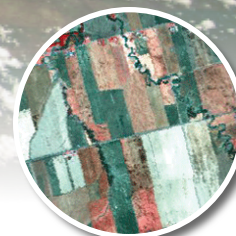




Agriculture and  
Agri-Food Canada

Agriculture et  
Agroalimentaire Canada



# Space for Agriculture: Challenges and opportunities to supporting a competitive agricultural sector in Canada through Earth Observation

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Canada

# Challenges for the Canadian Ag Sector

## Food Security:

- How to feed a growing population in a sustainable way?
- Market price volatility: food prices are increasing worldwide due to changes in energy and water availability, climate risk.

## Environmentally Sustainable Food Production:

- Energy, water, fertilizer/pesticide usage by agriculture.
- Greenhouse gas emissions from agricultural activities.
- Land conversion, loss of ecosystem goods and services.
- Consumer demands for sustainably grown foods, certification.

## Economic Sustainability of Agriculture:

- Need to expand markets, develop new products.
- Costs of water, energy, fertilizers/pesticides against food prices.
- Impact of climate variability, disease.



# EO is attractive for AAFC because...

## ... it can provide:

- Spatially complete information over large inaccessible regions;
- Well calibrated data over time;
- Information at wavelengths sensitive to vegetation and soil properties.

## ... it can support AAFC activities and programs:

- EO data at various spatial and temporal scales supports agricultural land use management, biomass estimation, modeling and monitoring.

## ... it will continue to provide data well into the future:

- New sensors launched or planned for launch by Canada, U.S., European Space Agency, India, Japan, Argentina.

AAFC has the experience and expertise to take advantage of new opportunities in EO to develop state-of-the-art methods to extract meaningful information from new platforms and sensors.





# What are these Challenges & Opportunities?

## Advances in satellite and sensor engineering...

- Miniaturization of electronics.
- Large light-weight structures.
- Compact optics.
- Improved cooling.
- High-performance onboard computing.
- More efficient transmitters.
- Increased power efficiencies.
- Reduced noise.
- Tunable systems.

## ... will lead to EO sensors with enhanced capabilities...

- Improved spectral, spatial and temporal capabilities.
- Enhanced monitoring capabilities.
- More detail, more frequently.
- Allows mapping of new variables.





# What are these Challenges & Opportunities?

... that will increase the availability of EO data at fine spatial AND temporal resolutions, ...

- Fine spatial resolutions needed to map locally often cannot meet temporal revisit needed for timely monitoring / Fine temporal resolutions needed to map frequently often cannot provide spatial resolution for fine-detailed studies.
- Advances in EO engineering and the launch of satellite constellations will provide more frequent and cheaper EO data at fine spatial resolutions.

... provide data continuity and long term data records, ...

- Long term data continuity is essential for monitoring and creation of consistent and reliable historical records for anomaly detection.
- Involves sensor inter-calibration to produce ready-to-use data and the seamless data streams required for maintaining monitoring efforts.
- Users want ready-to-use (“Analysis Ready”) data from sensors whose calibration is transparent to them.



# What are these Challenges & Opportunities?

... drive a new generation of scalable and spatially explicit agro-environmental indicators, and ...

- Input data to current agro-environmental metrics often missing or limited.
- Data is inappropriate if inconsistent or mis-matched to temporal or spatial resolutions required for metrics with detail necessary to inform decision making.
- New generation of EO-driven spatially explicit indicators will provide national-scale, cost-effective, timely, accurate and scalable producer-level information.

... improve the output of process-based models.

- Process-based models include many uncertainties and often use poorly known parameters to make their projections.
- Limitations addressed using EO data to provide spatially and temporally comprehensive information on environmental surfaces.
- Spatially distributed process models use EO data to define initial conditions, drivers of processes, state variables and crop phenology.



