Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

Local Sampling to Regional and National Monitoring an Example from the Terrestrial Monitoring Framework

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Canada

Agricultural Monitoring Framework (AMF) of the Terrestrial Monitoring Framework (TMF)

- Terrestrial Monitoring Framework (TMF) is an interdepartmental initiative to develop, test and establish integrated national monitoring frameworks to support a broad range of policy and program requirements related to the health of Canada's terrestrial ecosystems.

- Agricultural Monitoring Framework (AMF) is the agricultural component of the Terrestrial Monitoring Framework (TMF).

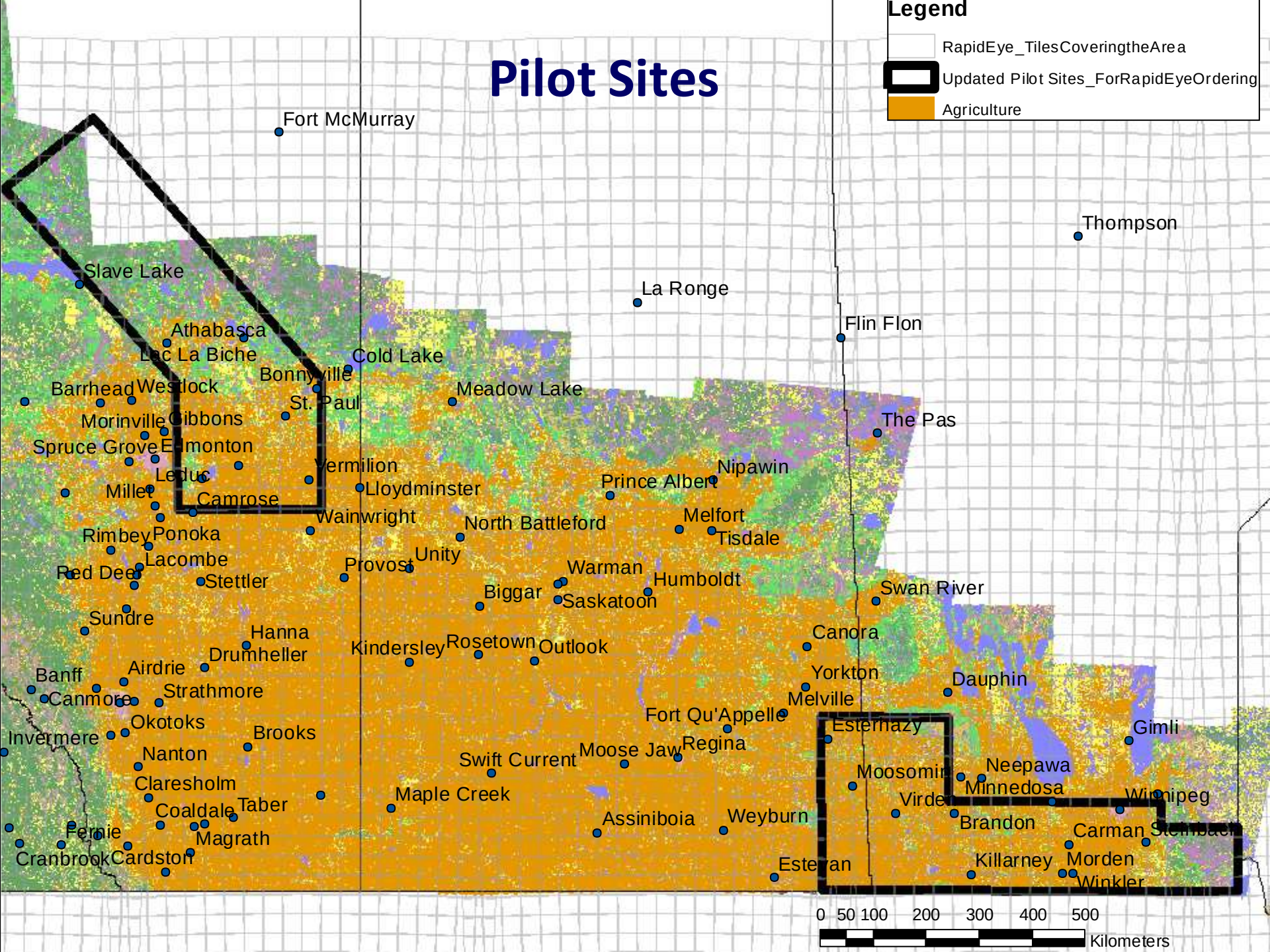
Agricultural Monitoring Framework (AMF) of the Terrestrial Monitoring Framework (TMF)

Involved departments:

- Agriculture and Agri-Food Canada (AAFC)
- Natural Resources Canada_Canadian Forest Service (CFS)
- Environment Canada (EC)
- Ducks Unlimited (DU)
- Collaborator: Statistics Canada_Agricultural Division (SC)

- TMF can provide a common sampling framework for all the involved departments and organizations at the national scale and will provide data updating and accessibility from a single source.

Pilot Sites


Legend
RapidEye_TilesCoveringtheArea
Updated Pilot Sites_ForRapidEyeOrdering
Agriculture
Fort McMurray
Thompson
Slave Lake
La Ronge
Flin Flon
Athabasca
Lac La Biche
Cold Lake
Bonnyville
Barrhead
Westlock
Meadow Lake
St. Paul
Morinville
Gibbons
The Pas
Spruce Grove
Edmonton
Vermilion
Nipawin
Leduc
Prince Albert
Millet
Lloydminster
Camrose
Wainwright
Melfort
North Battleford
Rimbey
Ponoka
Tisdale
Lacombe
Unity
Provost
Warman
Red Deer
Stettler
Humboldt
Biggar
Swan River
Saskatoon
Sundre
Hanna
Canora
Drumheller
Kindersley
Rosetown
Outlook
Airdrie
Banff
Yorkton
Dauphin
Strathmore
Canmore
Melville
Okotoks
Fort Qu'Appelle
Esterhazy
Gimli
Invermere
Brooks
Regina
Nanton
Swift Current
Moose Jaw
Neepawa
Moosomin
Minnedosa
Claresholm
Maple Creek
Virden
Winnipeg
Taber
Coaldale
Brandon
Assiniboia
Weyburn
Fernie
Carman
Magrath
Cranbrook
Cardston
Killarney
Morden
Esterhan
Winkler
0 50 100 200 300 400 500
Kilometers

Agricultural Monitoring Framework (AMF) of the Terrestrial Monitoring Framework (TMF)

MONITORING VARIABLES

LEGEND
- • Done or in progress
- ○ In the plan

Temporally Dynamic:

Annual

- • Crop types JECAM variable
- • Crop area
- • Crop yield (from crop insurance & AAFC modeling)

} → Crop production

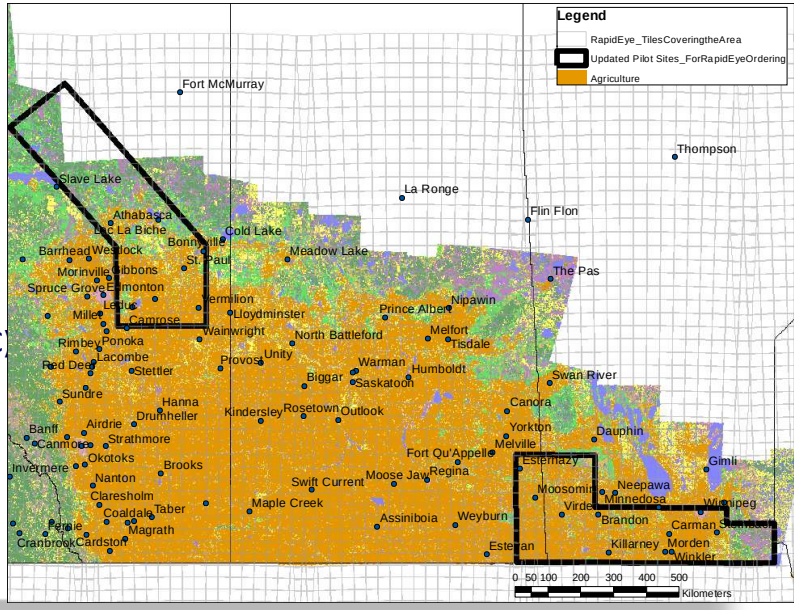
- ○ Crop Residue

Multi-year to annual

- ○ Sustainability indicators and carbon modelling (from AAFC Sustainability Metrics project)
- • Non agricultural land use/cover JECAM variable

