Modelling The Effect of Changing Weather Patterns on Farming Operations

Databases and Logic

Dan MacDonald, Ruth Waldick, Sampsa Hamalainen – AAFC, Ottawa, Scott Mitchell, Anna Zaytseva – Carleton University Ottawa, Ontario, Tonia Tanner – Carleton University
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The Question

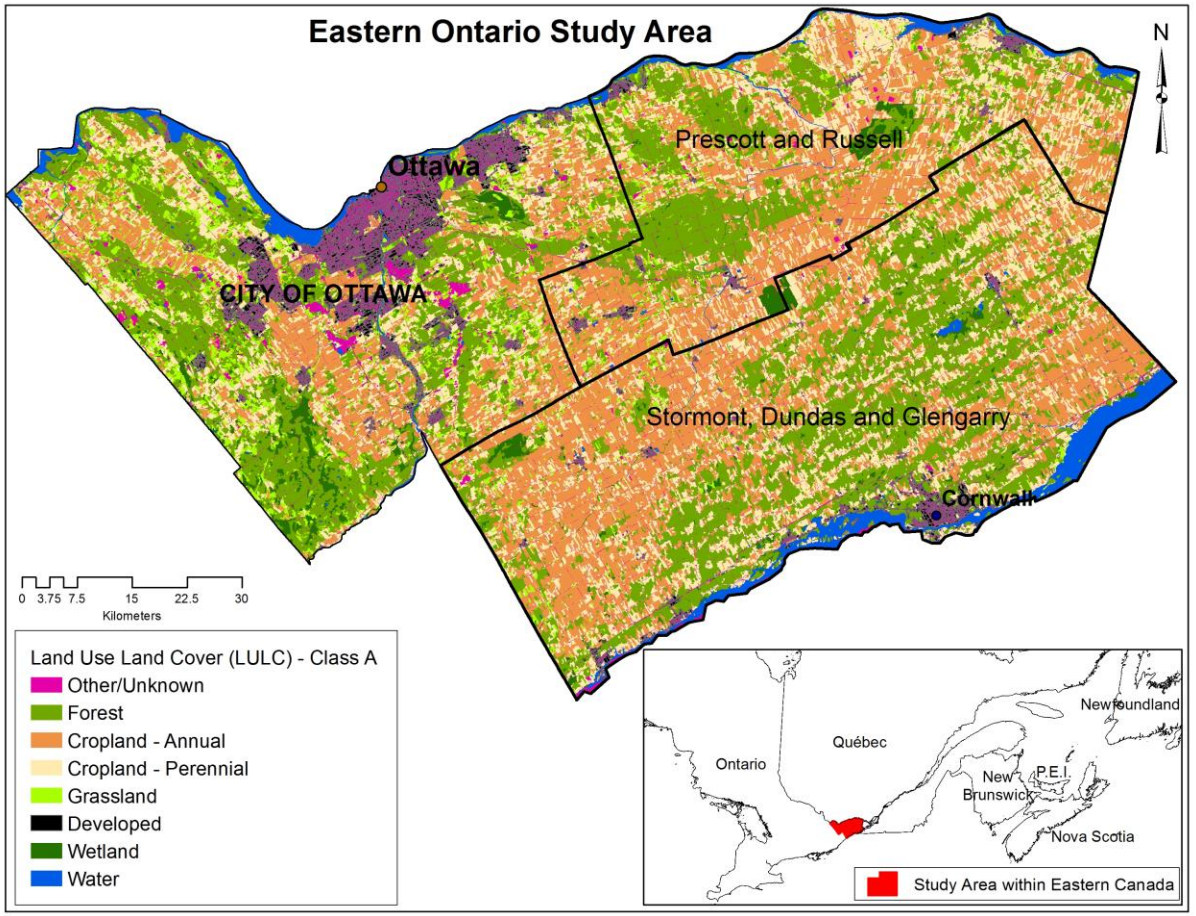
- How do we look critically at what a change in weather patterns does to farms in an Agricultural Region?

- Crop specific = Corn, Soy, alfalfa
- Spatially explicit = varied weather across the region
- Operationally sensitive = individual farms, varied seeding dates, impacted by weather.

First day of the growing season!!

Simulation model for Eastern Ontario

Study Area


Eastern Ontario Study Area
N
Prescott and Russell
Ottawa
CITY OF OTTAWA
Stormont, Dundas and Glengarry
Cornwall
0 3.75 7.5 15 22.5 30
Kilometers
Land Use Land Cover (LULC) - Class A
Other/Unknown
Forest
Cropland - Annual
Cropland - Perennial
Grassland
Developed
Wetland
Water
Ontario
Québec
Newfoundland
New Brunswick
P.E.I.
Nova Scotia
Study Area within Eastern Canada

Agricultural Systems in Eastern Ontario

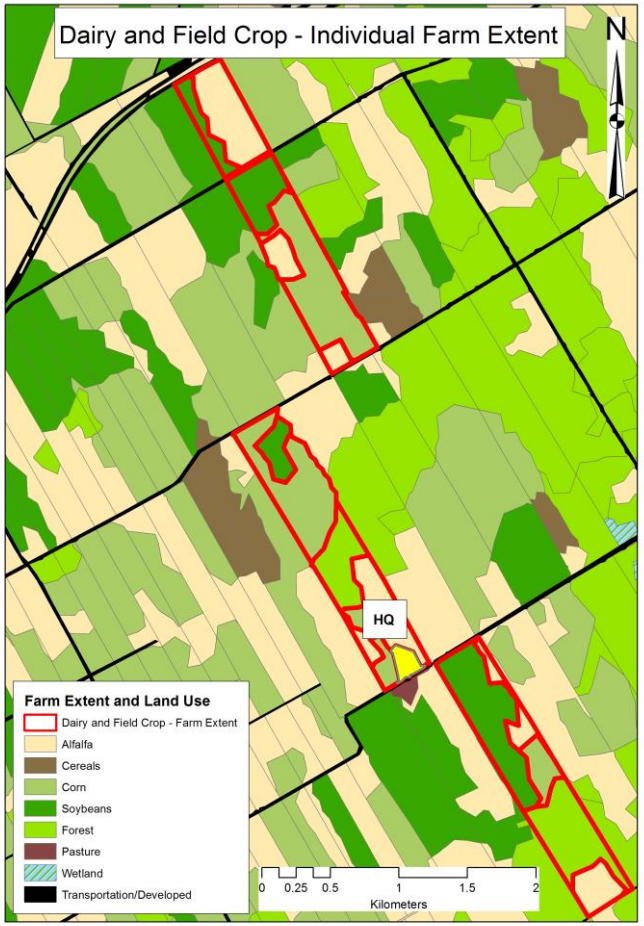
- Agricultural operations are primarily dairy, field or cash crop, beef with some pig and poultry production.
- The principal crops are corn, soy, cereals and perennial hay.

