Agriculture et Agroalimentaire Canada | Agriculture and Agri-Food Canada

# Meta-Analyses on an Eastern Canada Database of in-Season Corn Nitrogen Response Trials

**Nicolas Tremblay, agr., Ph.D., Research Scientist**

**Crop Nutrition and Management Team**

**St-Jean-sur-Richelieu**

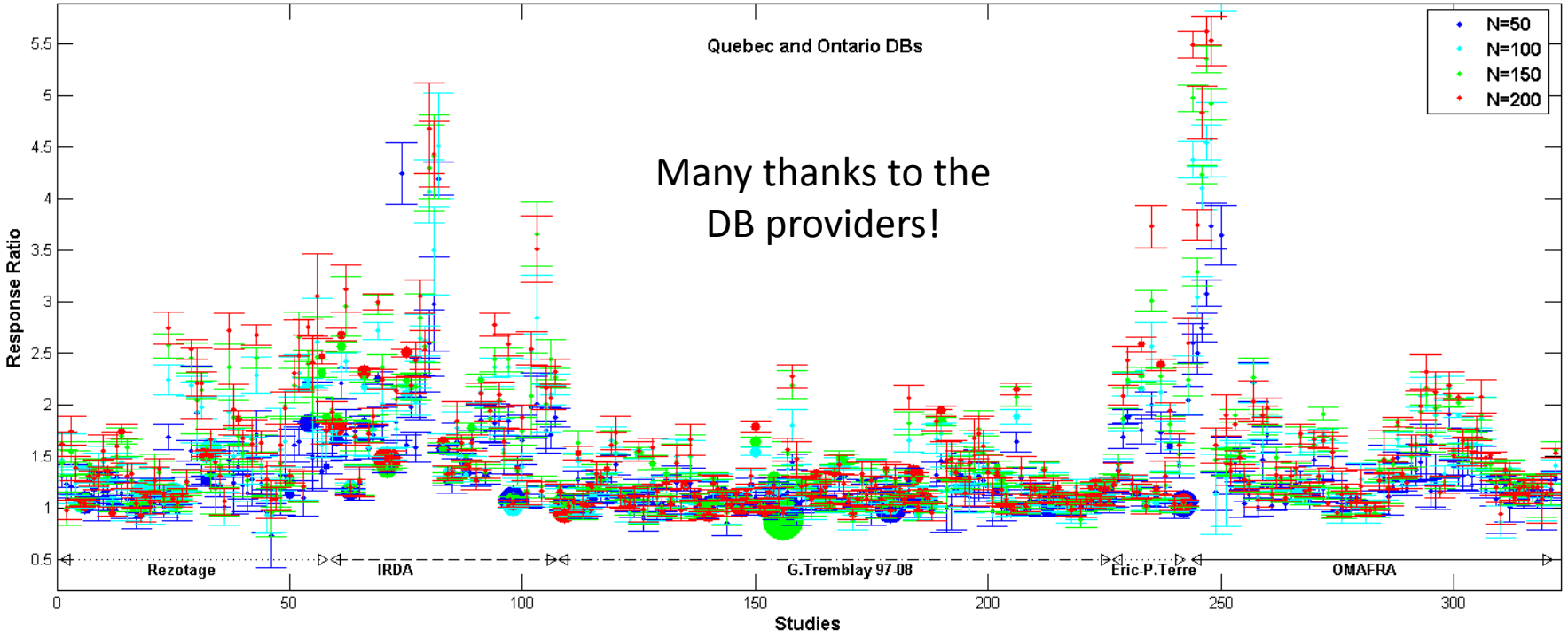
Canada

# Reducing Application Rates as a Priority Policy Goal

- "Corn is the most intensive user of nitrogen fertilizer, on a per acre basis and in total use. Fertilizer applied to corn is least likely to be applied in accordance with all three BMPs (rate, timing, method)."
- "Reducing the application of nitrogen fertilizers appears to be the **most effective BMP for reducing the emission of nitrogen into the environment**. … reducing application rates is the one BMP that reduces all forms of reactive nitrogen, even when the timing and method of application are not ideal."