***More frequent** (weekly/bi-weekly)*

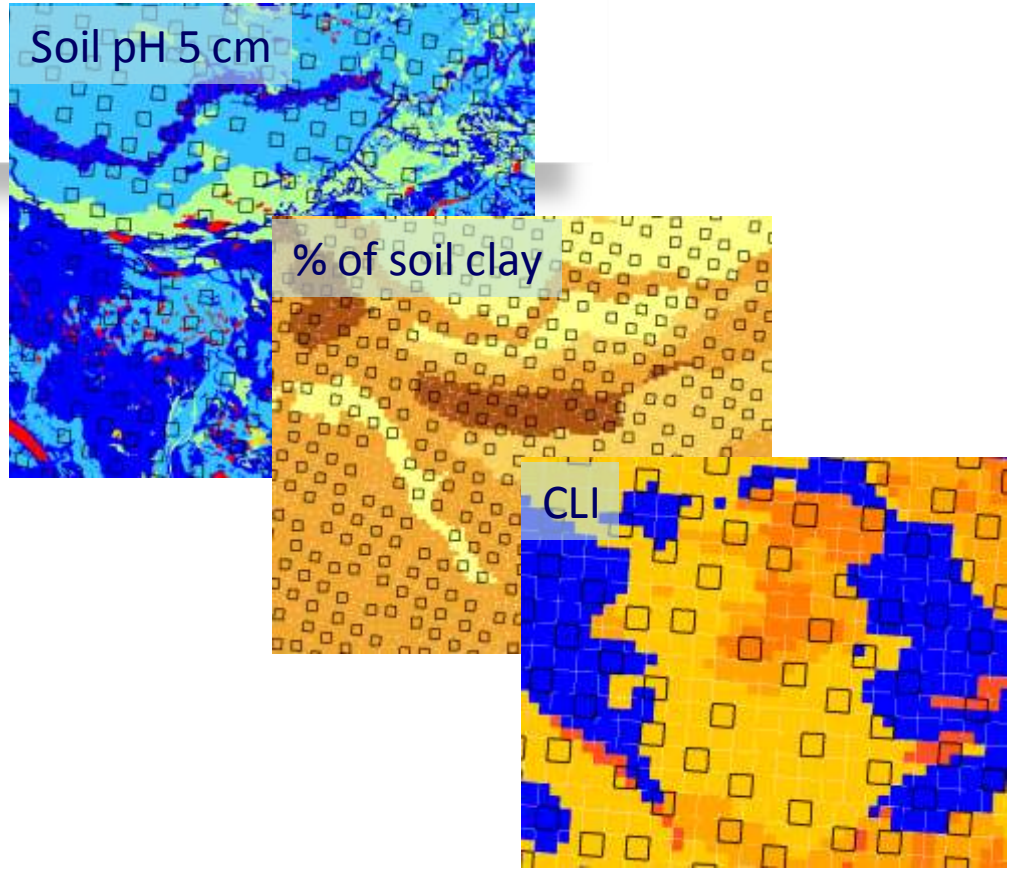
- ○ Soil moisture & soil moisture anomalies (from AAFC)
- ○ NDVI (from AAFC)



Agricultural Monitoring Framework (AMF) of the Terrestrial Monitoring Framework (TMF)

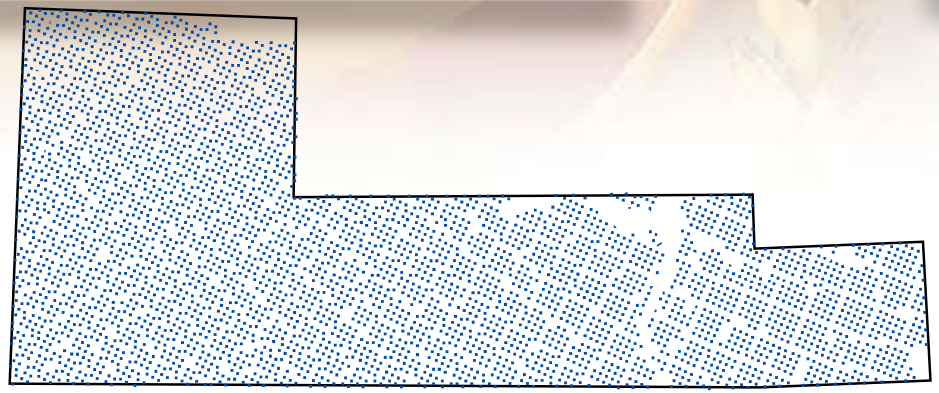
Temporally Static:

- Soil Landscape of Canada (SLC3.2) attributes (1:1000,000)
- Detailed soils attributes
- Canada Land Inventory (CLI) rating



Agricultural Monitoring

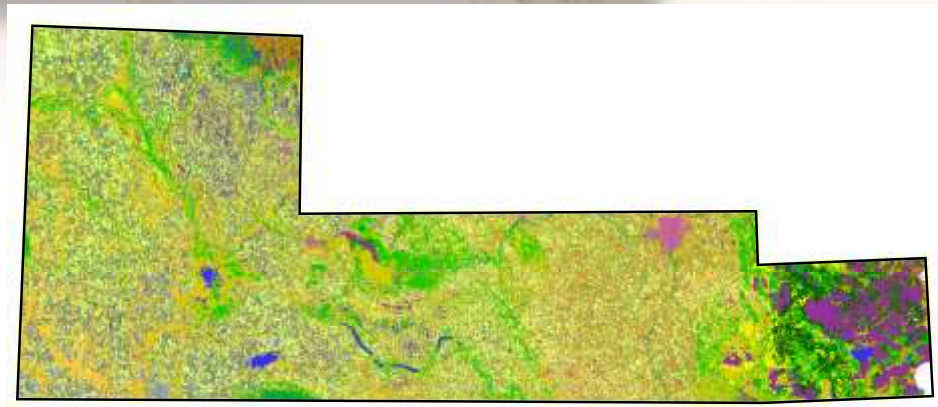
Sampling Framework (discrete)



Advantage:

- Applicable to variables that cannot be monitored continuously.
- Many variables can be assigned to the same sampling grid (i.e. <u>many variables</u> all in one table of attributes).

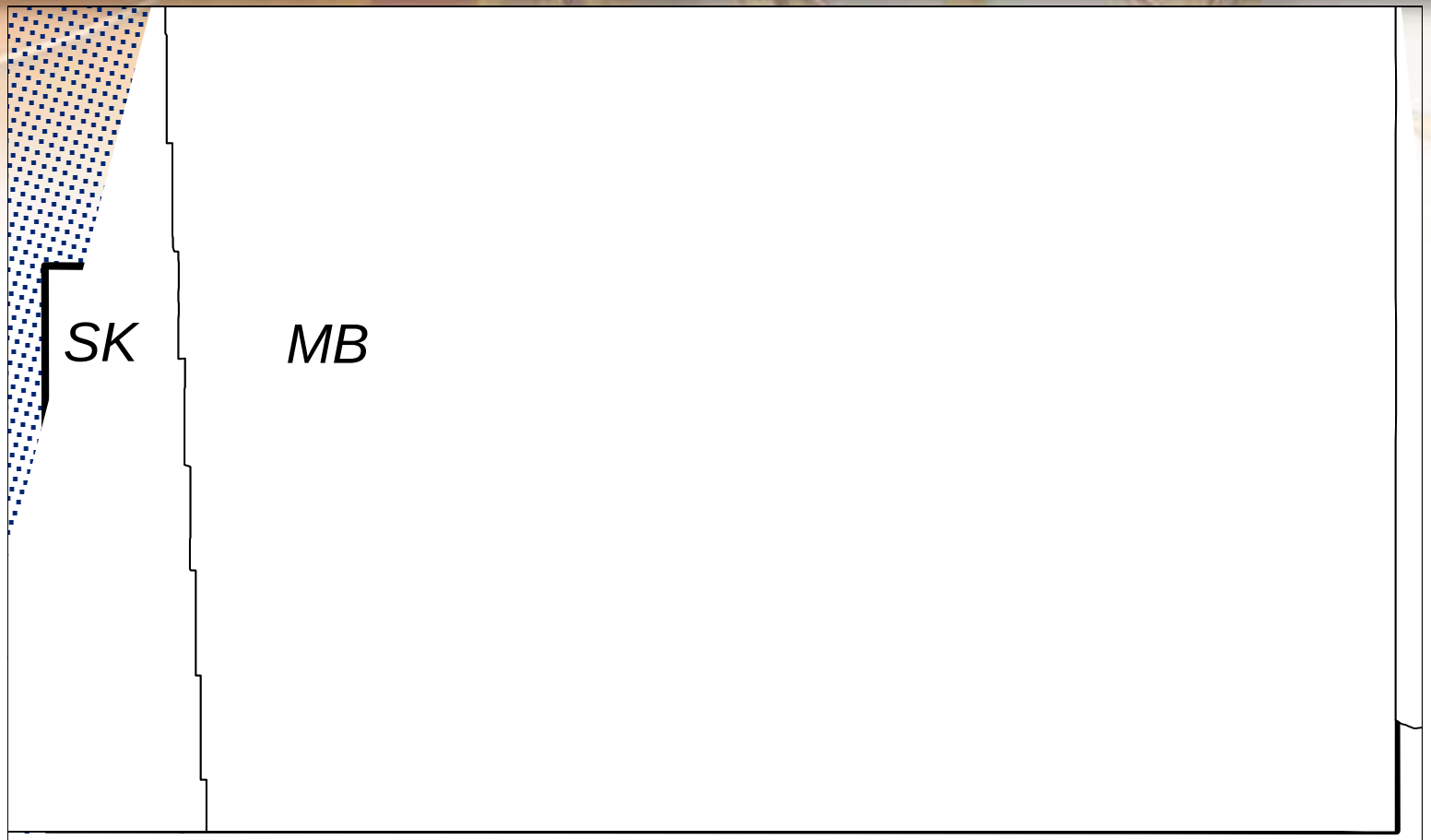
Wall-to-Wall (continuous)



Advantage:

- Contains a continuous spatial coverage for the monitoring variable.

