Demonstration on Agricultural crop and land cover statistics

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Statistics Canada

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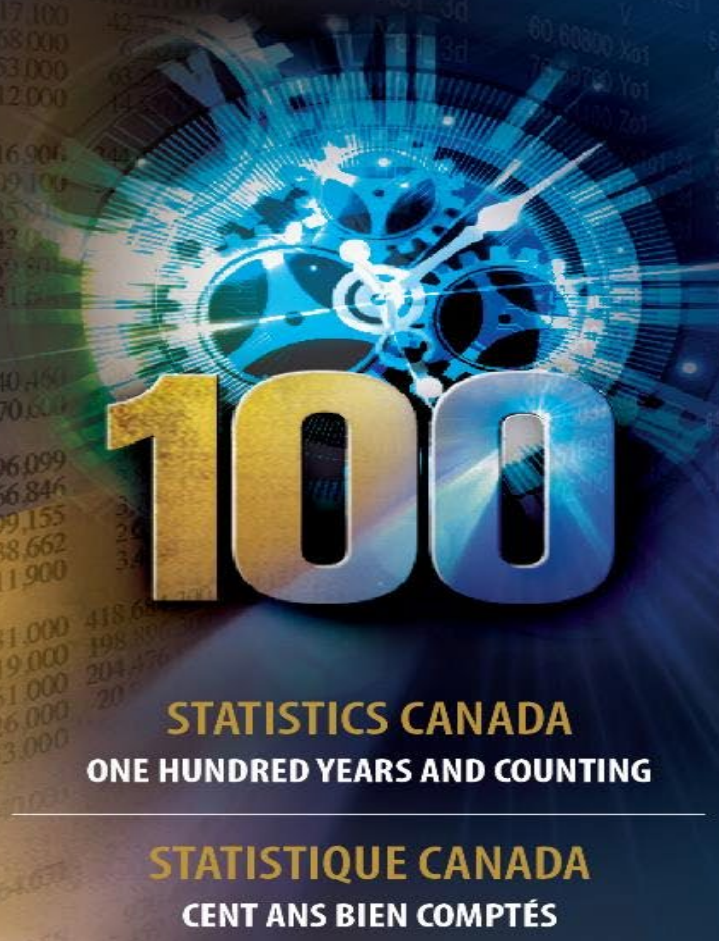


Context

- Official statistics are asked to present more timely and more disaggregated data

- Satellite imagery offers opportunities for official statistics and for the Sustainable Development Goals

- Today's presentation will showcase what is being done in the agriculture program

Context

- Motivation for Statistics Canada :
    - Field Crop Reporting Series - farm surveys
    - estimates seeded area, harvested area, expected yield and production
    - under increasing pressure to reduce response burden and cost of the traditional surveys
    - maintain relevance, accuracy, timeliness, accessibility, interpretability and coherence.

- **Objective**: **Develop a robust crop yield model for the principal field crops of Canada.**

Develop a robust crop yield model for the principal field crops of Canada

- Three data sources:

1. Coarse resolution satellite data
   - 1km: AVHRR – NOAA (1987 – present)
   - 250 m: MODIS (2000 – present)

2. Historical and current year statistical survey estimates

3. Agroclimatic data

Partnerships

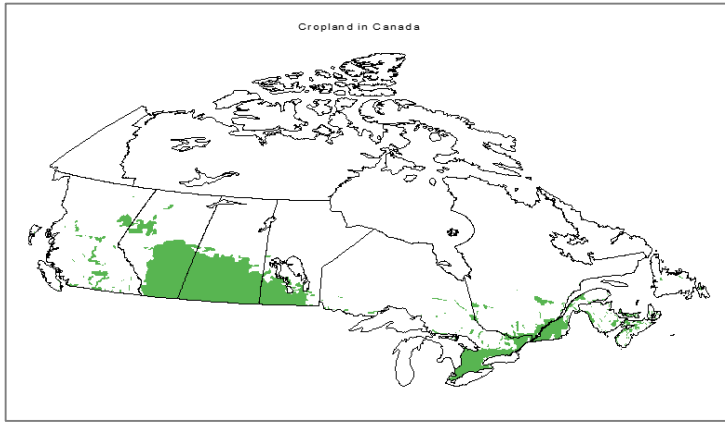
- Collaborative work
  - Statistics Canada and Agriculture and Agri-Food Canada
- Researched and evaluated existing models
  - Successful examples
    - European MARS Crop Yield Forecasting System
    - China Crop Watch
    - Regional yield forecasting products from Queensland,
    - Australia's Agricultural Production Systems Research Unit (APSRU)
- Material Transfer Agreement
  - Agriculture and Agri-Food Canada's yield model transferred to Statistics Canada