Envision Eastern Ontario Model

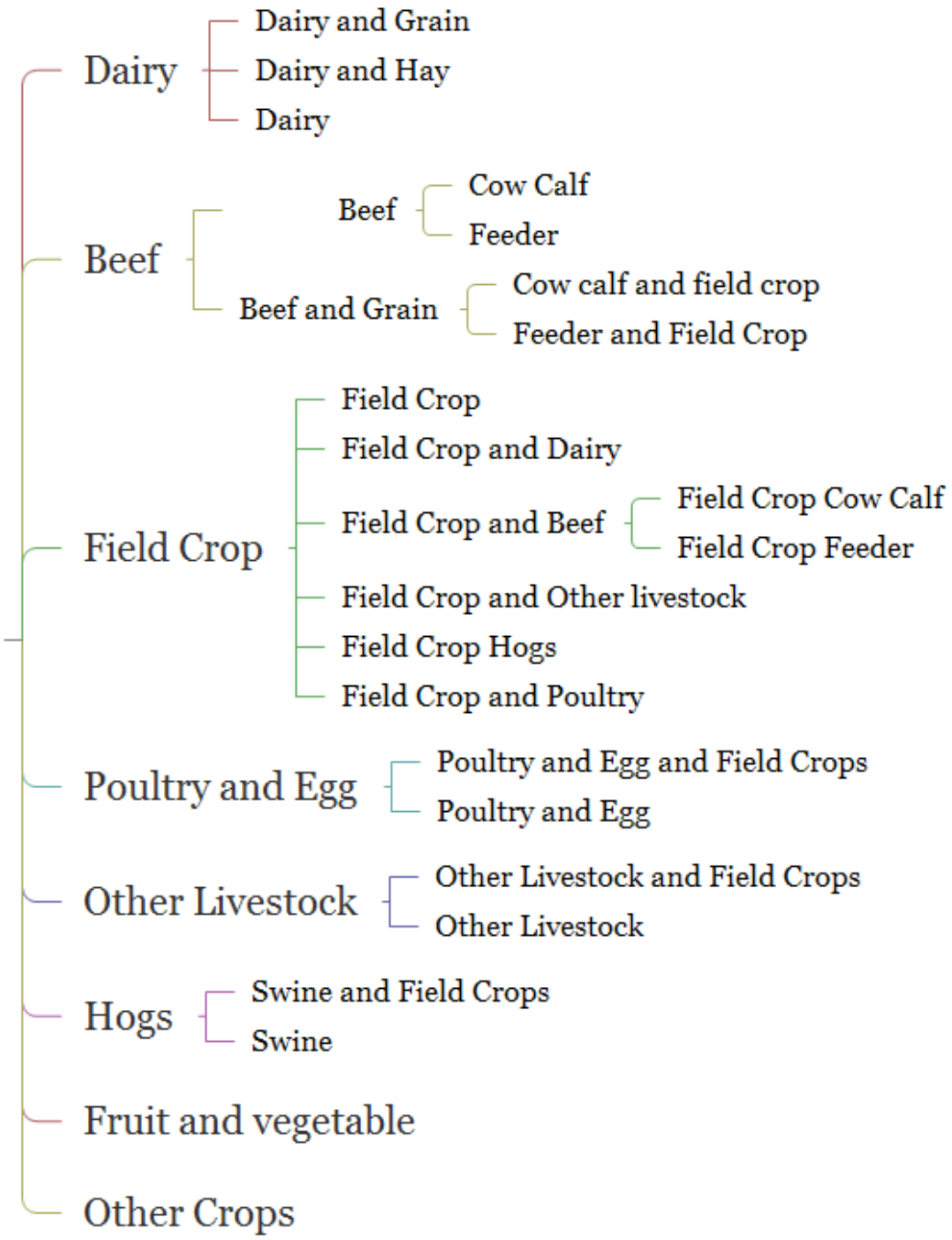
- 2844 farms of 22 farm types
  - Based on census of agriculture statistics
  - Spatially distributed on the landscape
    - Average farm size, not their real locations
- Weather and farming operations follow a daily time step.
  - Maximum and minimum temperature and precipitation.
- Crop development – Phenotypical growth curves.

Envision Eastern Ontario Model

- Two data classes, Field and farm
  - Fields = Integrated Decision Units (IDU)
    - AAFC Crop cover (2011)
    - Grouped in legal survey (cadastre) polygons
  - Farms = Collection of cadastre polygons



Farm Types


Dairy
Dairy and Grain
Dairy and Hay
Dairy
Beef
Beef
Cow Calf
Feeder
Beef and Grain
Cow calf and field crop
Feeder and Field Crop
Field Crop
Field Crop
Field Crop and Dairy
Field Crop and Beef
Field Crop Cow Calf
Field Crop Feeder
Field Crop and Other livestock
Field Crop Hogs
Field Crop and Poultry
Poultry and Egg
Poultry and Egg and Field Crops
Poultry and Egg
Other Livestock
Other Livestock and Field Crops
Other Livestock
Hogs
Swine and Field Crops
Swine
Fruit and vegetable
Other Crops

Separating classes

Total Field Crop (FC) Farms	725	
FC farms reporting Dairy Cows	29	29 Field Crop Dairy Farms
FC farms reporting Hogs (Sows + Weiner + Grower)	7	7 Field Crop Hog

Total Hog Farms	8	
Hog farms reporting field crops	2	2 Hog Farms with Field Crops
Hog farms without field crop	6	6 Hog only farms