Ribaudo, Marc, Jorge Delgado, LeRoy Hansen, Michael Livingston, Roberto Mosheim, and James Williamson. Nitrogen In Agricultural Systems: Implications For Conservation Policy. ERR-127. U.S. Dept. of Agriculture, Econ. Res. Serv. September 2011.

# New Quebec – Ontario Corn DB
# 322 sidedressed N rate studies assembled




Quebec: 242 site-years

Ontario: 80 site-years

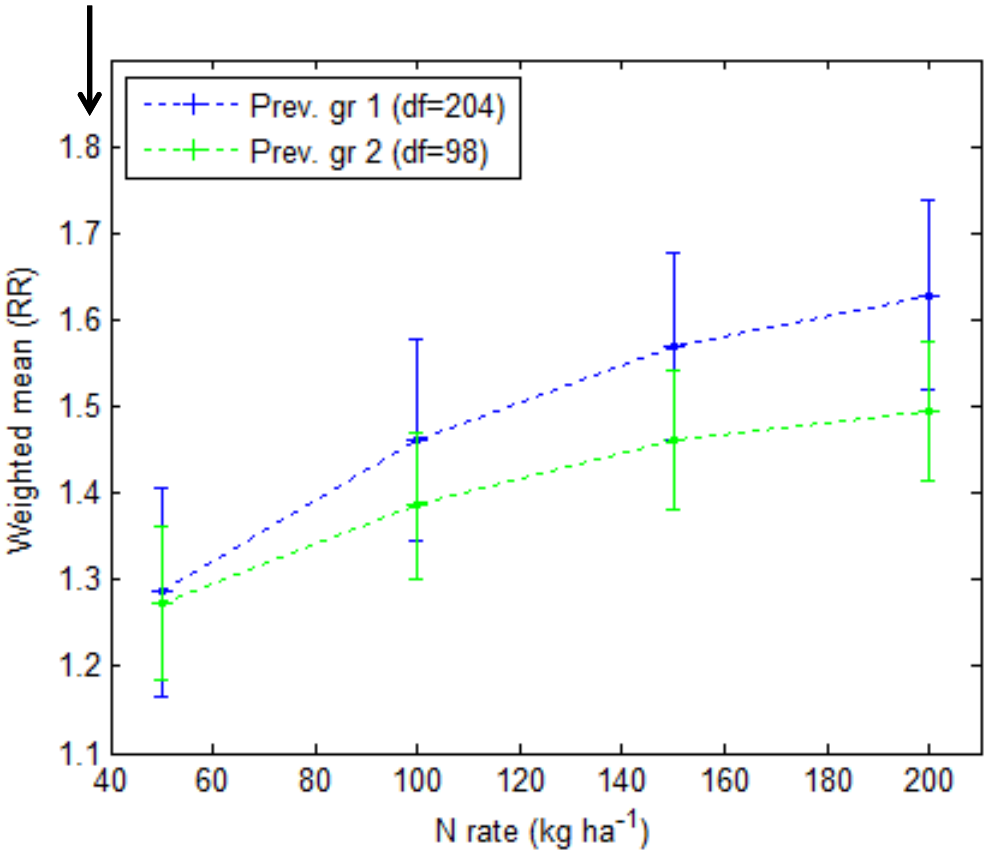
(Linear interpolation when needed to match the selected rates)

Note: SOM excluded because not available in Ontario

# Responses to N rates depending on **previous crop** groups

Control (no side-dressed N) rates 1 on this scale

- **Prev. gr 1**
  - (low N contribution)
  - Corn, wheat, barley, other cereals, potato
- **Prev. gr 2**
  - (high N contribution)
  - Soybean, bean, pea, prairie, green manure, alfalfa, others