Agricultural Monitoring Framework (AMF) of the Terrestrial Monitoring Framework (TMF)



National Forest Inventory (NFI) Points

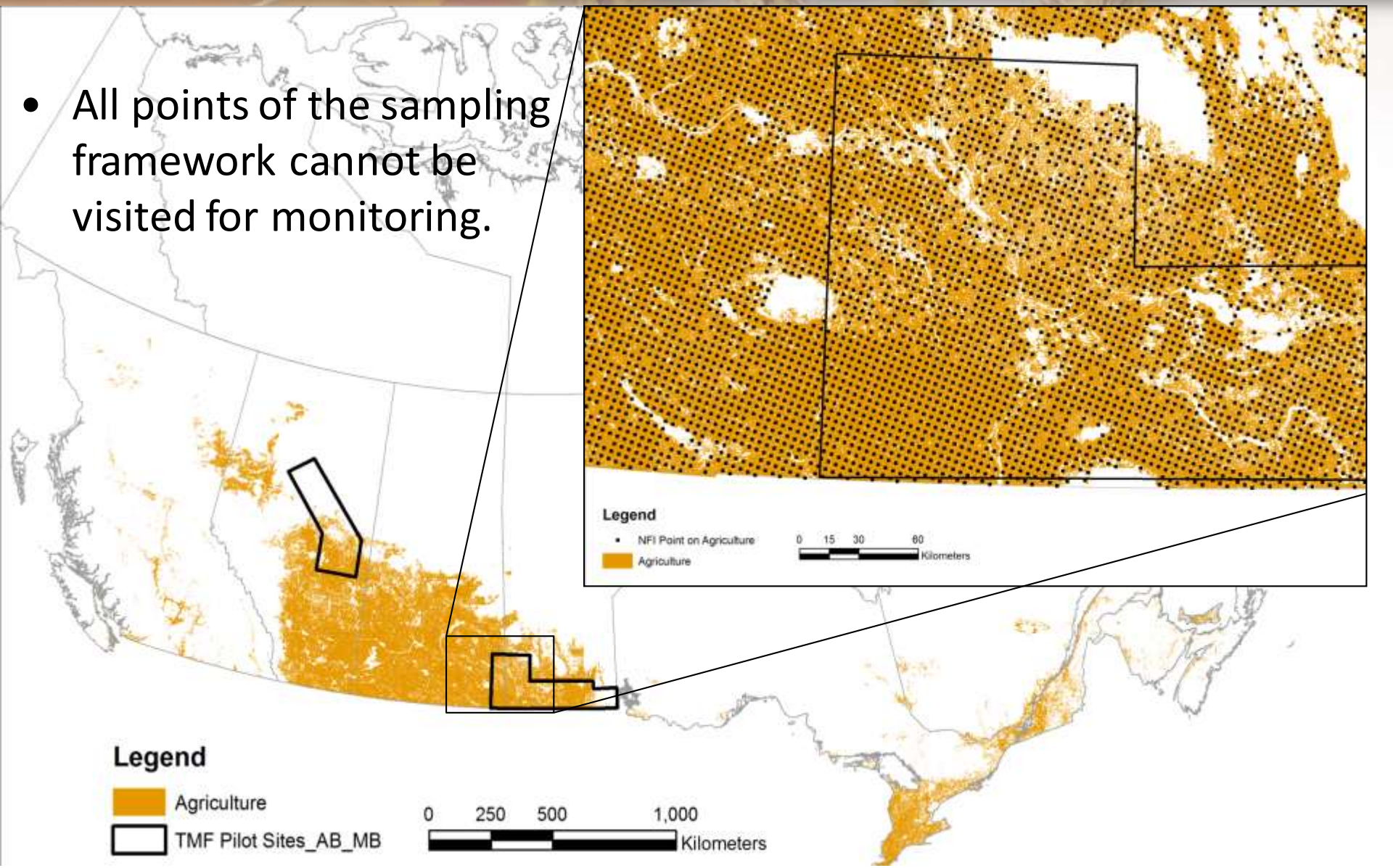
Legend

- NFI Point (4 x 4 km)

0 25 50 100 150 200
Kilometers

Agricultural Monitoring Framework (AMF) of the Terrestrial Monitoring Framework (TMF)

- All points of the sampling framework cannot be visited for monitoring.