# What are these Challenges & Opportunities?

## Open Data archives in Canada and elsewhere...

### B. Open Data - Open Data Without Borders

In its June 2014 report entitled *Open Data: The Way of the Future*, the House of Commons Standing Committee on Government Operations and Estimates indicated that open data has become the "raw material for the digital age," and encouraged the federal government to continue to "innovate and develop its vision for open data in Canada."

Building on the strong foundation of open data efforts to date, Canada's Action Plan on Open Government includes four specific commitments to unlock the innovation potential of open data over the next two years.

The first two open data commitments focus on deepening the collaboration on open data between Canadian governments at all levels, and with the private sector. The objective of these commitments is to harmonize open data services in Canada and encourage the reuse and commercialization of open data. The third commitment supports open data activities internationally in order to encourage the continued growth of the global open data movement, and reinforce Canada's role as an international leader for open government. Finally, the fourth commitment lays out improvements to be made to ongoing core open data activities.

#### What We Heard From Canadians

"Ensure portals are easy to use, data is easy to discover, and datasets are readable for all individuals, not just those with an extremely high level of data literacy."

"Work to integrate Open Government accountability mechanisms and Open Data access across federal, provincial, territorial and municipal jurisdictions."

## ... will improve access to data, products and services, ...

- Products are not useful if end users cannot readily access or use them. Product use is often limited by cost, software dependencies, and know-how,
- Increased push for easy discovery, access and use of data / information, and the desire to let end users use information in 'their way for their own purposes'.
- Federal Geospatial Platform hosts key Canadian geospatial data and deliver it through various formats and applications.





# What are these Challenges & Opportunities?

## ... increase international collaboration, ...

- The GEO Agricultural Community of Practice Established Joint Experiment for Crop Assessment and Monitoring (JECAM) to:

*Enhance international collaboration around agricultural monitoring towards the development of a “systems of systems” to address issues associated with food security and a sustainable and a profitable agricultural sector worldwide*

## ... and globally consistent methods for product validation.

- Independent validation data are required to determine product accuracy (in situ other data, imagery, maps, etc...).
- Methods are variable-dependent and determined by data availability.
- Validation standards for higher-order EO products yet to be fully developed.
- Product validation using common standards vital for meeting future needs of end users in the agricultural sector.



# What are these Challenges & Opportunities?

## Government Data Center centralization...

- New EO sensors with finer spatial and temporal resolutions mean even more data needs to be processed.
- Government of Canada Departments have variable capacity to deal with this growing volume of information.

... will allow increased data volumes to be more quickly and efficiently acquired, processed and stored.

- Movement to centralized data centers -- where organizations operate and manage their data processing and data storage -- will allow more efficient data processing under a Government of Canada wide solution.
- Non-production data centres will allow applications and systems to be developed and tested before going live. Production data centres will support live systems and applications.
- Moving applications to the data, rather than data to the applications will become the norm.



# The Application of EO at AAFC

Vision: ACGEO is a leader in understanding conditions affecting agricultural production and sustainability, making it an essential contributor to agricultural research, policy, programs and industry.

Decades of ACGEO research have led to the development of innovative agricultural monitoring capabilities that are, or close to being, operational:

- ✓ ○ Crop type, area and condition.
- ✓ ○ Snow cover, Soil moisture, Excessive wetness, Drought.
- ✓ ○ Climate and weather related impacts on production.
- ✓ ○ Crop yield forecasting.
- ✓ ○ Harvest progress monitoring.
- ✓ ○ Soil management (tillage, crop residue).
- ✓ ○ Biomass production.
- ✓ ○ Crop damage, disease and pests.
- ✓ ○ Soil health.