Develop a robust crop yield model

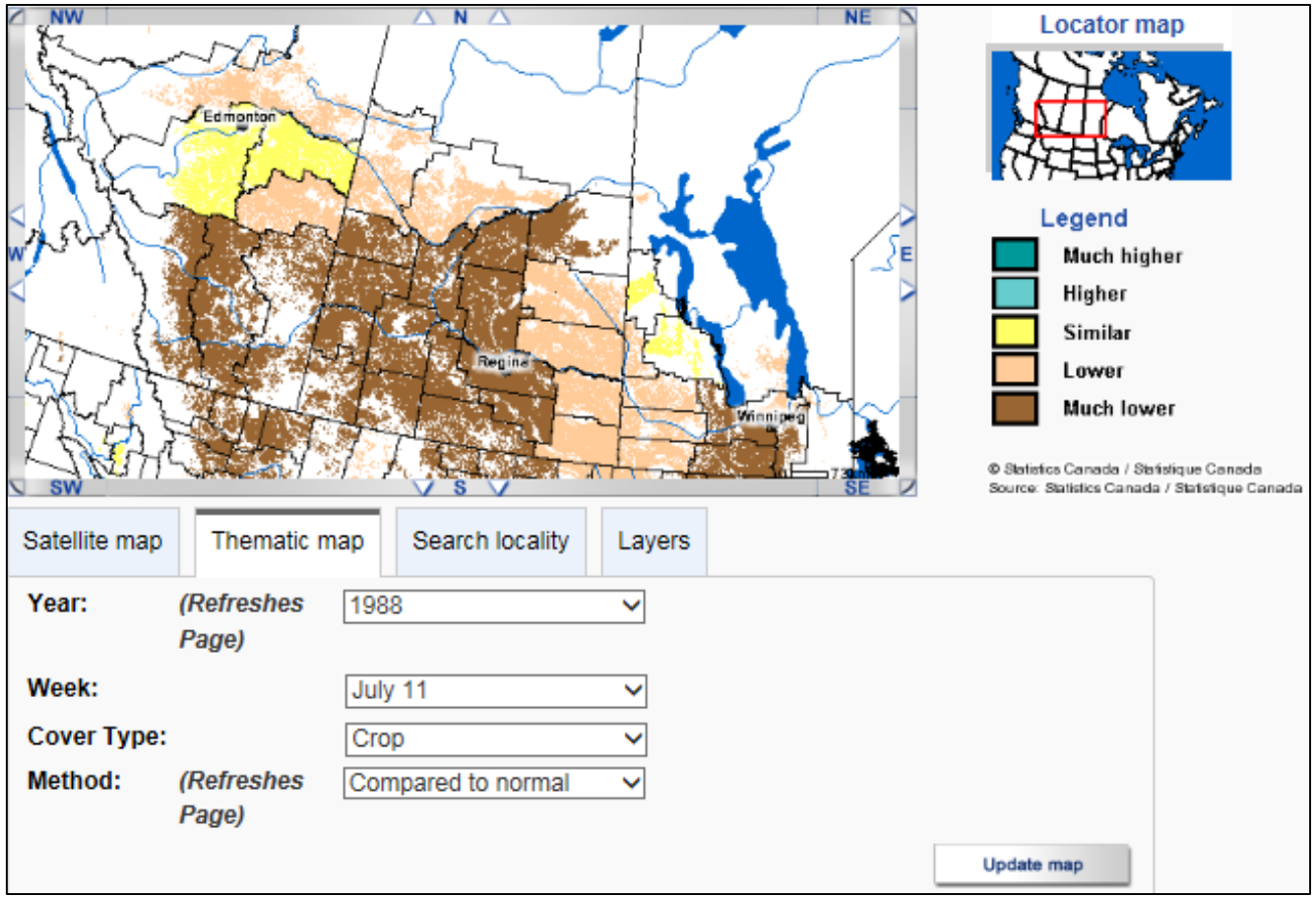
- StatCan modified the model within SAS

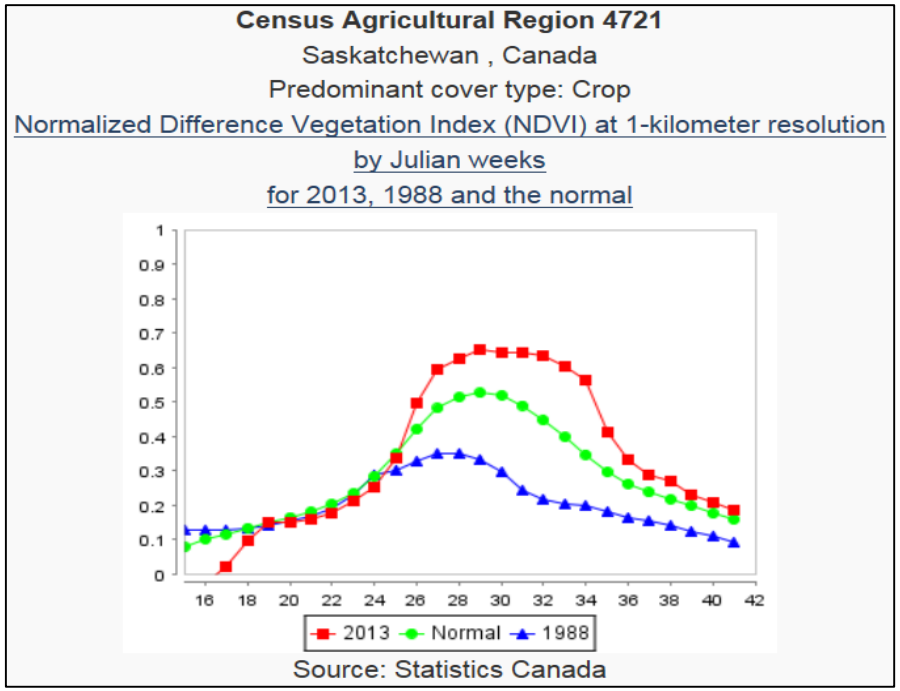
- Tested on 19 crops published within the September Farm Survey
  - Publication rules applied based on rules for data availability and quality
  - 15 crops published

- National Level
  - Provinces of Alberta, Saskatchewan, Manitoba, Ontario and Quebec
  - Accounts for about 98% of the agricultural land in Canada



First Data Source ; Normalized Difference Vegetation Index: 1987-2018





November Farm Survey
Spring Wheat Yield:

2013: 56.5 bu/ac (record yield)

Normal: 30.8 bu/ac

http://geodepot.statcan.gc.ca/ccap-peec/start-debut-eng.jsp

Second Data Source: Survey data

Crop survey data by Small Area Data Region:

- Harvested area
- Yield
- Production

Historical: November Farm Survey

Current year: June, July, November Farm Survey

Home › CANSIM

Table 001-0071 [1, 2, 9]

Estimated areas, yield and production of principal field crops by Small Area Data Regions, in metric and imperial units

annual

Data table | Add/Remove data | Manipulate | Download | Related information | Help

The data below is a part of CANSIM table 001-0071. Use the Add/Remove data tab to customize your table.

Selected items [Add/Remove data]