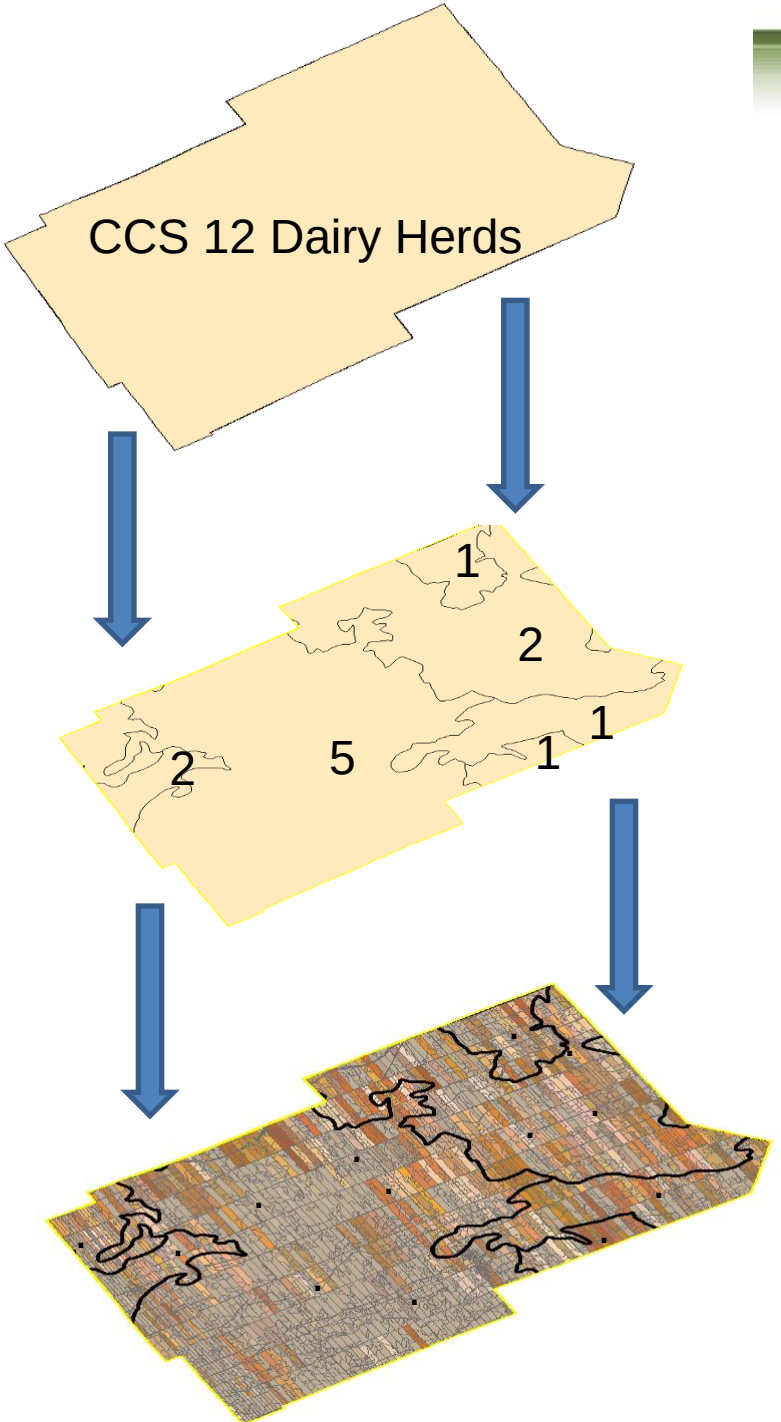
CCS - Consolidated Census Subdivision

Farm Types

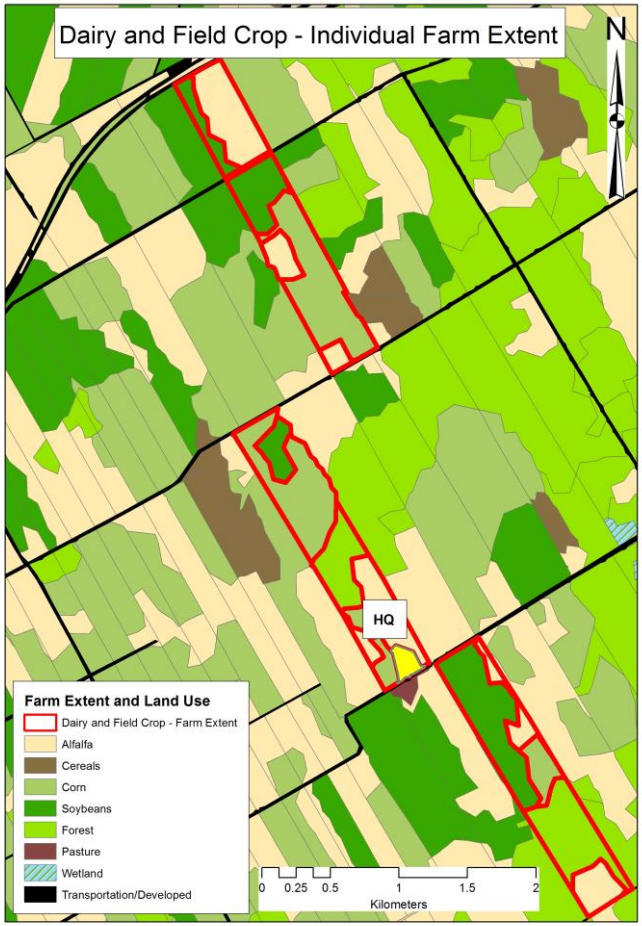
Ag Census SLC Regions

Derived from Soil Landscapes of Canada

IDU - Integrated Decision Unit

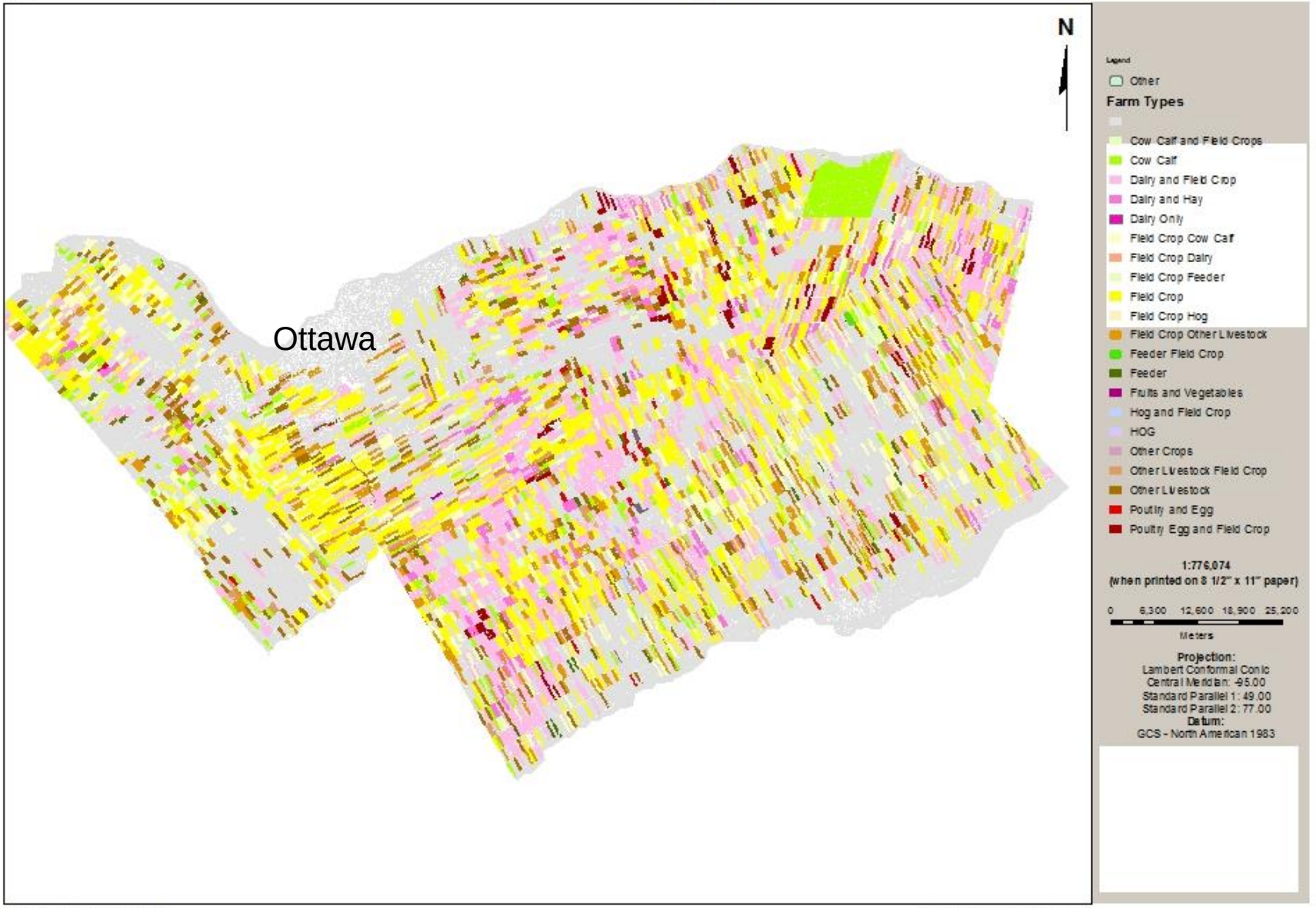


Individual Farm



Eastern Ontario Farm Types

Census of Ag 2011



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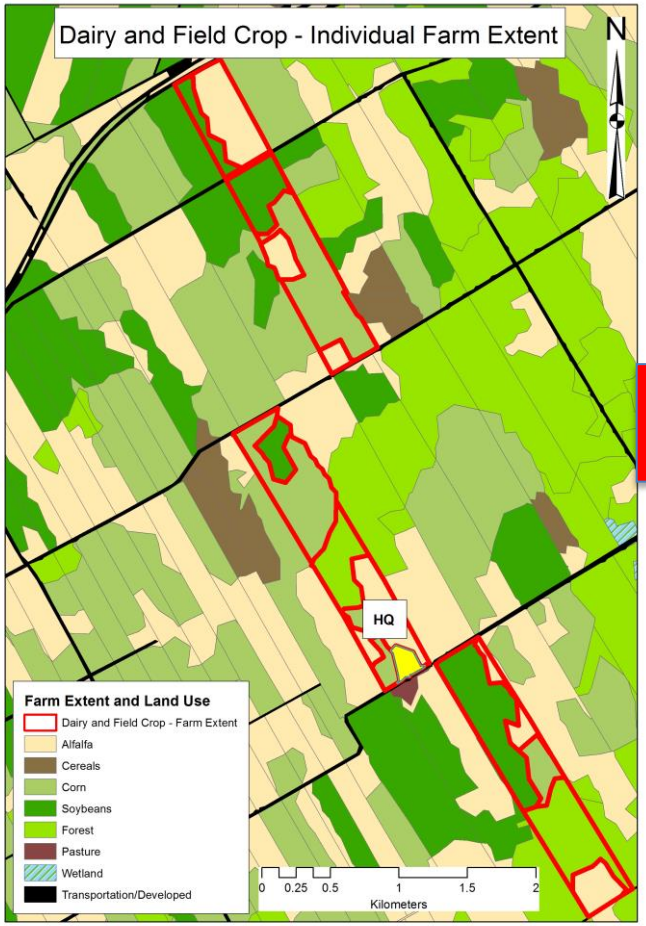
Agri-Environment Services Branch, Agri-Geomatics