✓	Operational
✓	In Development
✓	Planned



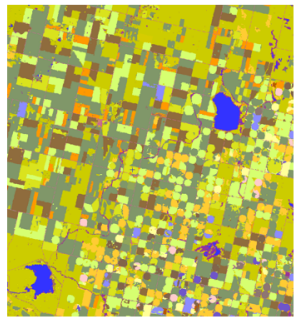
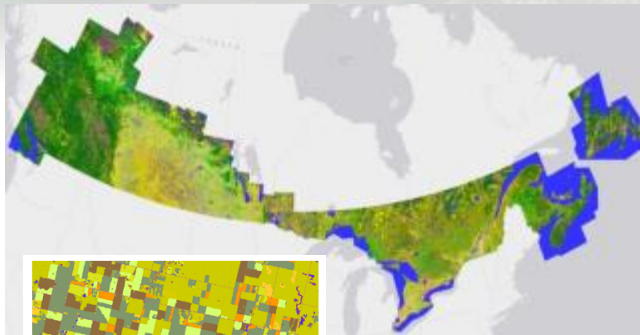
# EO Data Used by AAFC

- Recent convergence of technologies (software, hardware, data) and policies (cheaper, open data) offer operational solutions for AAFC policy development, program implementation and performance measurement.
- EO work at AAFC spans full R-D-T continuum. Involves development of...
  - Acquisition and pre-processing methods.
  - Models and their validation.
  - Applications and their operationalization.
  - Data and information delivery platforms and tools.
- ... using satellites and sensors with different...
  - Spectral resolution (wavelengths used; optical vs microwave);
  - Spatial resolution (< 1 metre to 50 km);
  - Temporal resolution (daily to every few weeks);
  - Radiometric resolution (sensitivity to changes on the landscape); and
  - Swaths (ground track that a single image covers - 10s km to 1000 km).
- ... from domestic and international space agencies and commercial vendors (CSA, USGS, NASA, ESA, Planet Labs, MDA, others...).

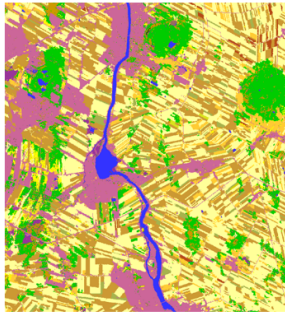


# EO-Based Operational Products

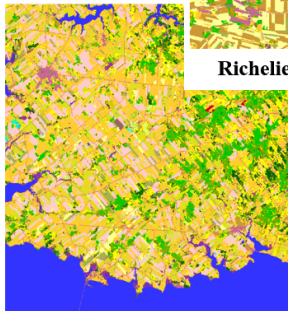
## 2016 Annual S-B Crop Inventory



Near Taber, Alberta



Richelieu River, Quebec



Central Prince Edward Island

## Annual Space-Based Crop Inventory

- Land use (crops) and cover (non-crop) within Canada's agricultural extent at the field level.
- EO-based: Optical (AWiFS; SPOT; DMC; Landsat-5, -7 and -8; GF-1) and SAR (RADARSAT-2) imagery.

## Decadal Land Use

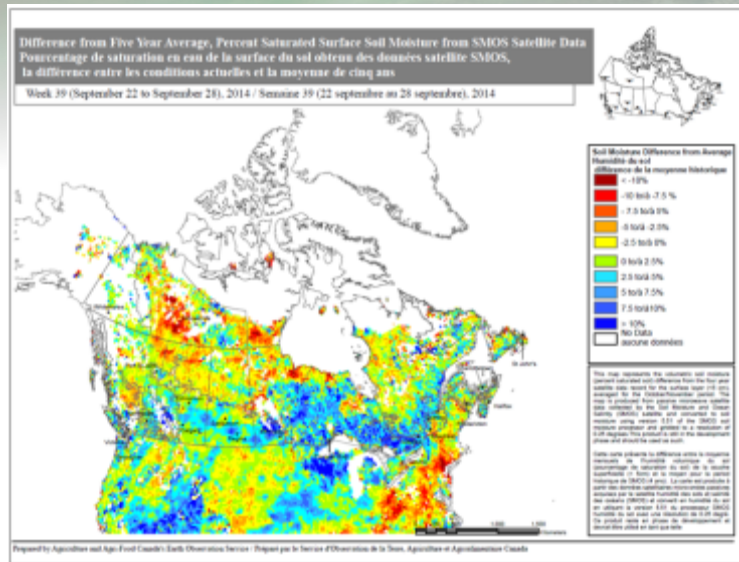
- Land use to meet AAFC commitments in international reporting (e.g. UNFCCC, OECD, FAO).
- Convergence of evidence: Land cover and crop maps and various NRCan CanVec layers (Buildings, Hydrography, etc... ).