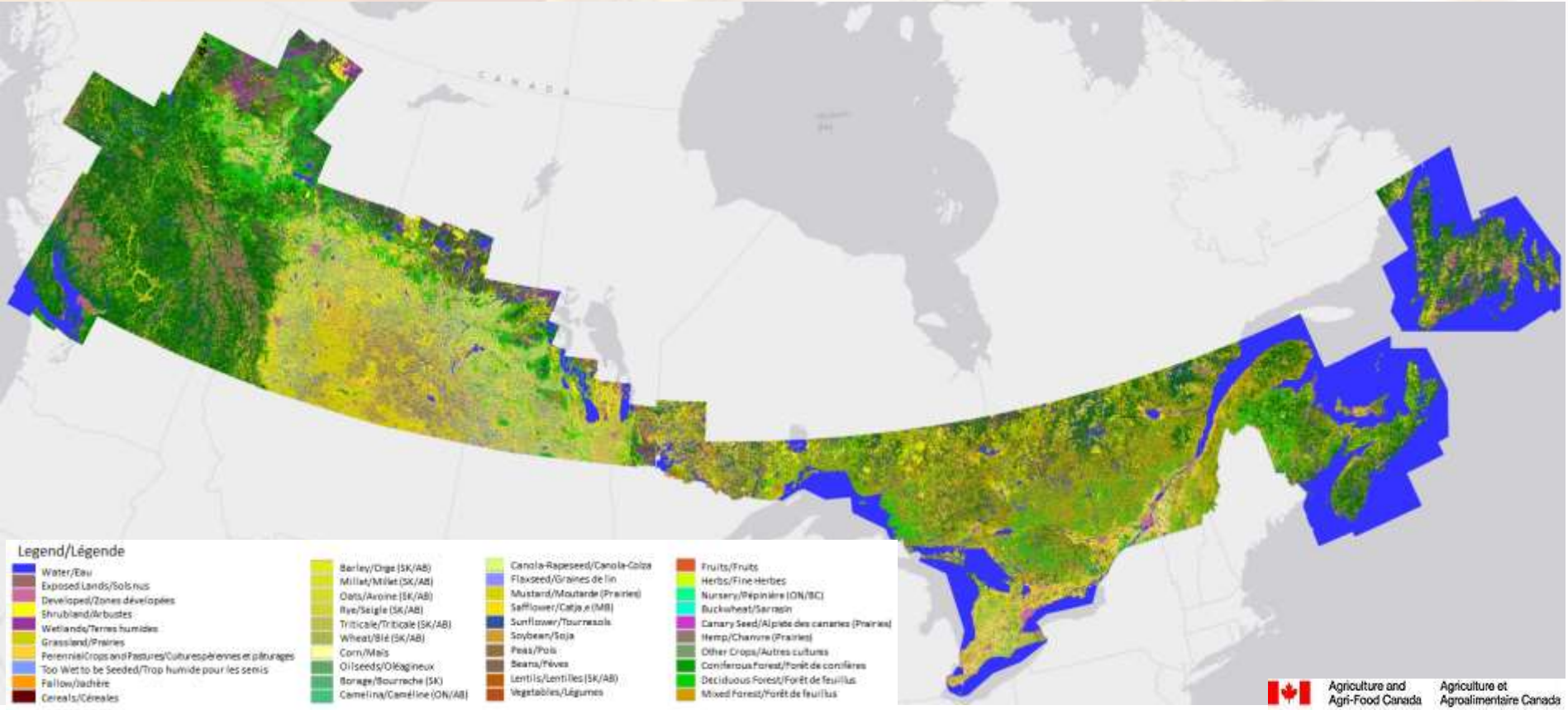


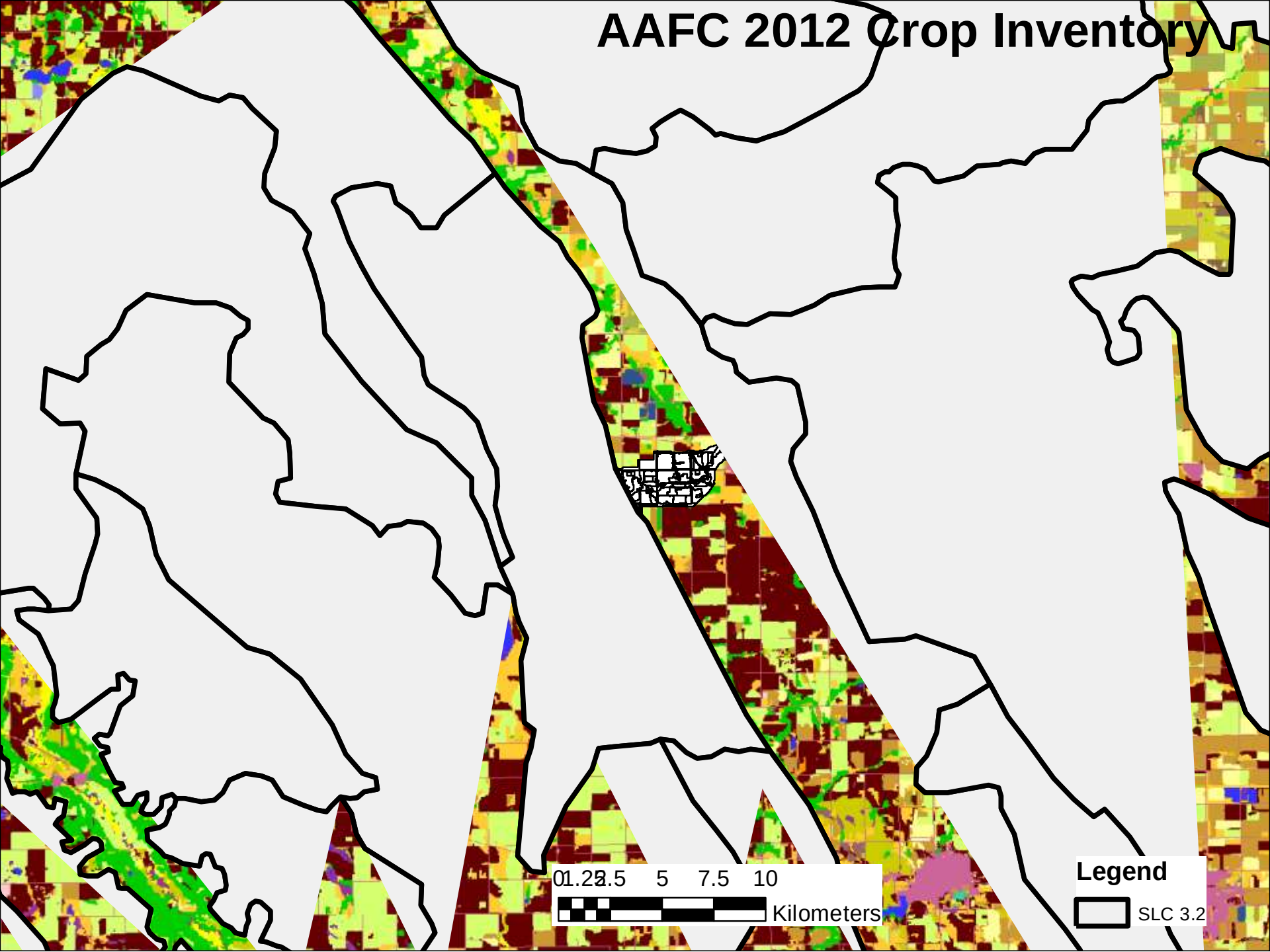
Agricultural Monitoring Framework (AMF) of the Terrestrial Monitoring Framework (TMF)

An Example
Monitoring Crop Types and Crop Areas
(Local Sampling to Regional & National Monitoring)

AAFC EO-based Annual Crop Inventory

The 2013 Crop Inventory



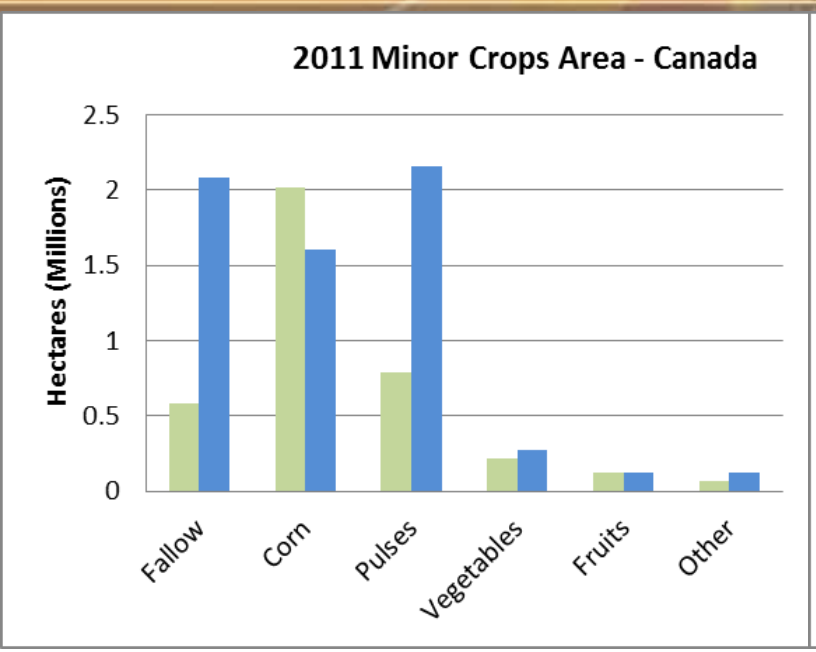

AAFC 2012 Crop Inventory
0 1.25 2.5 5 7.5 10
Kilometers
Legend
SLC 3.2

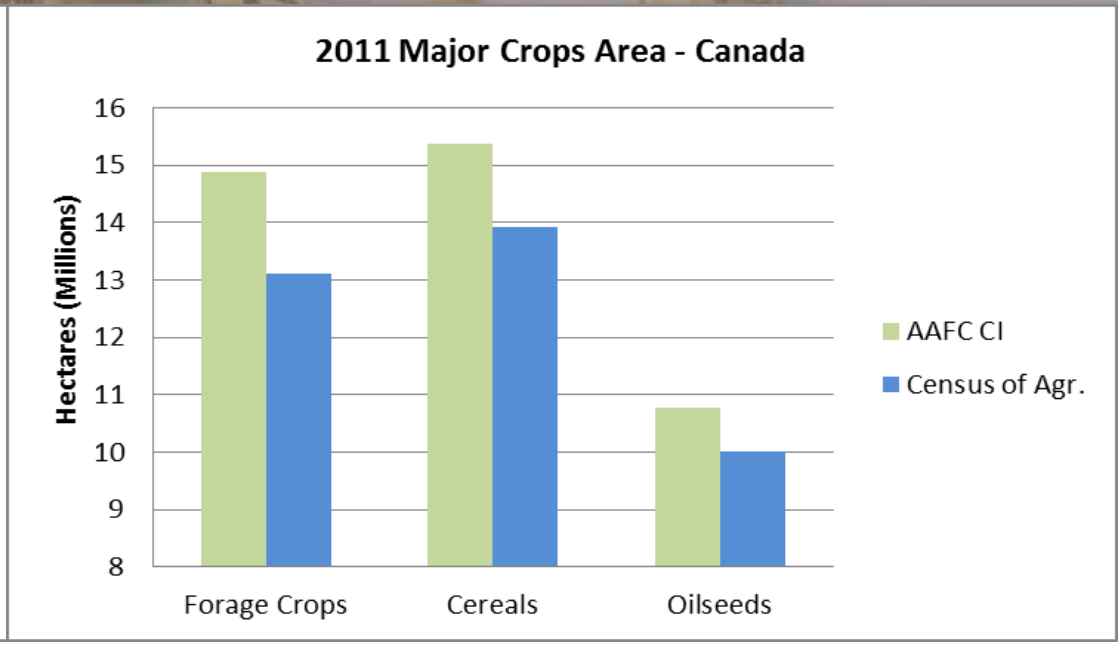
Overall Accuracies of the Annual Crop Inventory