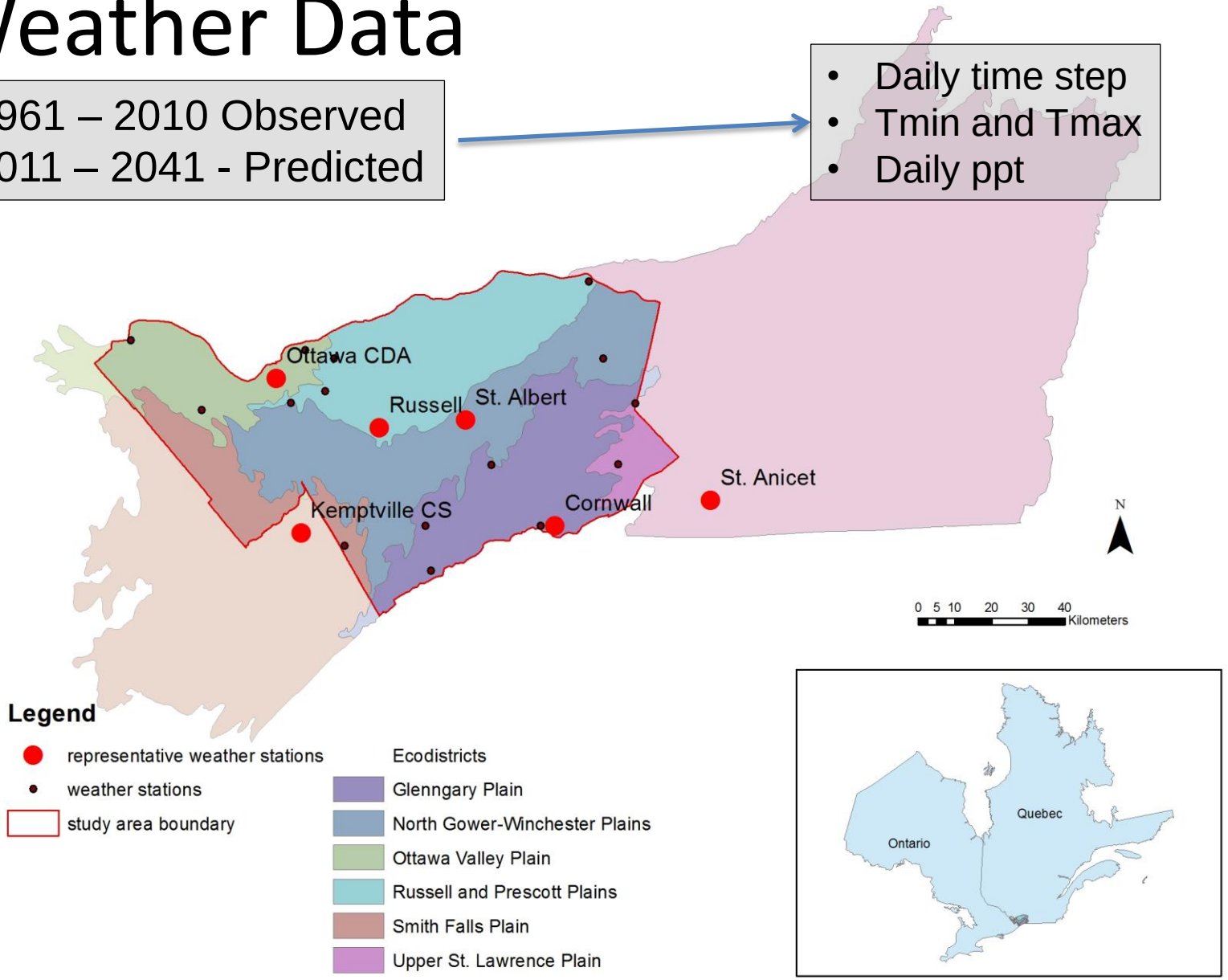
Farm Operations



Weather Data

- 1961 – 2010 Observed
- 2011 – 2041 - Predicted

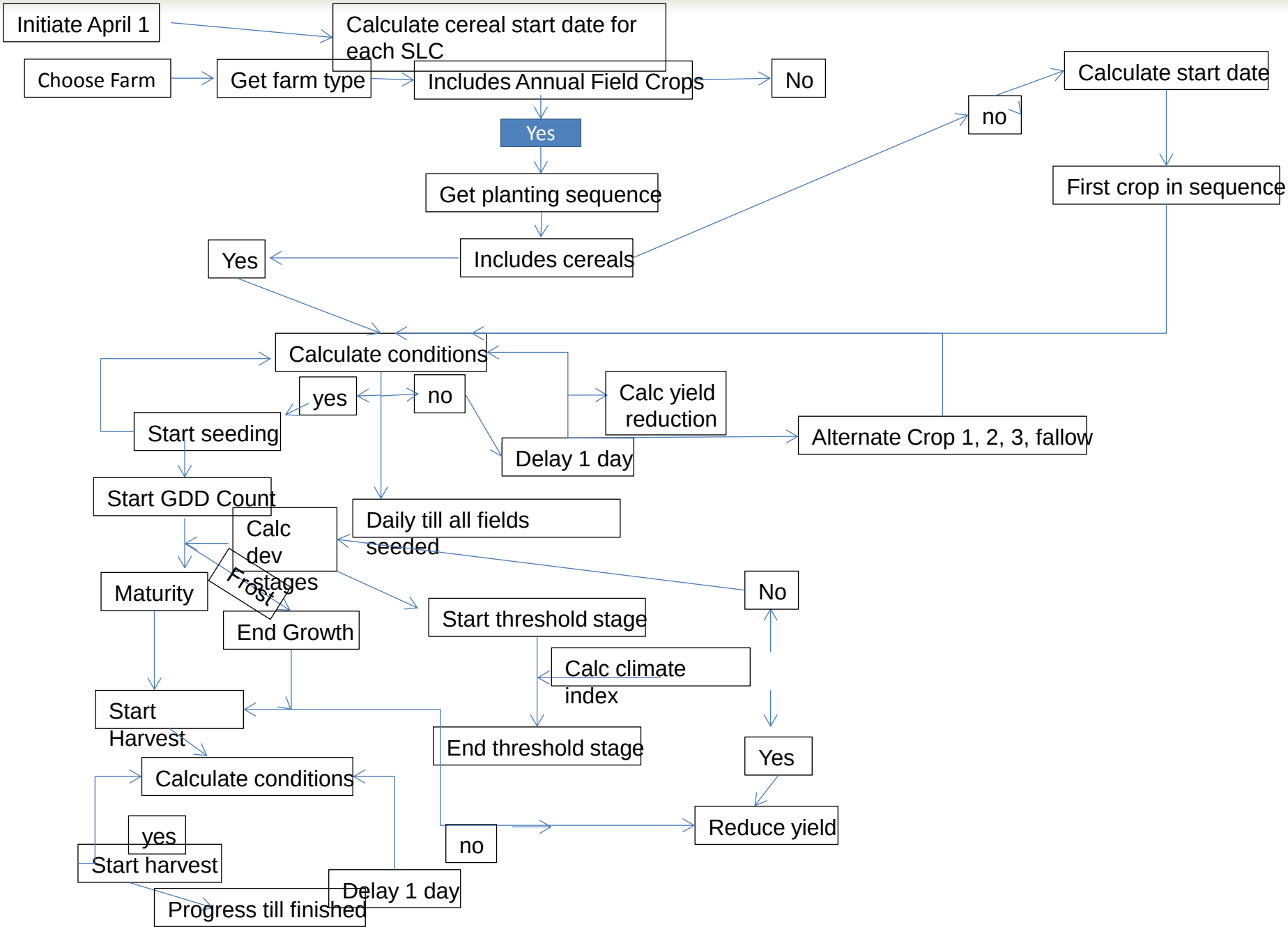
- Daily time step
- Tmin and Tmax
- Daily ppt