Type of crop = Barley

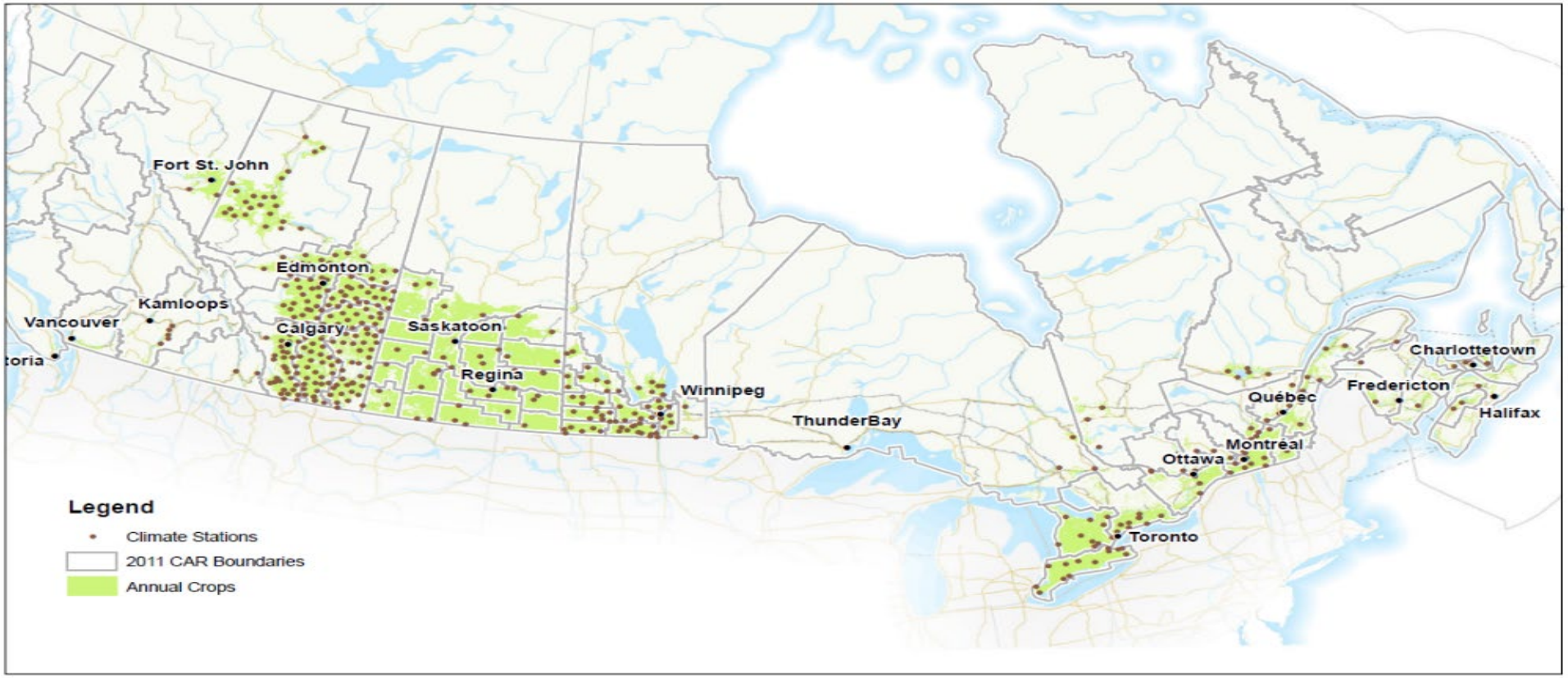
Geography	Harvest disposition	2011	2012	2013	2014	2015
Ontario [4]	Harvested area (acres)	120,000	118,000	105,000	102,000	110,000
	Average yield (bushels per acre)	61.7	64.4	58.9	68.1	66.4
	Production (metric tonnes)	161,100	165,500	134,600	151,300	158,900
Southern Ontario Region 1 - Ontario	Harvested area (acres)	3,200	4,700	6,400	2,300	4,000
	Average yield (bushels per acre)	43.7	61.5	27.8	40.3	64.7
	Production (metric tonnes)	3,000	6,300	3,900	2,000	5,600
Western Ontario Region 2 - Ontario	Harvested area (acres)	59,500	64,700	47,400	57,600	68,600
	Average yield (bushels per acre)	66.8	67.5	66.7	71.9	67.1

CANSIM Table 001-0071

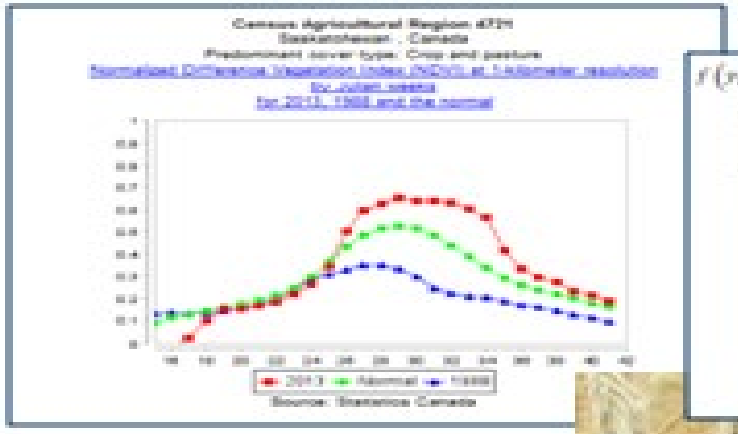
http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0010071&&pattern=&stByVal=1&p1=1&p2=50&tabMode=dataTable&csid

