AAFC Annual Crop Inventory: Status and Challenges

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Introduction

The Earth Observation Service (EOS) at Agriculture and Agri-Food Canada (AAFC) offers a source of high quality, timely and accurate data and expertise based on satellite based and in-situ earth observations, to address the sectors policy and program needs. Understanding the state and trends in agriculture production is essential to combat both short-term and long-term threats to stable and reliable access to food for all, and to ensure a profitable agricultural sector.

Starting in 2009, EOS began the process of generating annual crop type digital maps. Focusing on the Prairie Provinces in 2009 and 2010, a Decision Tree (DT) based methodology was applied using optical and radar based satellite images. For the 2011 growing season and future years, this activity is extended to other provinces in support of a national crop inventory. So far, this approach can consistently deliver a crop inventory that meets the overall target accuracy of at least 85% at a final spatial resolution of 30m.

Crop Mapping Methodology

For operational purposes, AAFC needs a crop classification system that is efficient, economic, stable and repeatable, and one that can handle a large data volume capacity. The classification can be broken down into 7 generalized steps that are required to produce a digital crop type map (Fig. 1).

1. Data Planification & Acquisition
   - Define Regions
   - Subdivide Agriculture extent
   - Cloud Masking
   - Speckle Filtering & Rescaling
   - Ortho-Correction
   - Ground Data (Crop insurance, field sample)

2. Data Pre-Processing
   - Optical Data (DMC, LDSAT-5, AWiFS)
   - Radar Data (RSAT-2, Other)

3. Data Post-Processing
   - Find best combination of imagery
   - Classification Process (Decision Tree)

4. Classification Process (Decision Tree)
   - Decision Trees
   - Random Forest (RF)

5. Classification Post-Processing
   - Objects based filtering
   - Landsat-5
   - DMC

6. Classification Post-Processing
   - Iteration #1: Updating LC to current conditions
   - Iteration #2: Improve agr. vs grassland
   - Iteration #3: Crop classification

7. Data Publication
   - Ortho-Correction
   - Data Planification & Acquisition

Successful crop identification relies on image acquisitions from multiple sensors during key crop phenological stages (reproduction, seed development and senescence). Multi-temporal optical data are the primary data source for crop classification because the NIR/SWIR channels are vital to crop classification. Over a growing season, at least 3 optical images are required to successfully identify crops. SAR images improve the overall accuracy, especially when some optical data is not acquired. To reduce file sizes and processing time, the agricultural extent is subdivided into more manageable regions (Fig. 2). Region files are classified individually with training data from various sources.

2011: First National Crop Map

Optical satellite data from the DMC constellation were used in combination with Landsat-5 and Radarsat-2 images to complete the 2011 crop classification, which was expanded to cover all Canadian provinces with the exception of Newfoundland (Fig. 3). This inventory was completed at an overall mapping accuracy of 85%.

Future Direction

Crop maps are typically delivered 8 months following the end of growing season (Fig. 4). To satisfy existing and potential new users, the product should ideally be made available by September or even within the growing season as an estimated inventory.

To resolve this issue, EOS staff will implement a new and fully automated classifier that should significantly reduce production time. As a major upgrade, classification regions will be defined automatically based on images extent, cloud coverage, training site distribution and preliminary accuracies. In addition to reducing analyst intervention, it will also optimize product accuracy. In 2012, the lack of affordable optical data will force AAFC to rely mostly on RSAT2 observations (Fig. 5). This brings new challenges, given a doubling of the number of images as compared to 2011. Over the next 2 years, modifications to our classification system will be made to ingest and process new satellites data such as Radarsat Constellation Mission (RCM), ESA's Sentinel and Landsat Data Continuity Mission (LCDM).

2011 Crop Mapping Timeframe

- Winter 2011: First National Crop Map
- Spring 2011: Winter 2012: 1st iteration
- Summer 2011: 2nd iteration
- Fall 2011: 3rd iteration
- Winter 2012: Crop classification
- Spring 2012: Publication

The value of this product is wide ranging and provides fundamental information on the state and changes in the agricultural landscape. For example, excessive wetness has been a recurring issue for Canadian agriculture, particularly in recent years. The 2011 annual crop inventory map generated for the Canadian Prairie Provinces was used to generate a map of acreages that were too wet to seed in the spring of 2011. The acreages were found to be within 3% of the independent estimates provided by the Provinces.

Significant headway needs to be made in methods development for the annual crop inventory. This includes new approaches for assimilating and processing the unprecedented volume of EO data required to map nationally, and the development of new classification methodology, increasing product accuracy, and significantly reducing the delivery time of the final product.

Reference