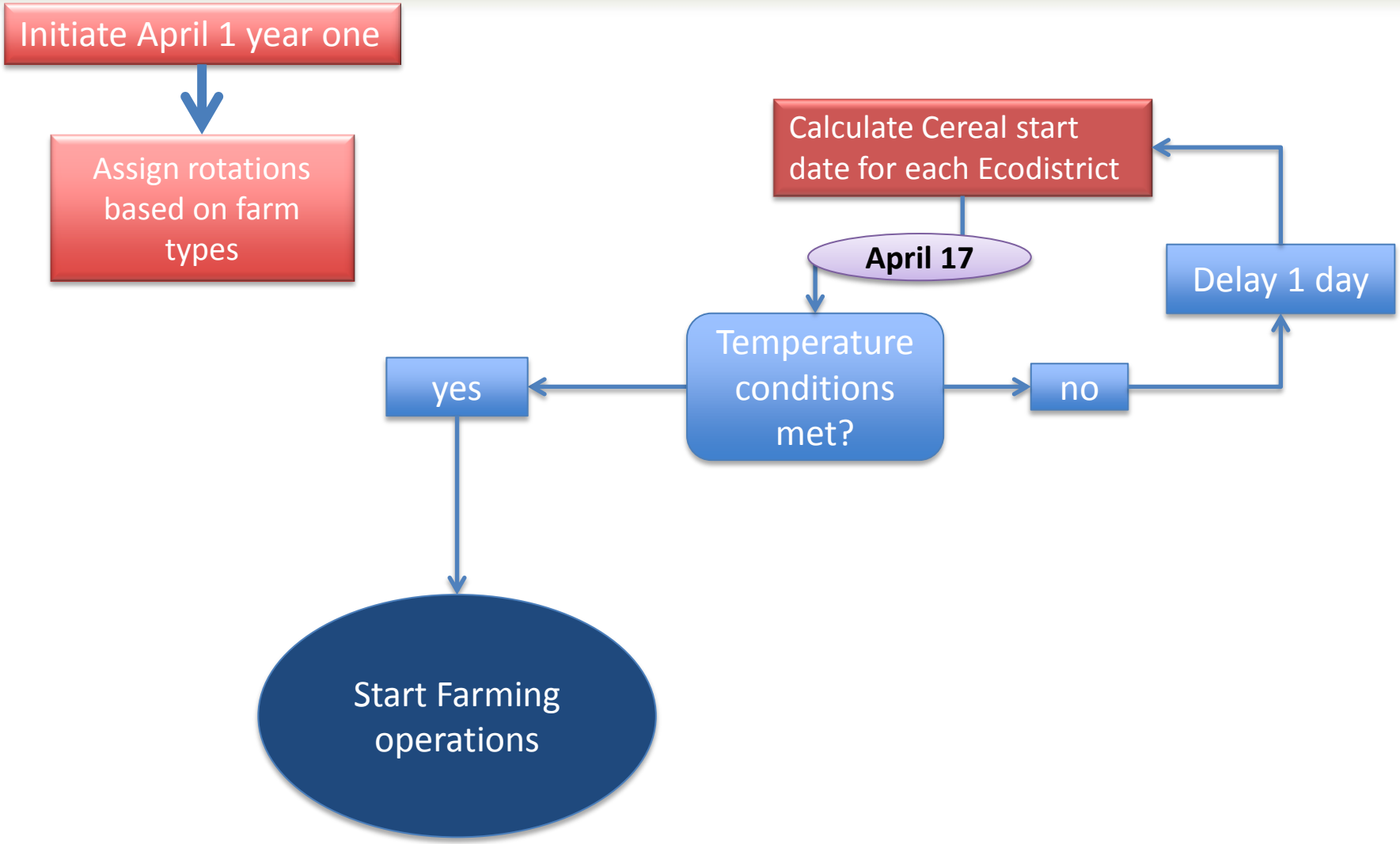


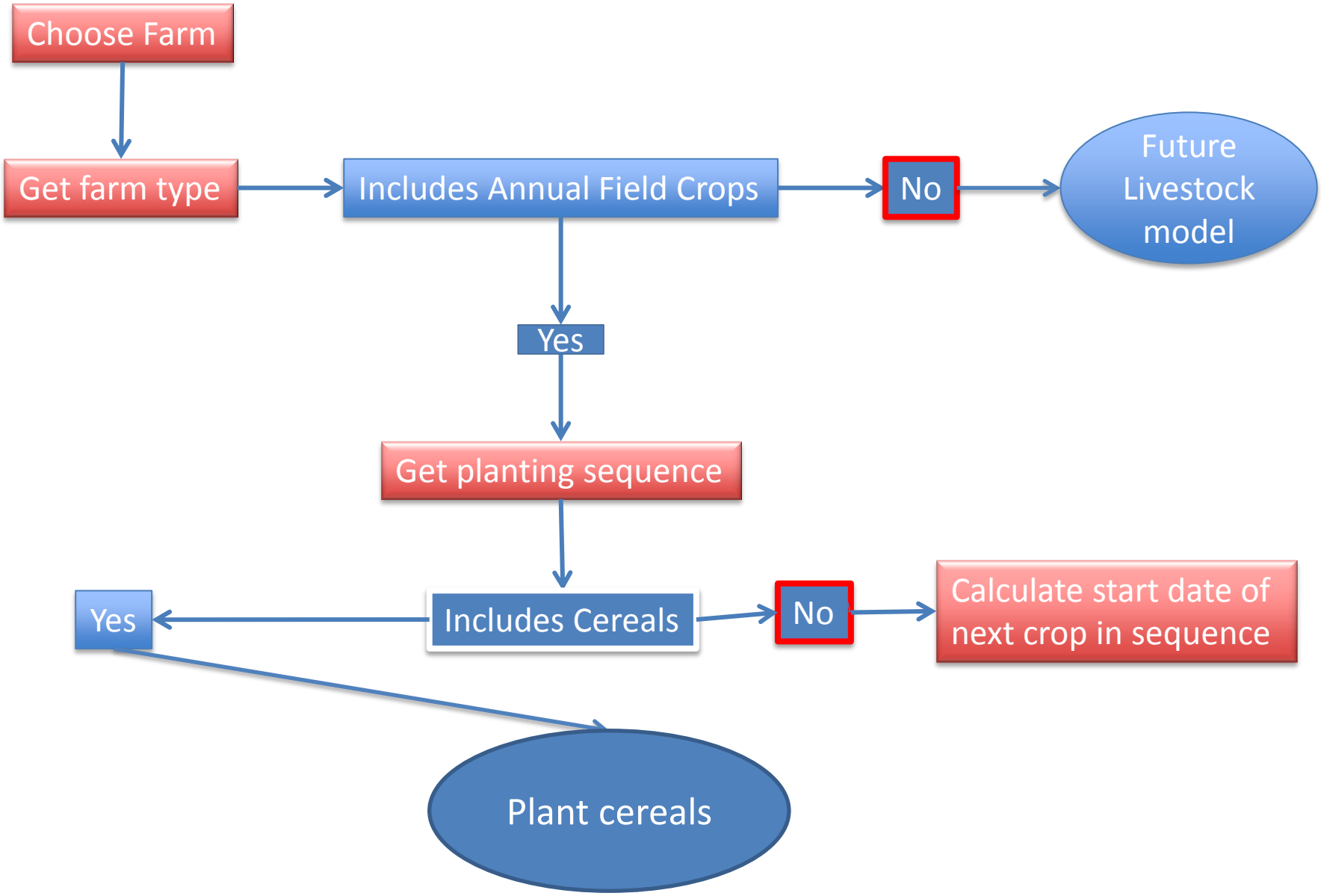
		Dairy and Field Crop				
		Business as Usual	Cool and Wet	Cool and Dry	Warm and Wet	Warm and Dry
April	Week 5					
	Week 6		delay	cereals go in	same as cold and wet for all situations	same as normal year.
	Week 7	April 17	delay			
	Week 8		delay switch corn			
May	Week 9	1. Corn starts May 1 2. alfalfa seeded under seeded to an annual forage crop (cereal).	delay until conditions improve	delay		
	Week 10		delay	corn starts		
	Week 11	soy - may 10	delay			
	Week 12		delay	soy delay		
	Week 13		If corn not seeded May 24 cornacres switch to soy			