Third Data Source:Agroclimatic data

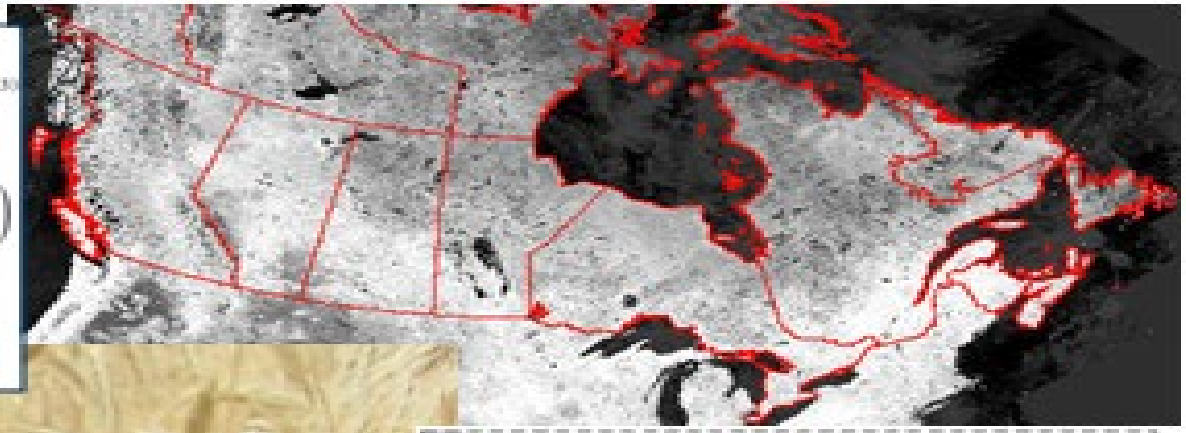
- 80 potential predictors ; maximum number of input variables set at five

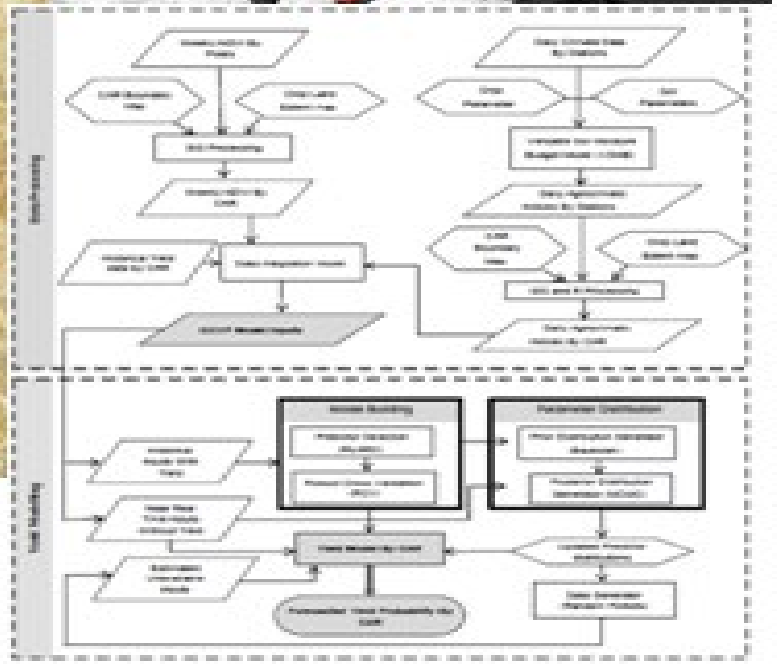


Crop Yield Modelling



$$
\begin{aligned}
&f\left(y_2,\ldots,y_n|y_1,\boldsymbol{\theta},\mathbf{D}_{(1:(q_2+m))}\right)\\
&=f\left(y_2|y_1\right)f\left(y_3|y_1,y_2\right)\cdots f\left(y_n|y_1,y_2,\ldots,y_{n-1}\right) \qquad (13)\\
&=N\left(y_0+2y_1+\sum_{i=1}^{m}\beta_2^{(i)}x_2^{(i)}+\sum_{i=m_{q-1}}^{q}\beta_2^{(i)}x_2^{(i)}+w y_1,\sigma^2\right)\\
&\times N\left(y_0+3y_1+\sum_{i=1}^{m}\beta_3^{(i)}x_3^{(i)}+\sum_{i=m_{q-1}}^{q}\beta_3^{(i)}x_3^{(i)}+w y_2,\sigma^2\right)\\
&\times\cdots\times N\left(y_0+wy_1+\sum_{i=1}^{m}\beta_n^{(i)}x_n^{(i)}\right.\\
&\left.+\sum_{i=m_{q-1}}^{q}\beta_n^{(i)}x_n^{(i)}+w y_{n-1},\sigma^2\right).
\end{aligned}
$$