## Ag Land Use Change Indicators

- Indicate where, how much and how agricultural land use has changed.
- Allows annual land use changes to be tracked between important cover types.

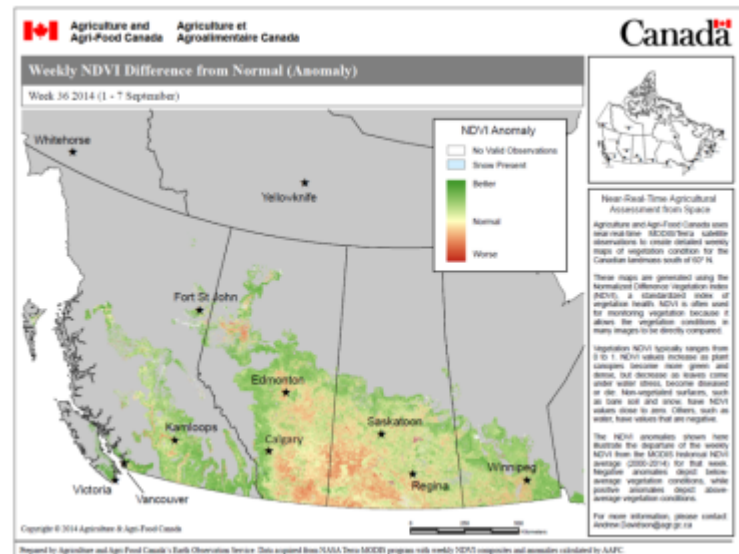


# EO-Based Operational Products



## NRT 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.

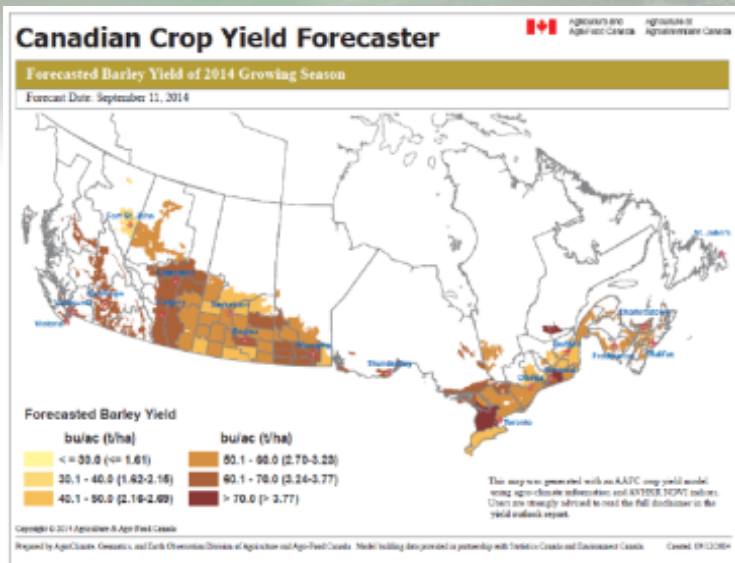


## NRT Crop Condition Assessment

- 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).