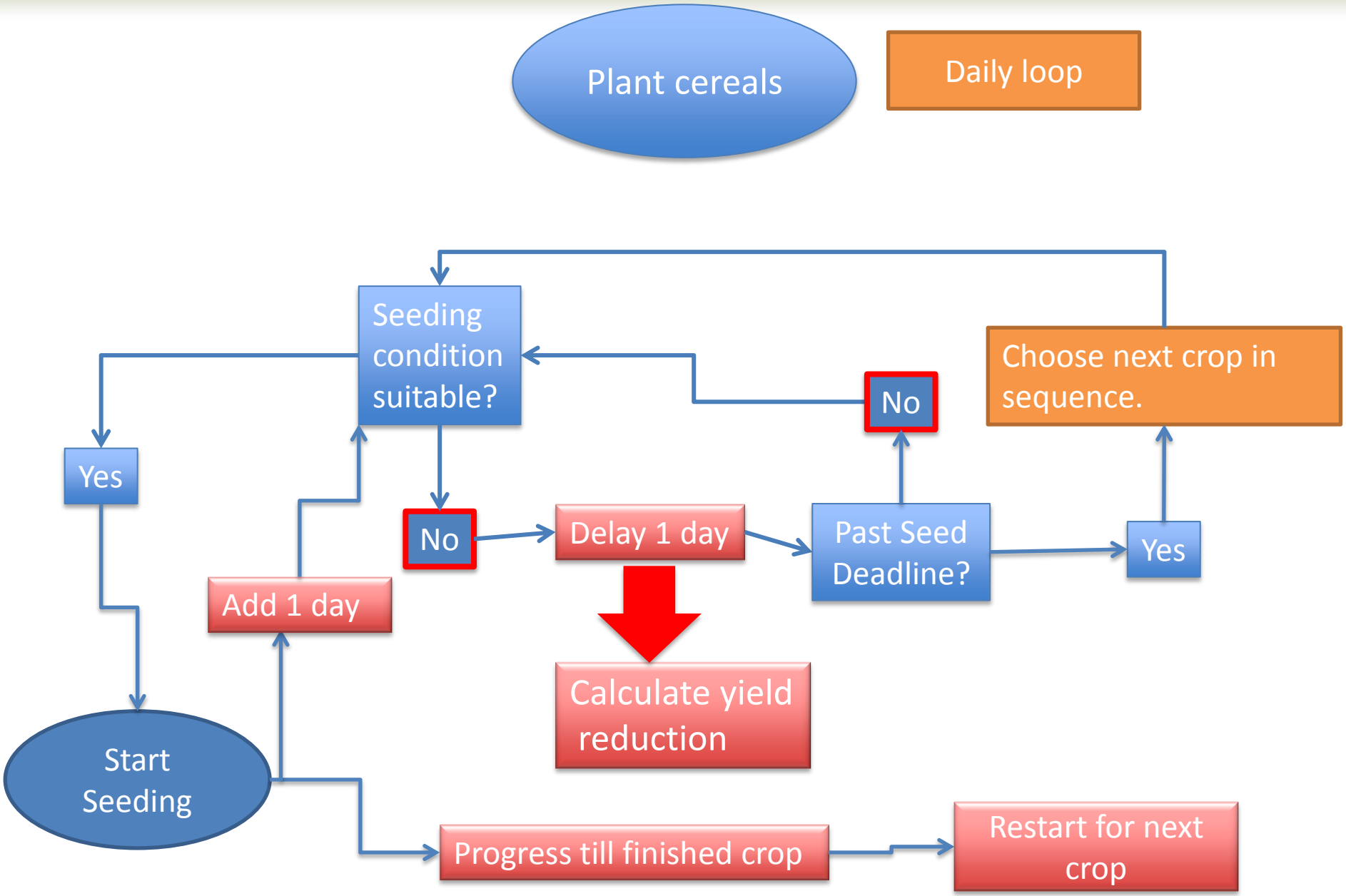
Crop Rotations

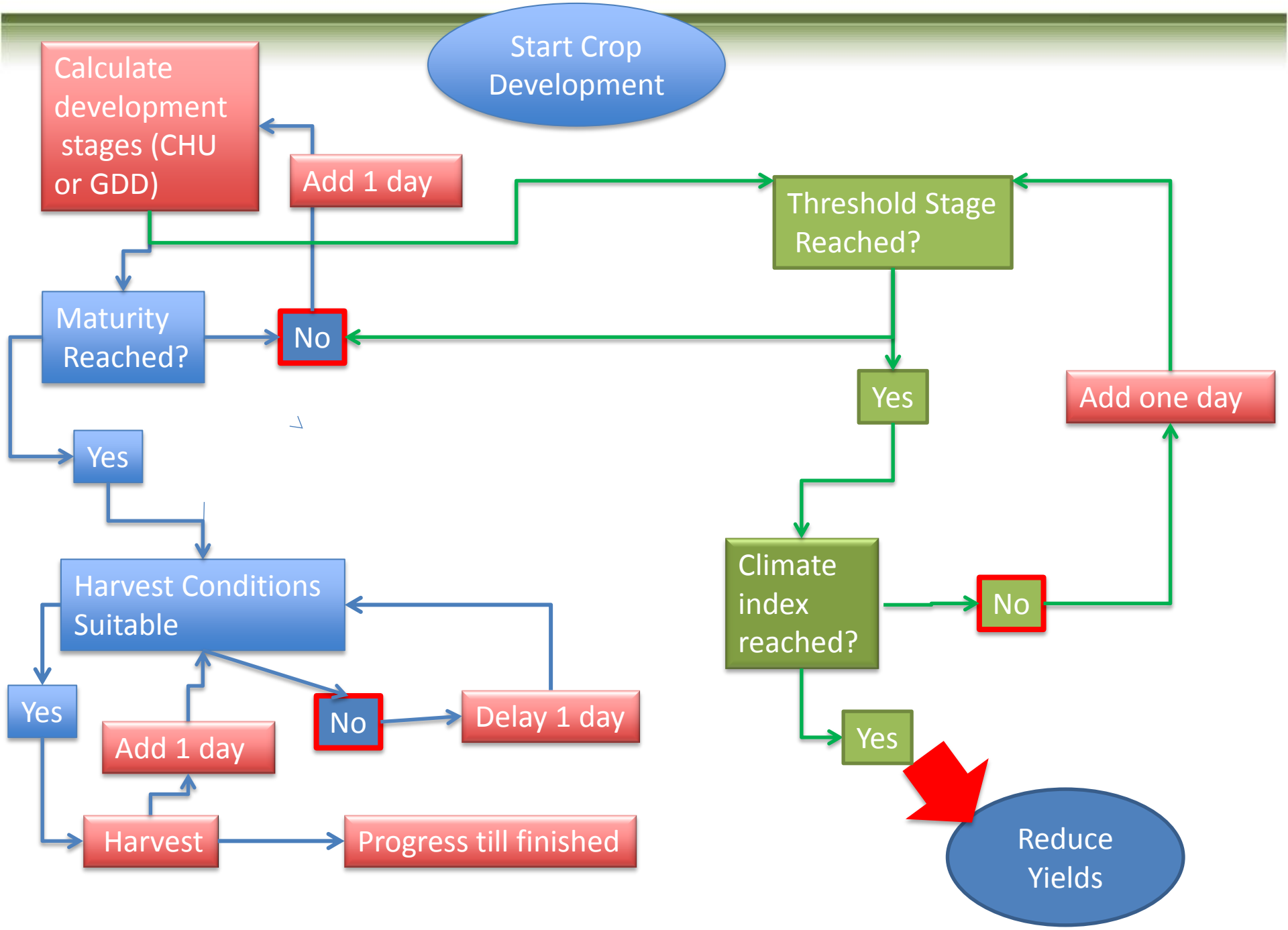
- Generalized crop rotations
  - Corn – Soy – Cereal
  - Corn – Soy – Corn – Soy – Cereal
    - Field Crop Only farms
    - Field crop and confined livestock (poultry and hog)
  - Corn – Soy – Cereal – Alfalfa – Alfalfa – Alfalfa
  - Corn – Soy – Corn - Soy – Cereal – Alfalfa – Alfalfa – Alfalfa
    - Field Crop farms with livestock (dairy or beef)