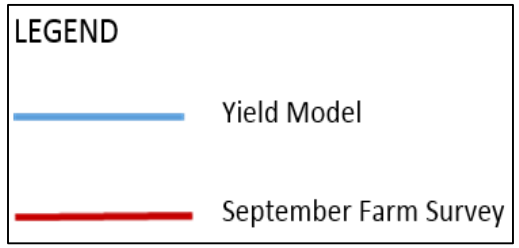


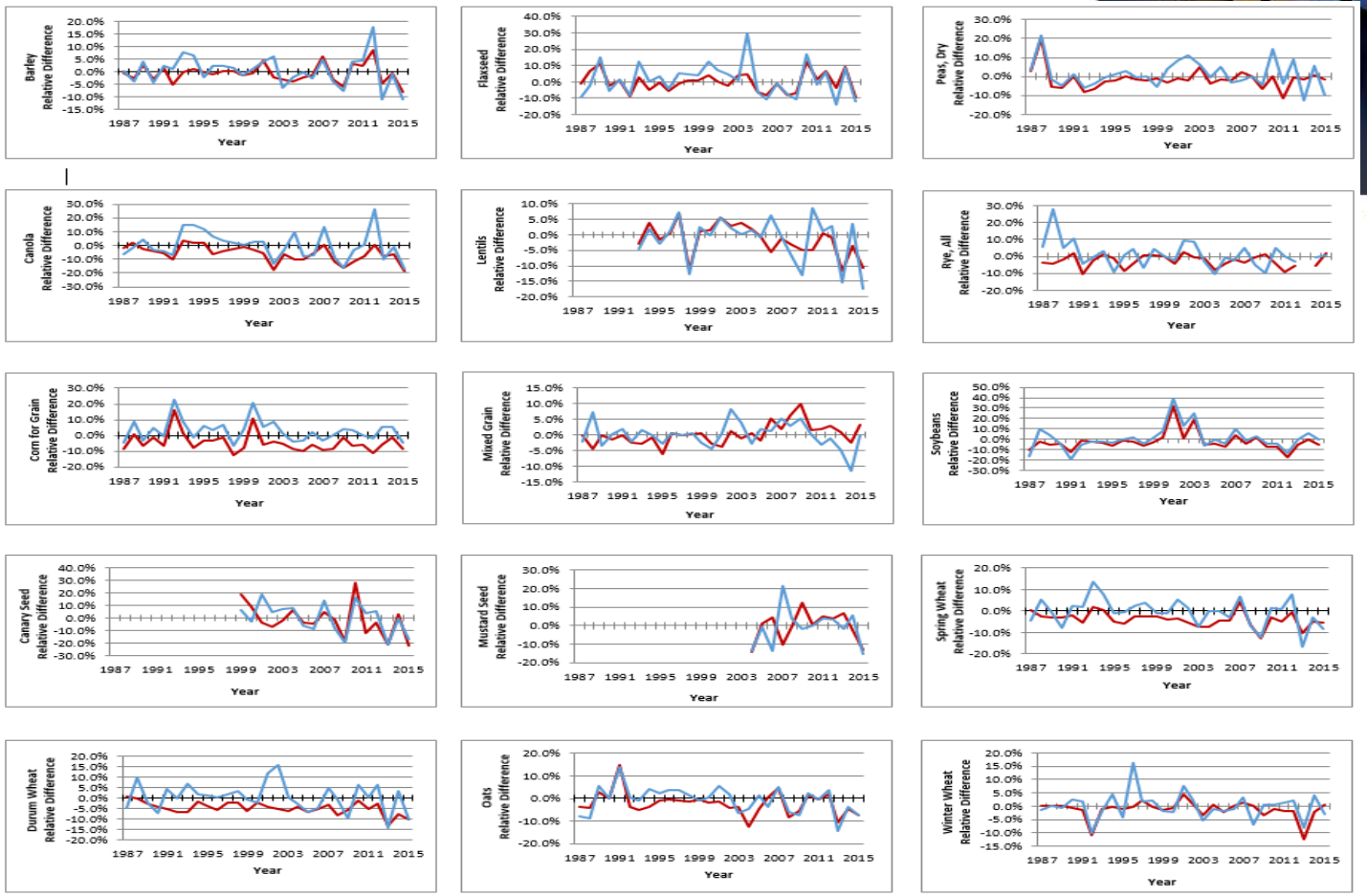
Leave One Out Cross Validation: 1987 - 2015