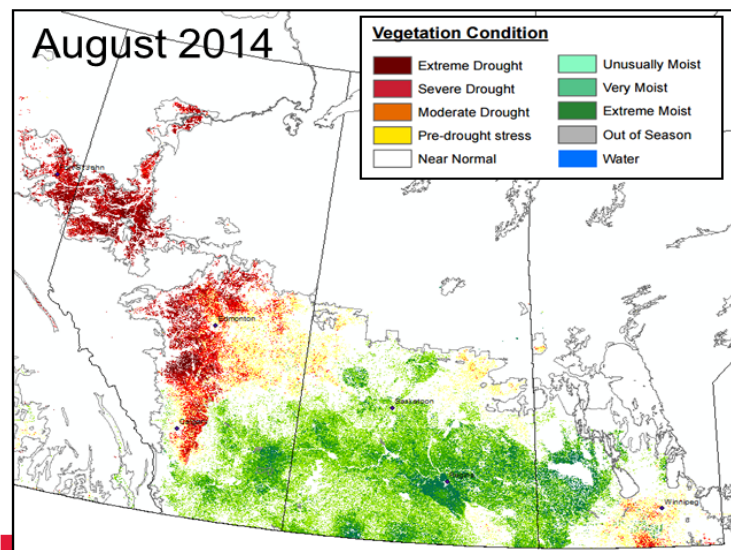


# EO-Integrated Operational Products



## Crop Yield Forecaster (CCYF)

- Monthly crop yield forecasts during the growing season using statistical forecast models, agro-climate information and remotely sensed data.
- Provides similar quality data to that collected in the annual Statistics Canada crop survey, without the burden on farm operators.
- Canada one of first countries to release model-based crop yield estimates as official statistic.



## Vegetation Drought Response Index

- Integrates multiple AAFC geospatial datasets and regional expertise to report bi-weekly on 17 climate-related risks to production.
- Plays significant role in evaluating weather and climate-related risks to Canadian agriculture and supports policy and program decisions.

# Who Are AAFC's Clients?

## Primary:

- Departmental (STB, MISB, SPB);
- Other Government of Canada Departments (AAFC, EC, STC, ...);
- Provinces (BC, AB, SK MB, ON, NS, ...);
- Commodity Groups (Canola, ...).

## Others:

- Agri-Business;
- Non-Govern't Organizations (NGOs);
- Universities and research laboratories;
- International (GEOGLAM / JECAM).



# Importance of Value-Added Products

Canola Digest, Nov, 2011.

## A NATURAL FIT TO FUEL EUROPE

By Heidi Dancho

Canada's canola industry gears up to help satisfy the world's largest market for sustainable biodiesel.

market demand and production by 2015," says McArthur. "There are a lot of variables, but Western Canada could potentially export one to two million tonnes of seed equivalent a year into the EU biodiesel market."

### SUSTAINABILITY – A GROWING CONCERN

#### KEY RED CRITERIA

A key RED criteria and pre-condition to program participation is the grower signing a Self Declaration stating that no crop was produced from a farm if any land (owned and rented) was cleared after January 1, 2008. The clearance of minor areas (less than one acre) such

#### SATELLITE MAPPING TOOL

A new satellite mapping tool being developed by Agriculture and Agri-Food Canada with the support of the CCC will be a useful screening function for the trade and auditors on the RED land clearance issue. It uses satellite imaging data from 2000 and 2010 to identify and compare forest clearance in agriculture

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are already audit-ready," he says. "It's just a reflection of good management practices and abiding by Canada's environmental and labour laws."

The CCC has developed a pre-audit checklist of the ISCC requirements which can be found at [canolacouncil.org](http://canolacouncil.org).

## Better reporting on ag state and change enhances...

- Policy development;
- Program delivery;
- Program reporting;
- Targeting.

## ...and results in:

- Better decision making;
- More timely decisions;
- Enhanced accountability;
- Increased opportunity;
- New avenues for research.