Initiate April 1
Calculate cereal start date for each SLC
Choose Farm
Get farm type
Includes Annual Field Crops
No
Yes
Get planting sequence
Includes cereals
Yes
no
Calculate start date
First crop in sequence
Calculate conditions
yes
no
Calc yield reduction
Start seeding
Delay 1 day
Alternate Crop 1, 2, 3, fallow
Start GDD Count
Daily till all fields seeded
Calc dev stages
Frost
Maturity
End Growth
No
Start threshold stage
Calc climate index
Start Harvest
End threshold stage
Yes
Calculate conditions
Reduce yield
yes
no
Start harvest
Delay 1 day
Progress till finished

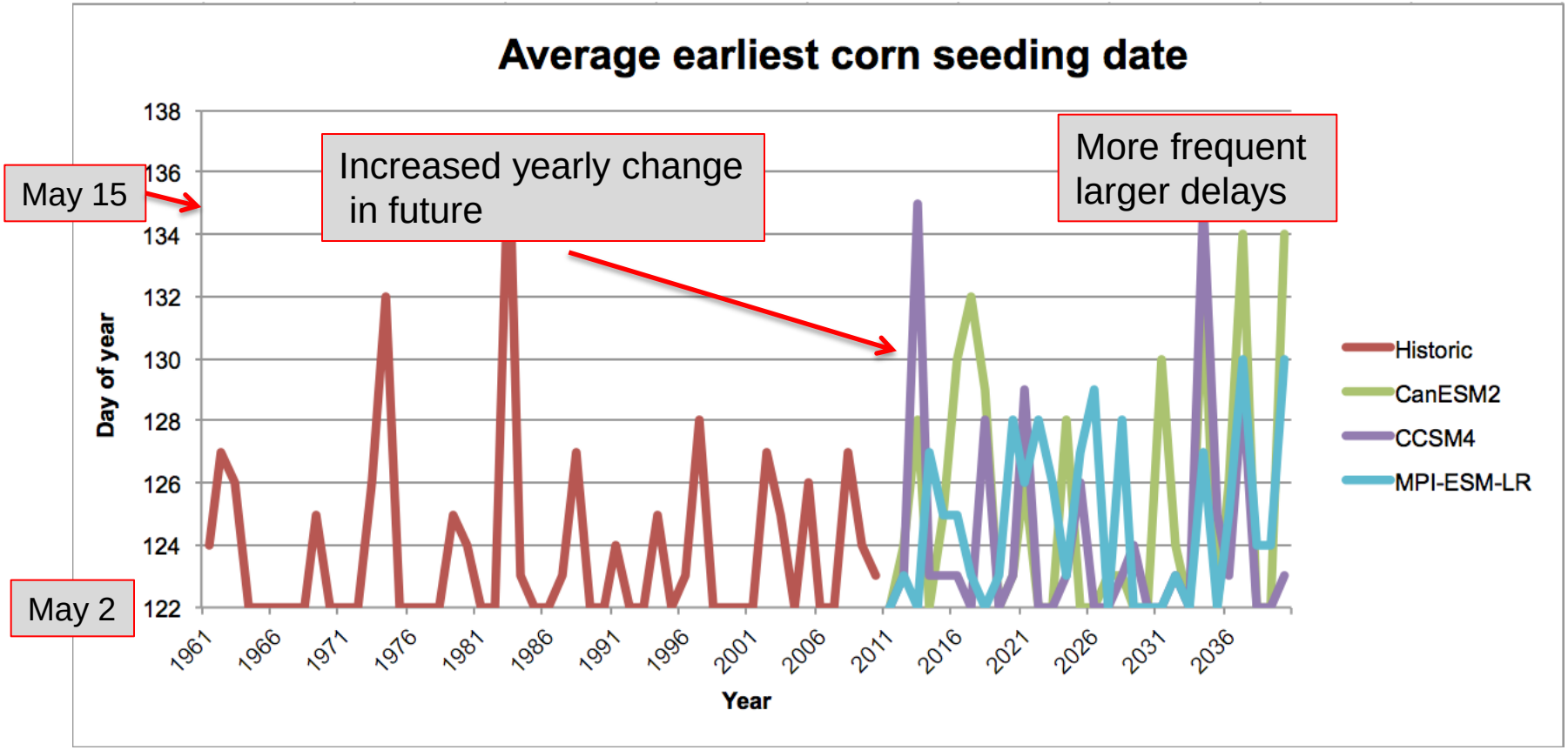

Initiate April 1 year one
Assign rotations based on farm types
Calculate Cereal start date for each Ecodistrict
April 17
Temperature conditions met?
yes
no
Delay 1 day
Start Farming operations


Choose Farm
Get farm type
Includes Annual Field Crops
No
Future Livestock model
Yes
Get planting sequence
Yes
Includes Cereals
No
Calculate start date of next crop in sequence
Plant cereals


Plant cereals
Daily loop
Seeding condition suitable?
Yes
No
Delay 1 day
Past Seed Deadline?
No
Yes
Choose next crop in sequence.
Add 1 day
Calculate yield reduction
Start Seeding
Progress till finished crop
Restart for next crop