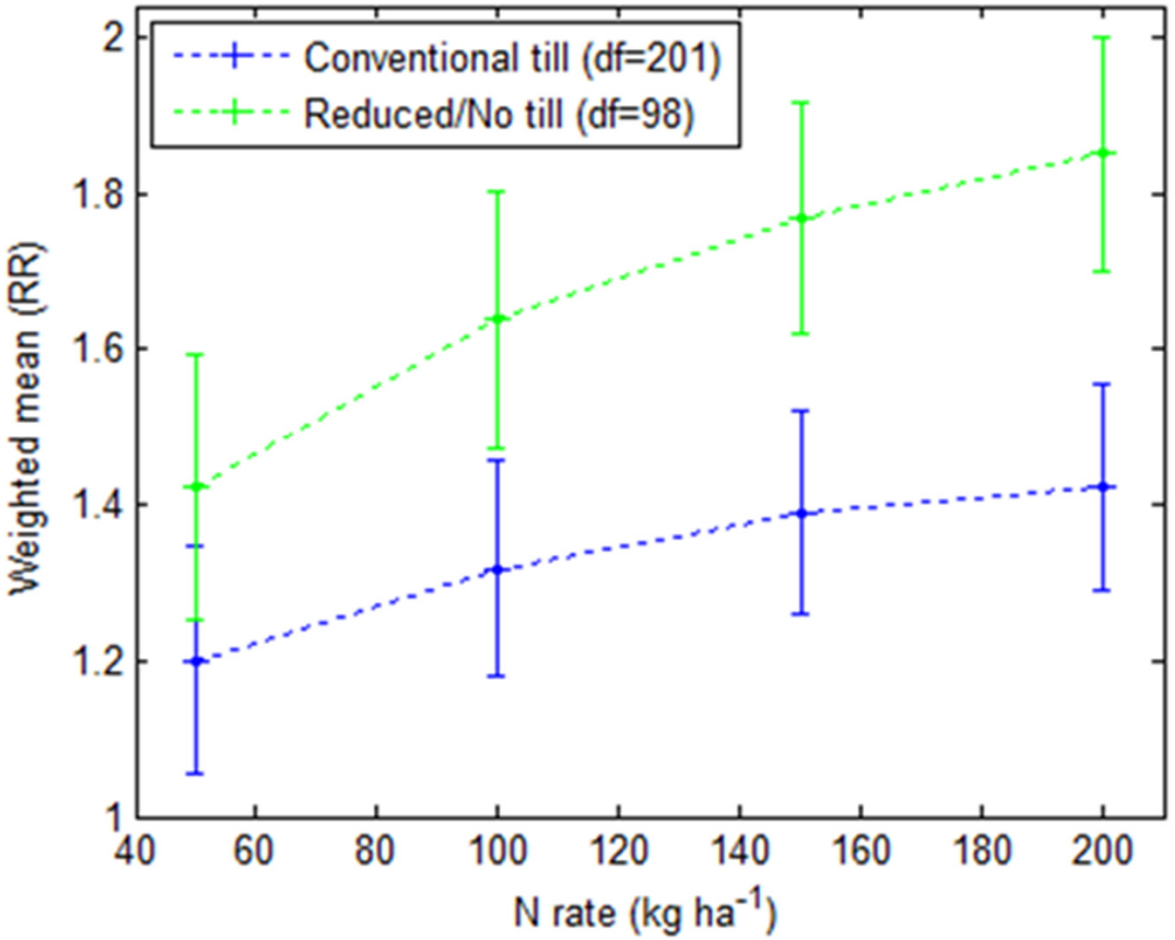



Quebec – Ontario Corn DB

# Responses to N rates depending on **tillage systems** groups

**Conventional till**
- Moldboard plow

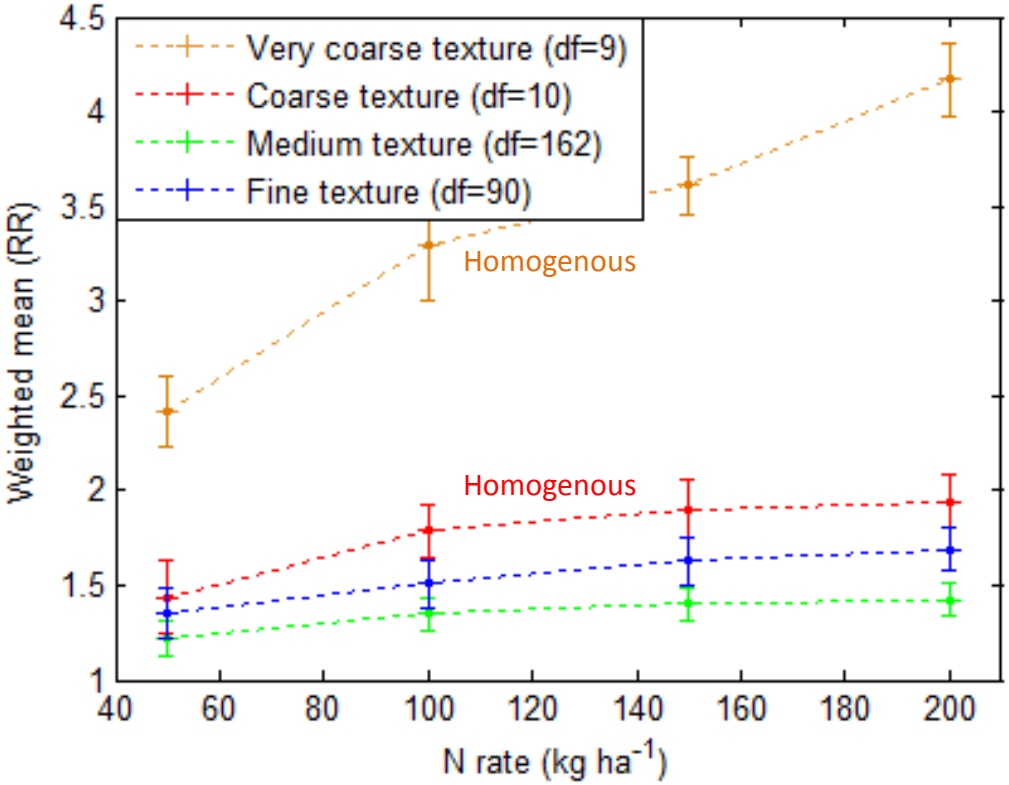
**Reduced/No till**
- Direct sowing
- Reduced tillage
- No till




Quebec – Ontario Corn DB

# Responses to N rates depending on **soil surface textural** groups

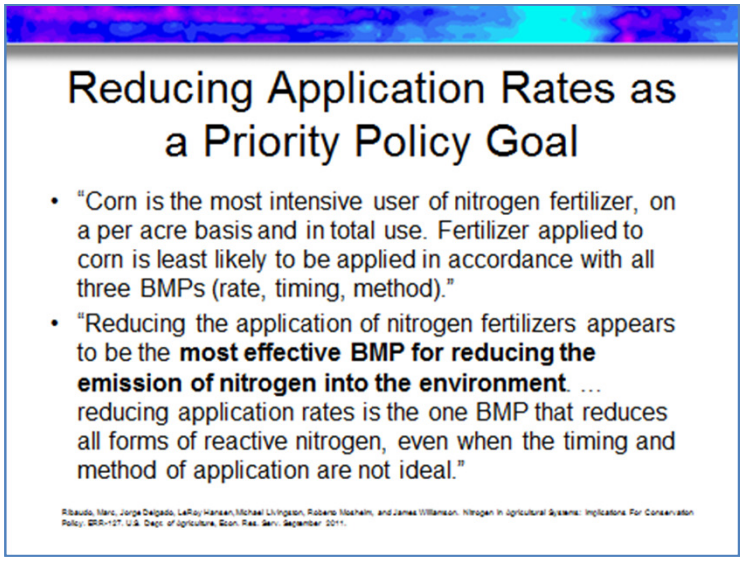
- **Fine**: heavy clay, clay, loamy clay, sandy clay, and clay loam
- **Medium** : Silt loam, loam, clay loam, sandy-clay loam, sandy loam, stony loam, silt loam, silt-clay loam, fine sandy loam
- **Coarse** : Fine sand, fine and loamy sand, loamy sand
- **Very coarse** : Sand




Quebec – Ontario Corn DB

# Meta-analysis for N

- Quantified relationships applicable to known conditions
- Derived over large datasets; no publication bias
- Ready for implementation in a decision-support system