LOOCV completed by crop

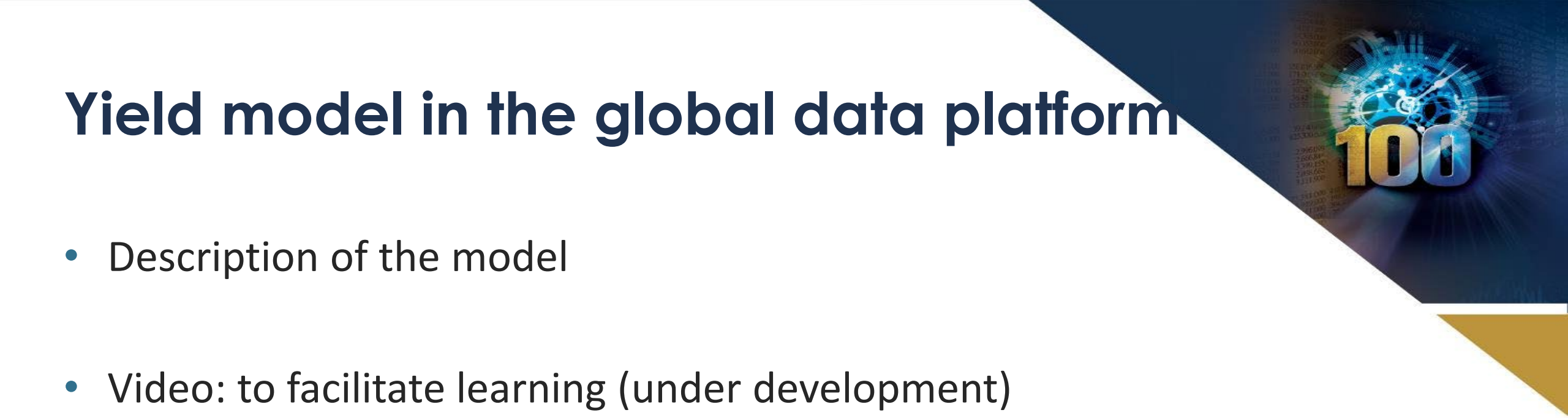
- 19 crops (15 published)
- Census of Agriculture Region (82)
- Provincial level (10)
- National level (1)

- Equal to 1767 comparisons





Yield model in the global data platform



- Description of the model
- Video: to facilitate learning (under development)
- Links to FCGEO platform (Canadian geospatial platform)
- Sample data

Way forward

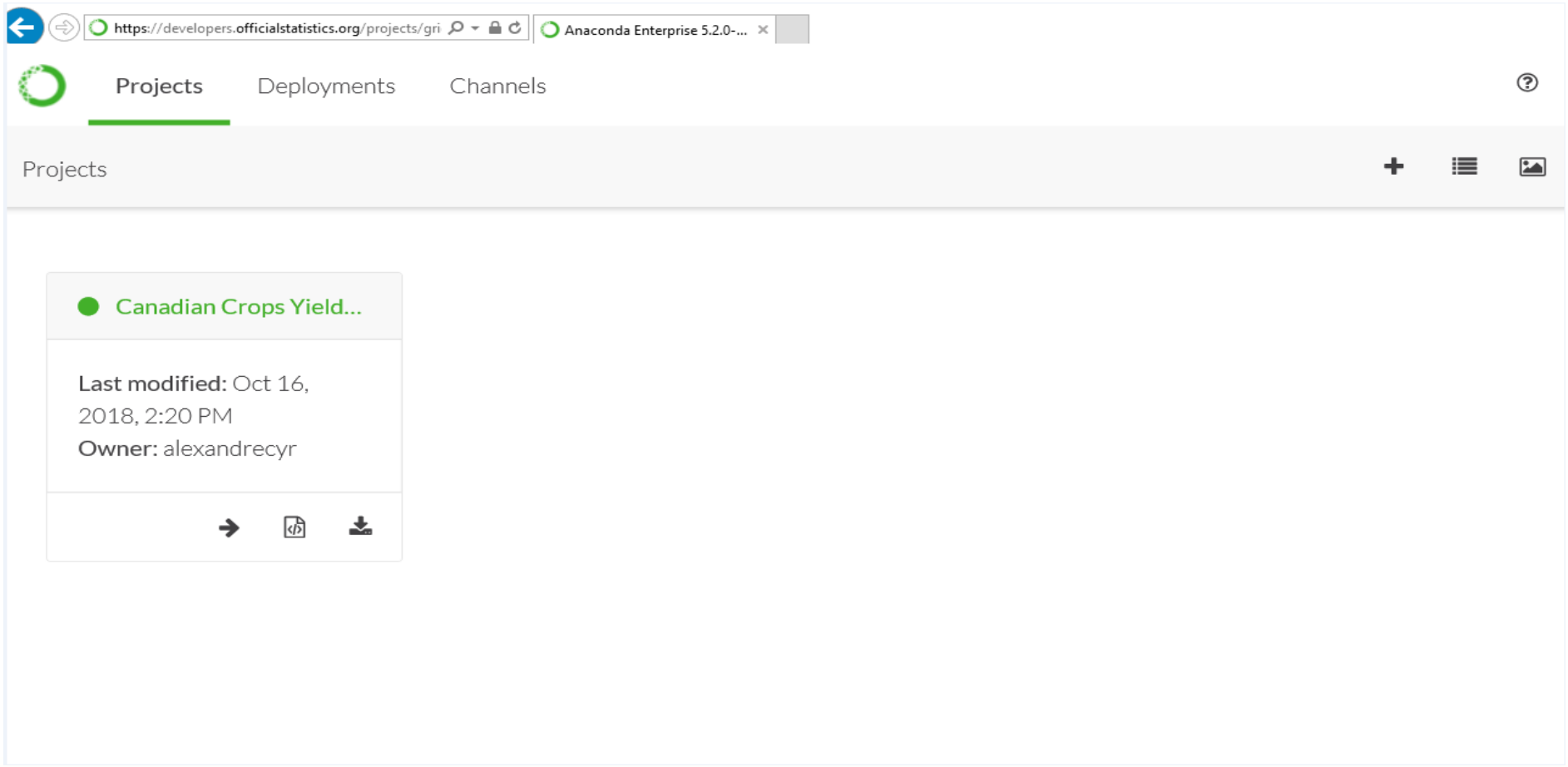
The use of satellite imagery offers opportunities