Overall accuracies of crop classes per province and per year

Provinces	Overall Accuracy (Per Year)				
	2009	2010	2011	2012	2013
PEI	-	-	67.5%	78.7%	87.9%
NB	-	-	88.1%	88.0%	87.3%
NS	-	-	64.2%	89.9%	74.2%
QC	-	-	81.4%	81.8%	87.5%
ON	-	-	80.8%	76.2%	88.2%
MB	80.0%	-	79.0%	85.9%	85.4%
SK		88.3%	87.1%	82.4%	86.5%
AB			87.7%	88.4%	89.9%
BC	-	-	-	-	79.2%
Canada	80.0%	88.3%	85.3%	83.9%	86.0%

Comparing Crop Areas

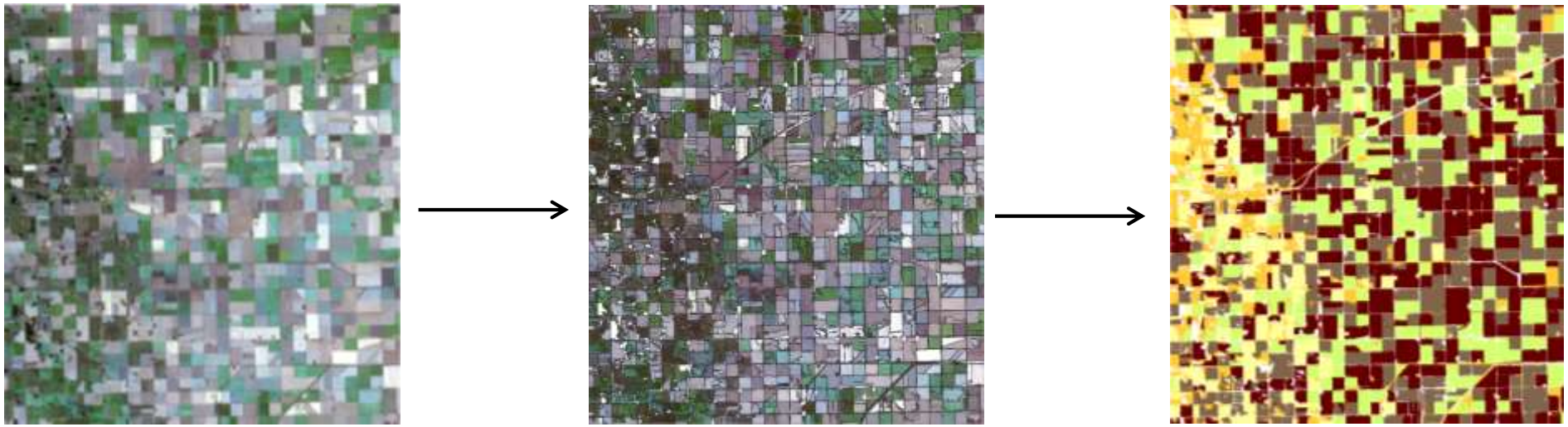


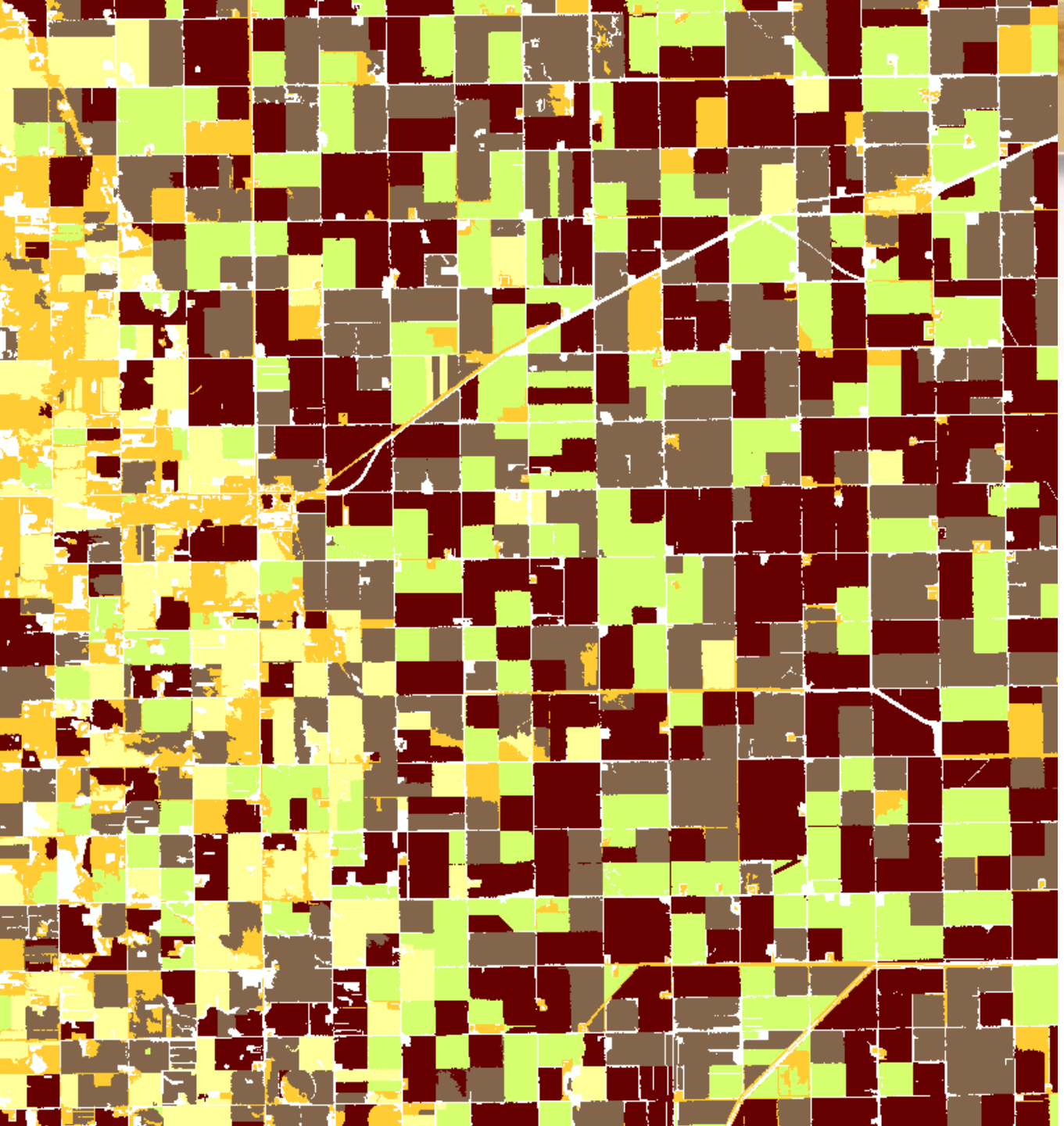


Comparing crop areas estimated from the Annual Crop Inventory and the 2011 Census of Agriculture

Agricultural Monitoring Framework (AMF) of the Terrestrial Monitoring Framework (TMF)

- Object-based crop inventory mapping with high resolution (5 m) EO data were tested resulting in very high classification accuracies. Such results indicated that this kind of crop mapping can replace a major part of the direct field observation at the location of the monitoring sampling framework.





Classification Result

- Very high classification accuracy (over 95% are achieved for different target crop types).
- Can be considered as direct field observations.