# Open Government

The screenshot shows the Government of Canada Open Government portal. It features a navigation bar with links to Jobs, Immigration, Travel, Business, Benefits, Health, Taxes, and More services. The main content area is titled "Open Government" and includes a search bar, a "Follow" button, and a "Search through our Open Government Portal" section. Below this, there are sections for "Open data" and "Open information", each with a brief description and a link to "Open dialogue".

The screenshot shows the "Annual Crop Inventory" page on the Government of Canada Open Government portal. It includes a "Have your say" section with a rating and comments, and an "Additional information" section with contact details and keywords. Below this is a "Resources" table listing various crop inventory datasets.

Resource Name	Resource Type	Format	Language	Links
AAFC Crop Inventory	Application	HTML	English	<a href="#">Access</a>
AAFC Crop Inventory	Application	HTML	French	<a href="#">Access</a>
Annual Crop Inventory 2009	Web Service	ESRI REST	English	<a href="#">Access</a>
Annual Crop Inventory 2009	Web Service	ESRI REST	French	<a href="#">Access</a>

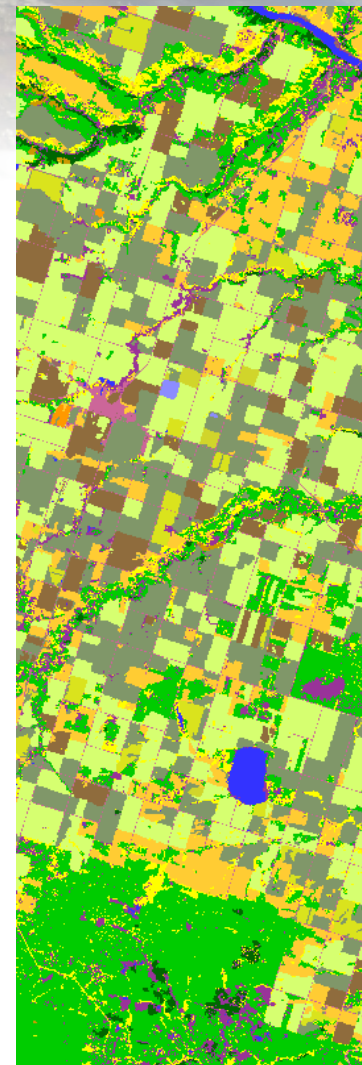
The screenshot shows the "Agriculture and Agri-Food Canada" page on the Government of Canada Open Government portal. It features a navigation bar with links to Programs and Services, Industry, Markets and Trade, Science and Innovation, and Help. The main content area is titled "Annual Crop Inventory" and includes a map of Canada showing crop distribution. Below the map, there is a "10 Interesting Things about Geomatics in AAFC" section with numbered items.

The screenshot shows the "Canadian Drought Monitor Current Conditions (UMAP Map Journal template)" page on the Government of Canada Open Government portal. It includes a navigation bar with links to Jobs, Immigration, Travel, Business, Benefits, Health, Taxes, and More services. The main content area is titled "Canadian Drought Monitor" and includes a map of Canada showing drought conditions. Below the map, there is a "10 Interesting Things about Geomatics in AAFC" section with numbered items.

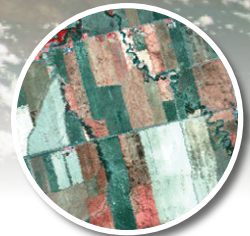


# Moving Forward: AAFC R&D Supporting Better Decision Making

- AAFC will continue to focus investment in research to guide the development of EO-based tools to support agricultural decision making, and R&D support from the CSA (e.g. GRIP, DUAP) will continue to be instrumental in moving AAFC's EO science into the operational domain.
- AAFC will continue to further develop its EO products and applications to support a broad range of stakeholders within the agriculture sector including business risk management.
- AAFC will take advantage of collaborative opportunities with its federal partners to leverage their EO-related investments in IT and data management expertise.
- AAFC will continue to actively support the development of Federal EO policy, and its various boards and working groups to advance the use of the data within the GoC.







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