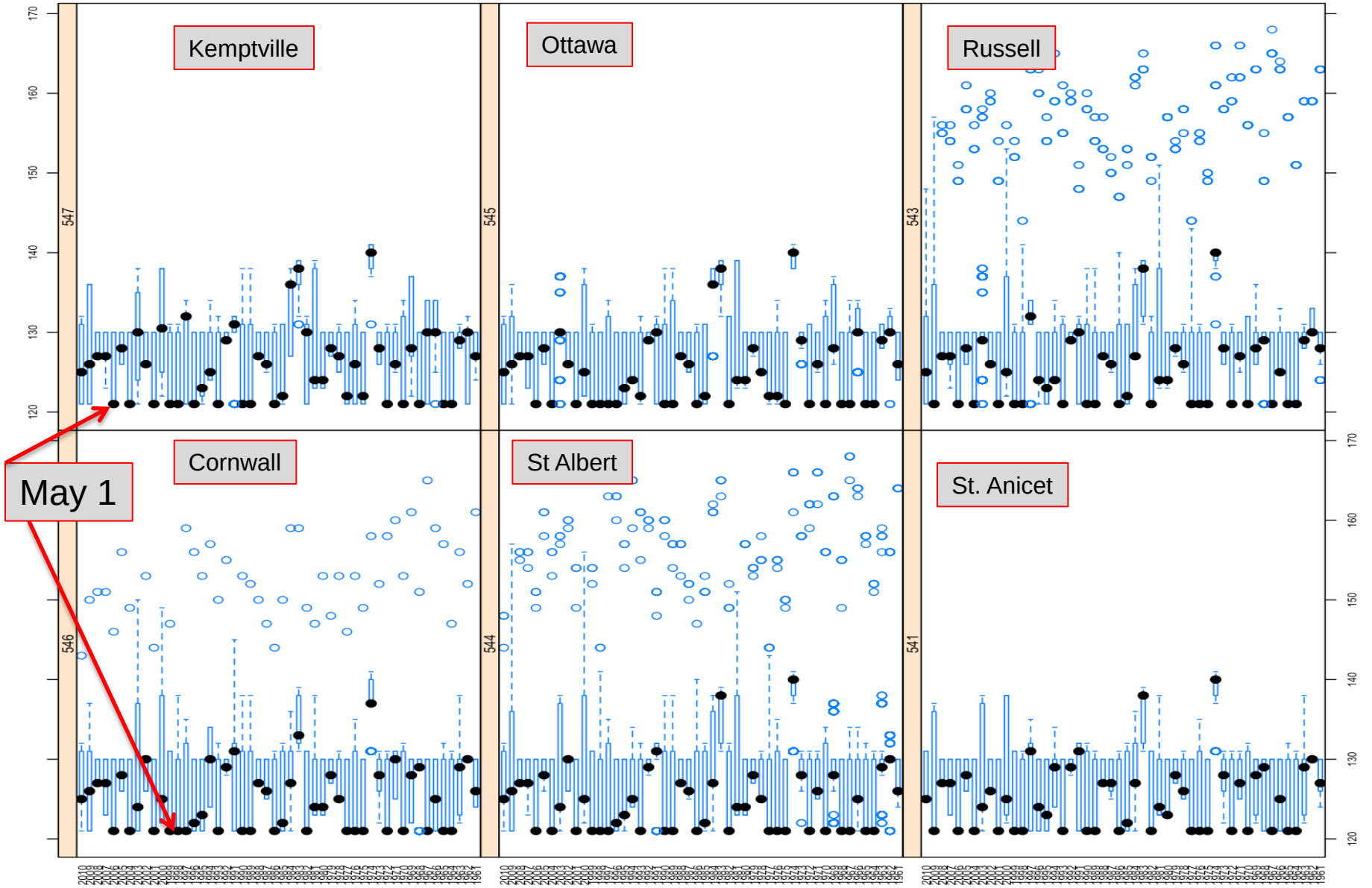

Start Crop Development
Calculate development stages (CHU or GDD)
Add 1 day
Threshold Stage Reached?
Maturity Reached?
No
Yes
Add one day
Yes
Harvest Conditions Suitable
Climate index reached?
No
Yes
No
Delay 1 day
Add 1 day
Yes
Harvest
Progress till finished
Reduce Yields

Weather Impacts – Seeding Date

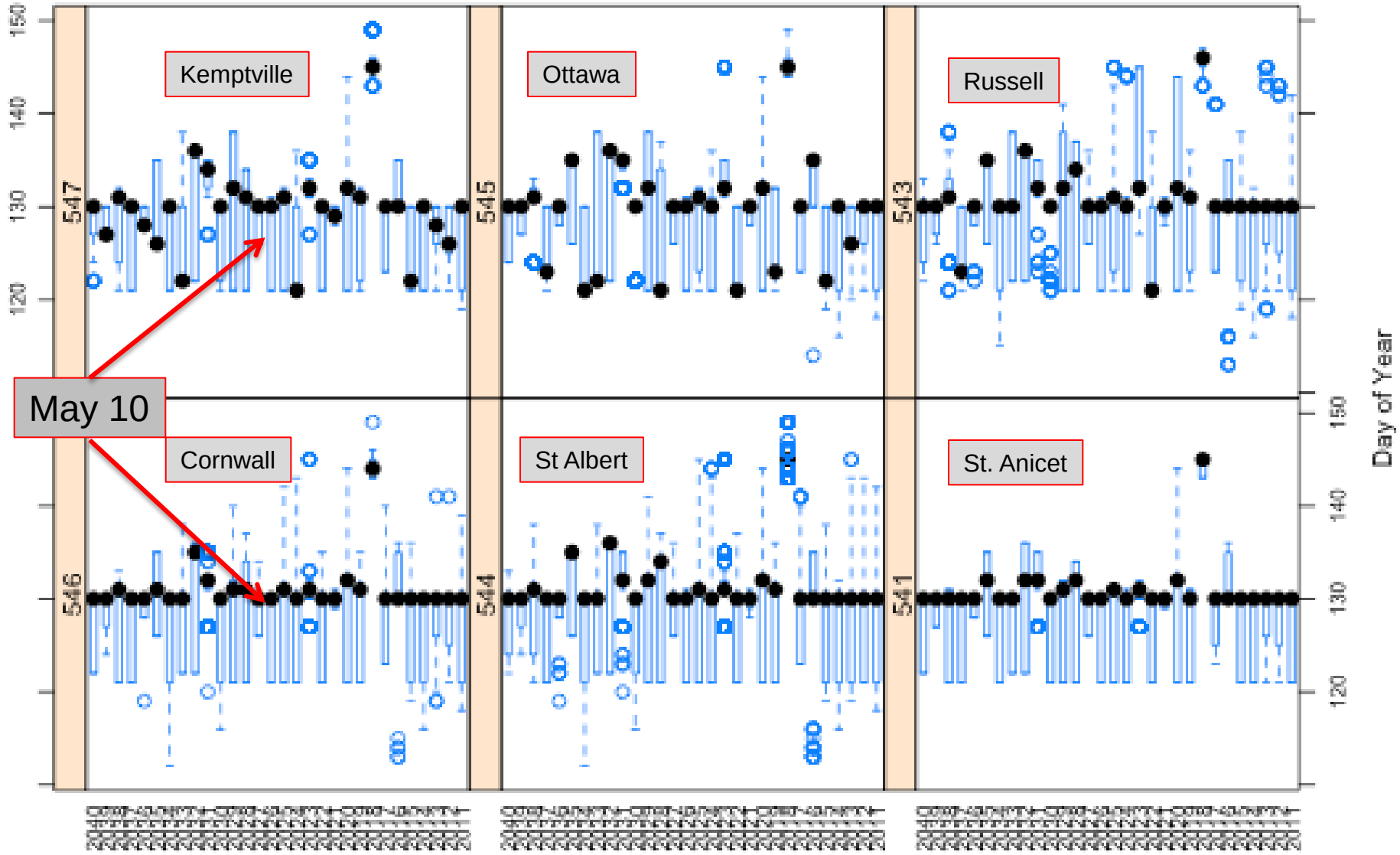


30% increase in 7 day ppt over 30 year average = delay 1 day

Average Planting date - historic



Average Planting date - CCSM



Questions, comments?

Dan MacDonald

AAFC, Ottawa

Dan.macdonald@agr.gc.ca