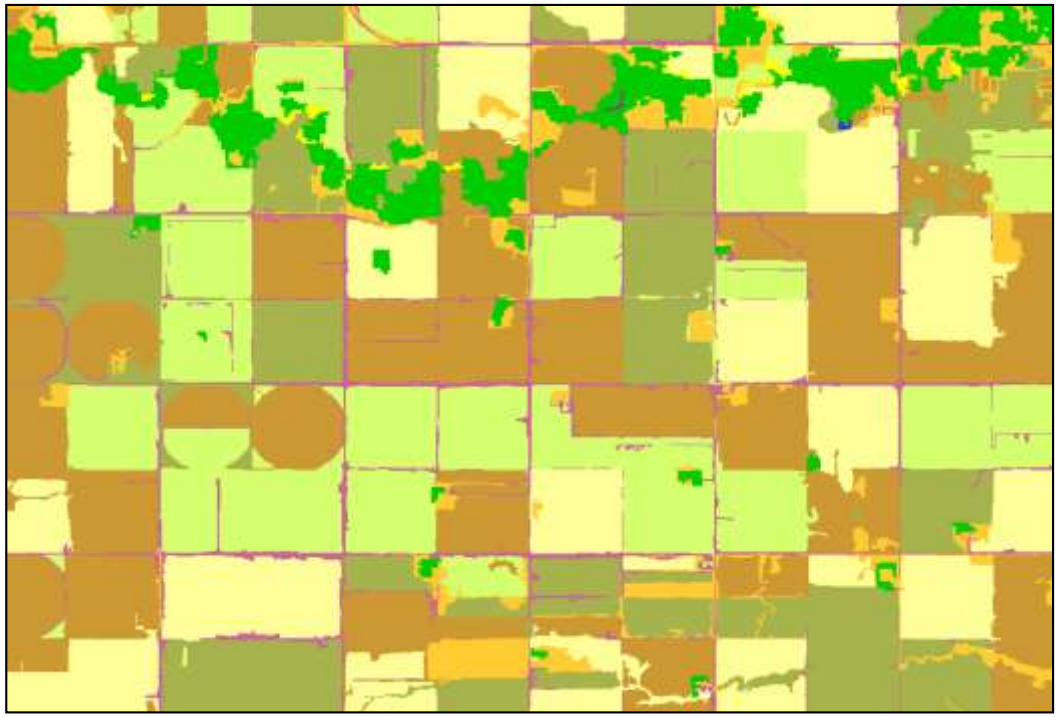
CLASS_NAME
- Canola
- Cereals
- Corn
- Pasture
- Soybean

Delineating Field Boundaries

Comparison to 2013 Annual Crop Inventory

2013 Crop Inventory
Accuracy of crop classes ~ 85%

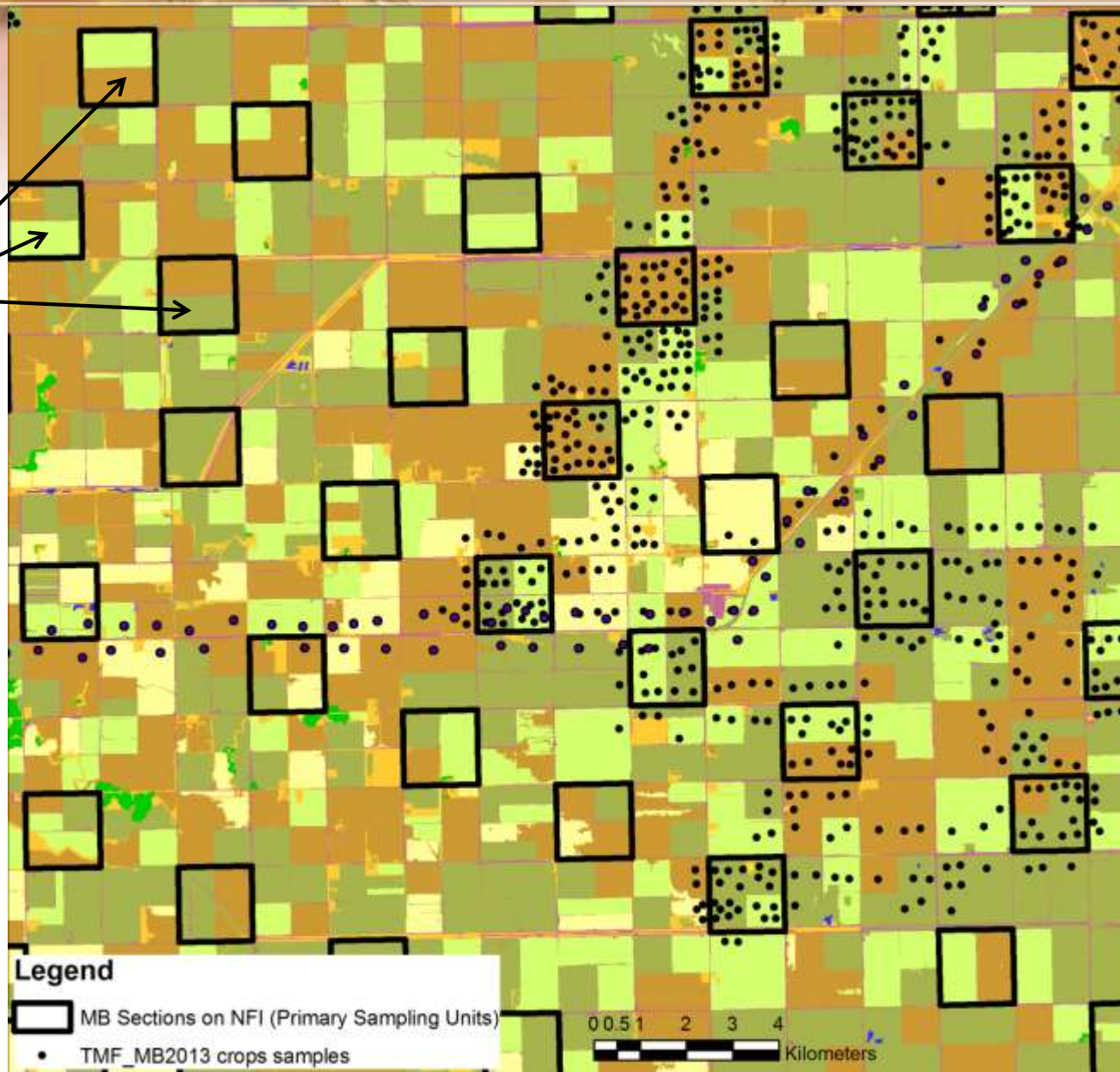
2013 Object-based crop classification (based on RapidEye & Radarsat 2)
Accuracy of crop classes ~ 95% or more in some regions.

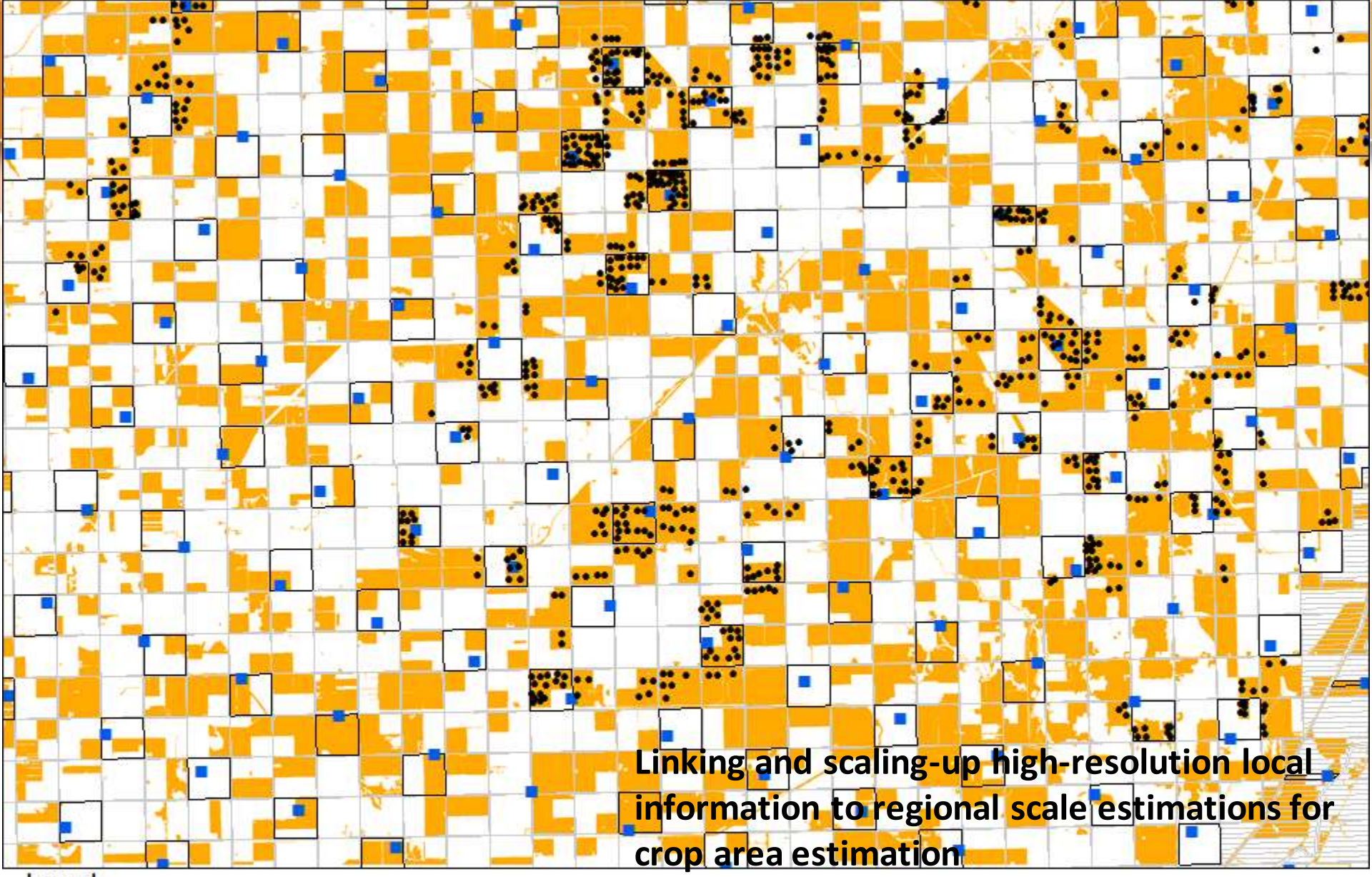


Legend
- Canola
- Cereals
- Corn
- Pasture
- Soybeans
- Road
- Urban
- Water
- Shrubland
- Coniferous
- Broadleaf
- Mixedwood

Agricultural Monitoring Framework (AMF) of the Terrestrial Monitoring Framework (TMF)

Classification result is so accurate (> 95%) that the un-sampled Primary Sampling Units (boxes) can have values and be considered as sampled.