There is a need to accelerate learning, provide an environment where people can experiment, assess quality

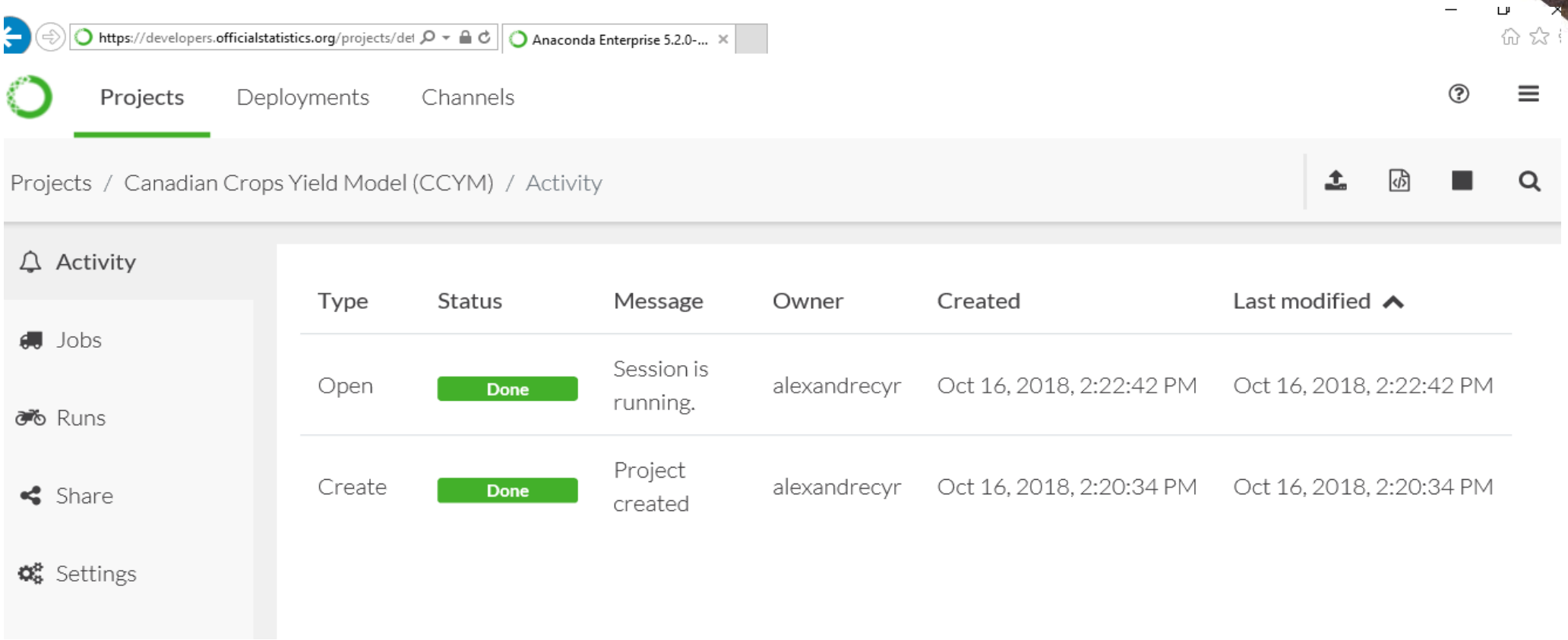
The benefits of a platform might be in facilitating collaboration using trusted:

- methods
- data
- partnerships

Global Platform Crops Yield Project



Crops Yield Project



Crops Yield Project Files