
- Development of long-term data records for SM anomaly detection.
- Cal/Val of SMAP pre- and post-launch (SMAPVEX12 &16, MB).

Harvest Progress Monitoring
- Development of methodologies to map progress of harvest on a national scale.
Future Science Directions

Domestic: Accelerated Operationalization of R&D

- Early season crop acreage estimates. Yield forecasting with crop area estimates will provide in-season crop production estimates. Supports:
  - Proactive programs (early warning);
  - Market access, competitiveness, in-season crop quality;
  - Producers, open market information to support management decisions.

- Improved yield forecasts linked to StatCan Surveys to provide more reliable productivity assessments at higher resolutions. Requires:
  - Soil Moisture Monitoring (integrated EO, in-situ and modeling);
  - Crop growth parameters (LAI, fPAR) and NRT crop condition assessment;
  - Harvest Monitoring.

- EO-based farm management information (e.g. on tillage type, timing and crop residue) supports indicators and market access issues.

International: AAFC commitments to G20 (GEOGLAM)

- Moving JECAM research from what works at one site to guidelines on what works at different sites globally. Will improve our capacity to monitor diverse landscapes, provide information to support decision making.
Looking Forward......

- Collaboration between EO science, Market Analysis and Statistical Surveys has been a great success story, joining expertise in multiple domains to produce better public good information.

- Earth Observation team plays an important part in the bi-weekly interdepartmental market information meetings of AAFC, which brings together the key participants from the research, forecasting and transportation parts of the department to discuss key issues.

- Information is released and used broadly to spur further research, and support programs and policies ranging from risk analysis to tax deferral designations.

- Future work will further improve accuracy and timeliness of information & integration between market, statistic and scientific teams.
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Open Data:
http://www.agr.gc.ca/atlas/geoplatform#home
www.data.gc.ca
Drought Watch:
http://www.agr.gc.ca/eng/?id=1326402878459
Extra Slides
EO-Based Products (Operational)

2013 Canadian Crop Inventory

Circa 2000 Ntln Land Cover of Canada
- Based on Landsat-5 and -7 data (30m).

Annual Space-Based Crop Inventory
- Annual crop inventories for all agricultural lands at field level (incl. too-wet-to-seed).
- Analysis is based on Radarsat-2 and optical (AWiFS, SPOT, DMC, Landsat-8) imagery.

Agricultural Land Use Change Indicators
- Indicators indicate “where”, “how much” and “how” agricultural land use has changed.
- Allows annual land use changes to be tracked between important cover types.
- Recent application to facilitating market access for Canadian Canola producers.
EO-Based Products (Operational)

Near-Real-Time Surface Soil Moisture Mapping

- Near-real-time weekly, bi-weekly and monthly surface soil moisture maps derived from daily passive microwave data from the Soil Moisture and Ocean Salinity (SMOS) satellite.
- Collaborating with USA (NASA and USDA) on the calibration of the Soil Moisture Active passive (SMAP) satellite.

NRTCrop Condition Assessment

- Near-real-time weekly maps of crop condition and differences from normal conditions using daily Moderate Resolution Imaging Spectroradiometer (MODIS) reflectance observations.
- Contributes to the Canadian GEOGLAM crop condition assessments for the Agricultural Market Information System (AMIS).
EO-Based Products (Operational)

**Crop Zones and Densities**
- Historical Annual Crop Inventory archive is used to map the growing zones of Canada’s major crops.
- Maps indicate the overall geographical distribution of selected crops as well as their frequency and density of occurrence.

**Interpolated Crop Yield**
- Based on historical Annual Crop Inventory Archive and interpolated (kriged) crop insurance information.
- Maps indicate single-year and multiple-year yields and their variability for a selection of major crops.
EO-Integrated Products (Operational)

North American Drought Monitor (NADM)
- Cooperative effort between drought experts in Canada, Mexico and United States with aim of monitoring ongoing drought across NA.
- AAFC has participated in the NADM since its inception in 2002 (via Canadian Drought Monitor) and reports on drought for agricultural and non agricultural regions of Canada.

Drought Watch (DW)
- Provides timely information on weather and climate relevant to the ag sector in Canada.
- Includes information on weather and climate conditions (historic, current, forecasts), impacts throughout Canada at national and regional scales and best management practices.
- More than 500 maps are produced daily.
EO-Integrated Products (Operational)

Agroclimate Impact Reporter (AIR)

- An online tool for the collection and reporting of agro-climate impacts across Canada.
- Reports collected using a network of registered users as well as anonymous and media input.
- Information gathered plays a significant role in evaluating weather and climate-related risks to Canadian agriculture and supports policy and program decisions.