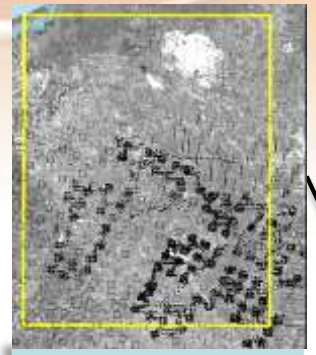
Legend

- TMF_MB2013 cereal crops samples
- NFI point
- Primary Sampling Unit (Sections intersecting with NFI points)
- Manitoba Sections
- Cereal crops (from very accurate classification)

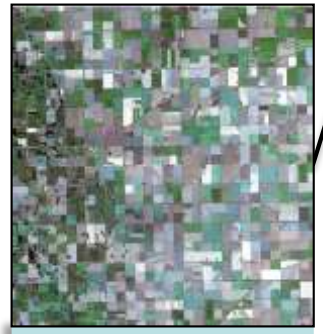
0 1.252.5 5 7.5 10 Kilometers

Cereal Crops MB 2013

Linking and Scaling-up High-resolution Local Information to Regional Scale Estimations for Regional Crop Area Estimation

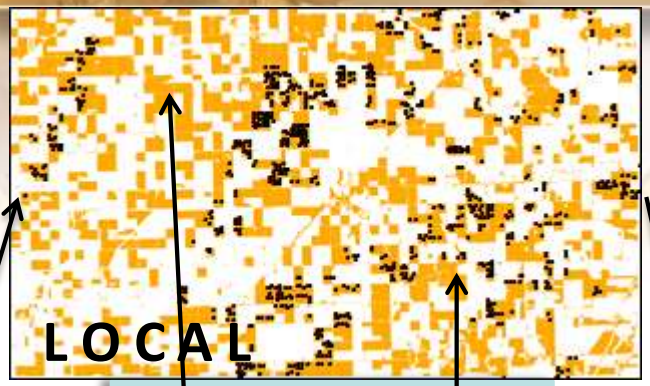


Field Observations in Limited Areas

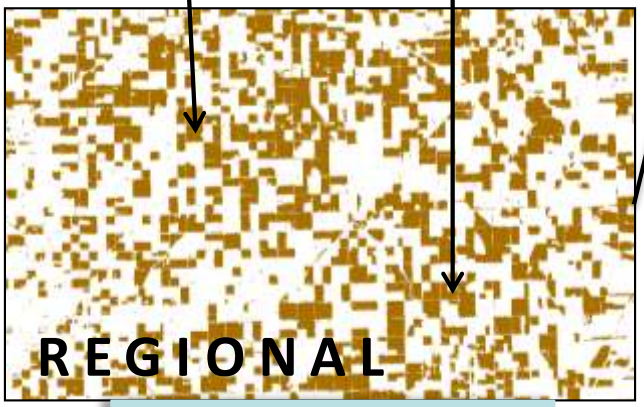


EO Data (RapidEye, Radarsat2,…)

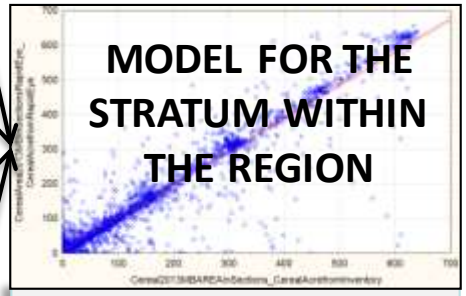
Very Accurate Crop Type Map



Creating More Reference Data For Cereal Crops for Sections Covering the Area



Cereal Crops from Annual Crop Inventory for the Same Area



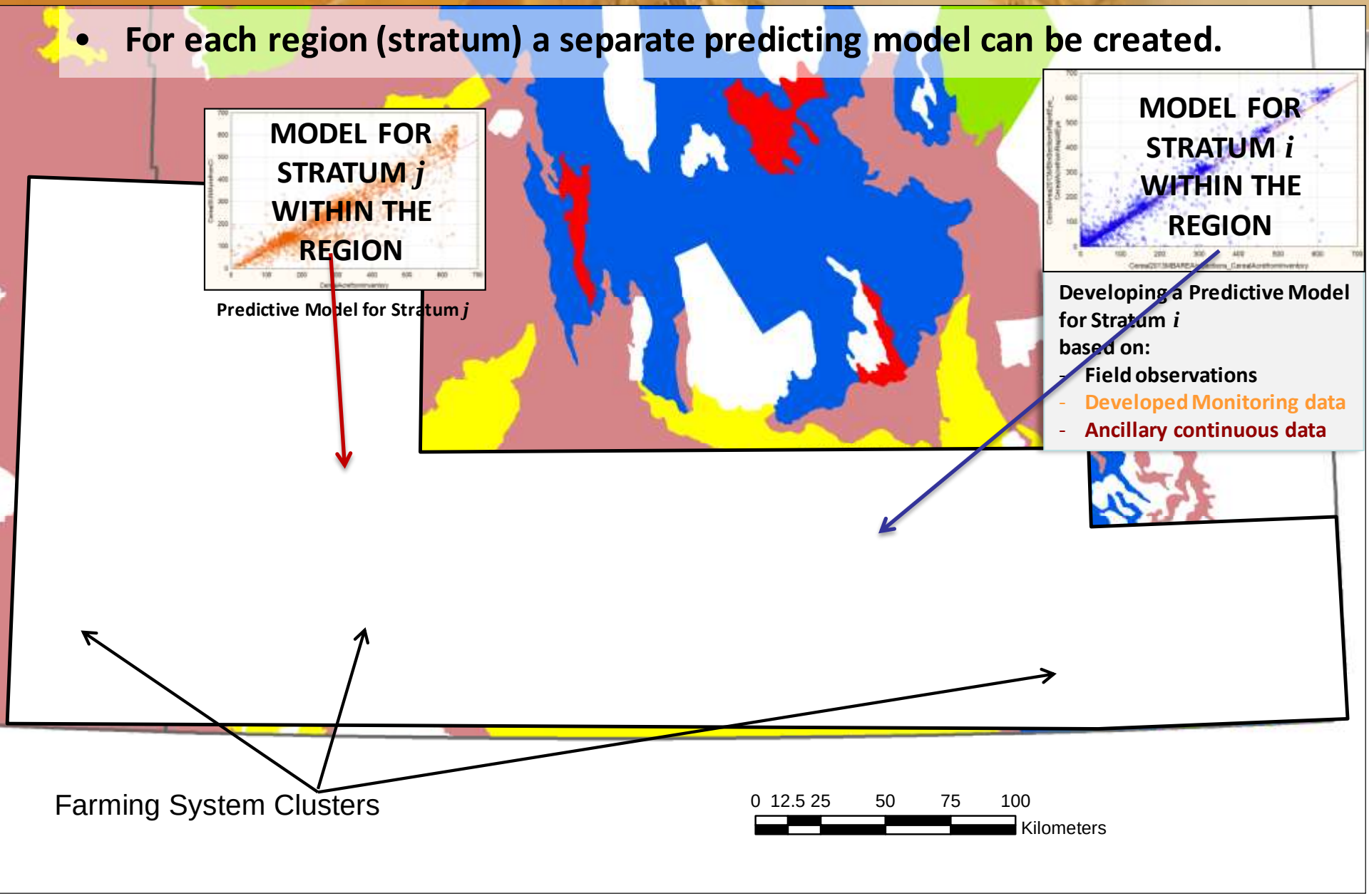
Developing a Predictive Model for Stratum *i* based on:

- Field observations
- Developed Monitoring data
- Ancillary continuous data

Developing a Predictive Model to Accurately Estimate Area of Cereal Crops for a Region

Stratification for Modelling Global Variables

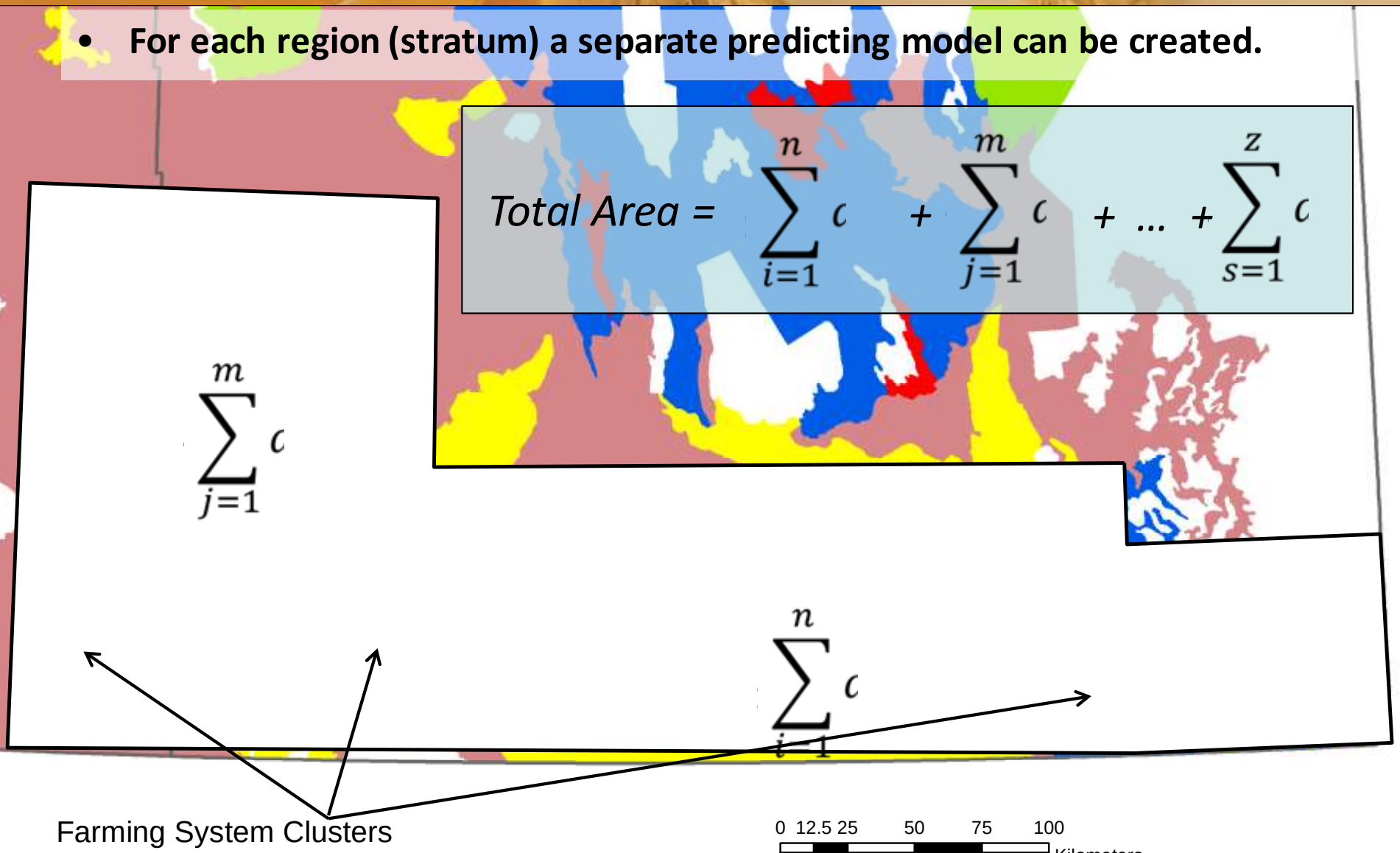
- For each region (stratum) a separate predicting model can be created.



Stratification for Modelling Global Variables

- **For each region (stratum) a separate predicting model can be created.**

$$\textit{Total Area} = \sum_{i=1}^{n} c + \sum_{j=1}^{m} c + \ldots + \sum_{s=1}^{z} c$$



Canadian Crop Yield Forecaster

Agriculture and Agri-Food Canada / Agriculture et Agroalimentaire Canada

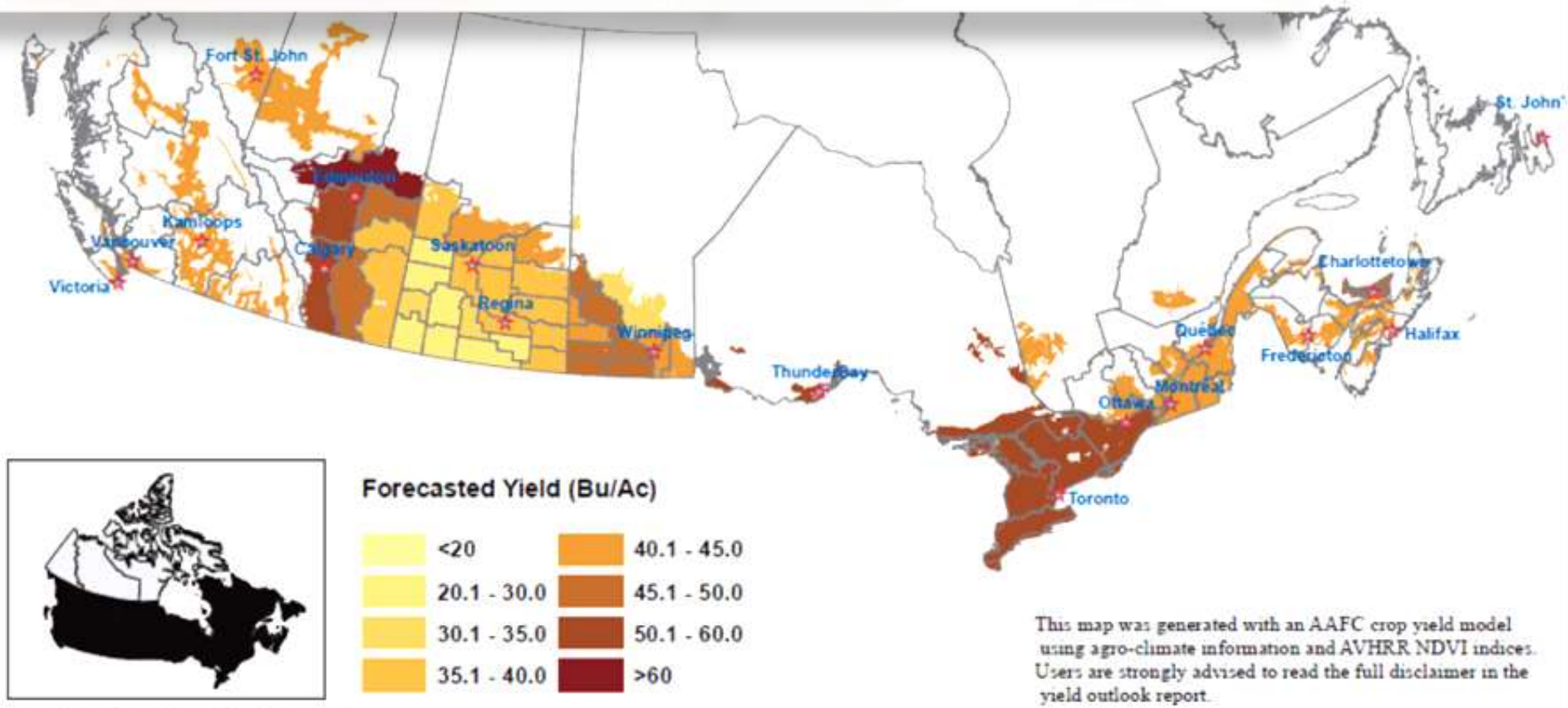
Forecasted Spring Wheat Yield of 2014 Growing Season

Forecast Date: July 11, 2014

Annual Monitoring Variables

- Crop area
- Crop yield (from crop insurance & AAFC modeling)

→ Crop production can be estimated



This map was generated with an AAFC crop yield model using agro-climate information and AVHRR NDVI indices. Users are strongly advised to read the full disclaimer in the yield outlook report.

Prepared by Agriculture and Agri-Food Canada's National Agroclimate Information Service (NAIS). Model building data provided in partnership with Statistics Canada and Environment Canada. Created: 07/14/2014

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