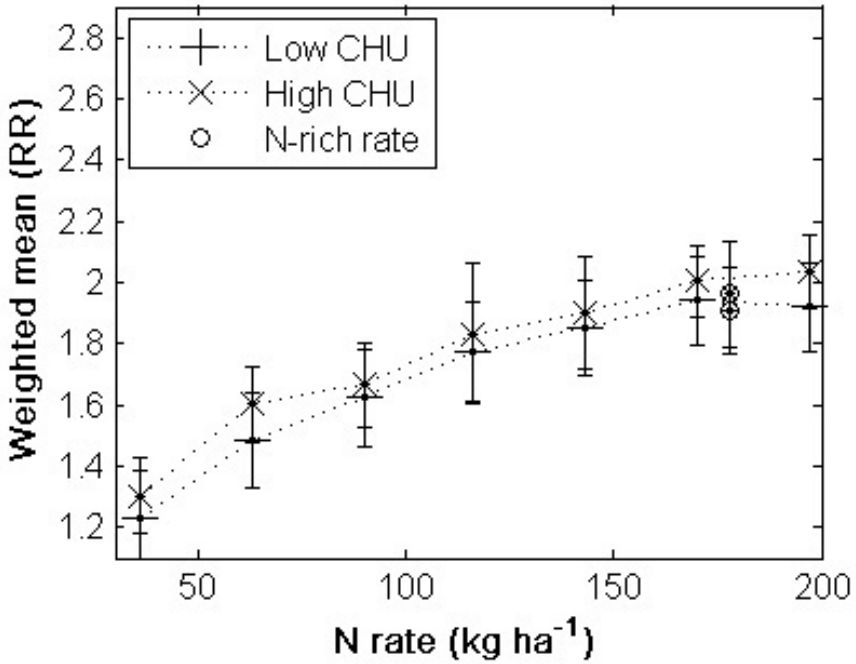


# Do farmers waste fertilizer?

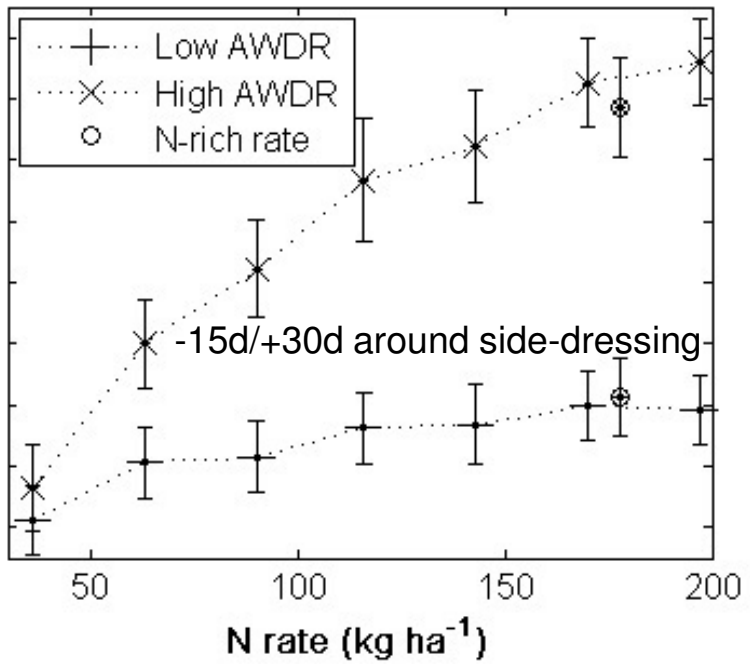
- Yes: excess fertilizer N in corn = 24 to 36%
  - Babcock (1992)
- But why, after all the studies conducted on N effects (SOM, previous crops, tillage systems, soil texture) in the literature?
- “The decision to apply more than average to take advantage of good years is appropriate...”
  - Uncertainty about the season
  - Rajsic and Weersink (2008)
- What is a season characterized by?
  - Temperature (corn heat units)
  - Rainfall

# Rain, not temperature, determines N effect on yield

Corn **Heat** Units (CHU)

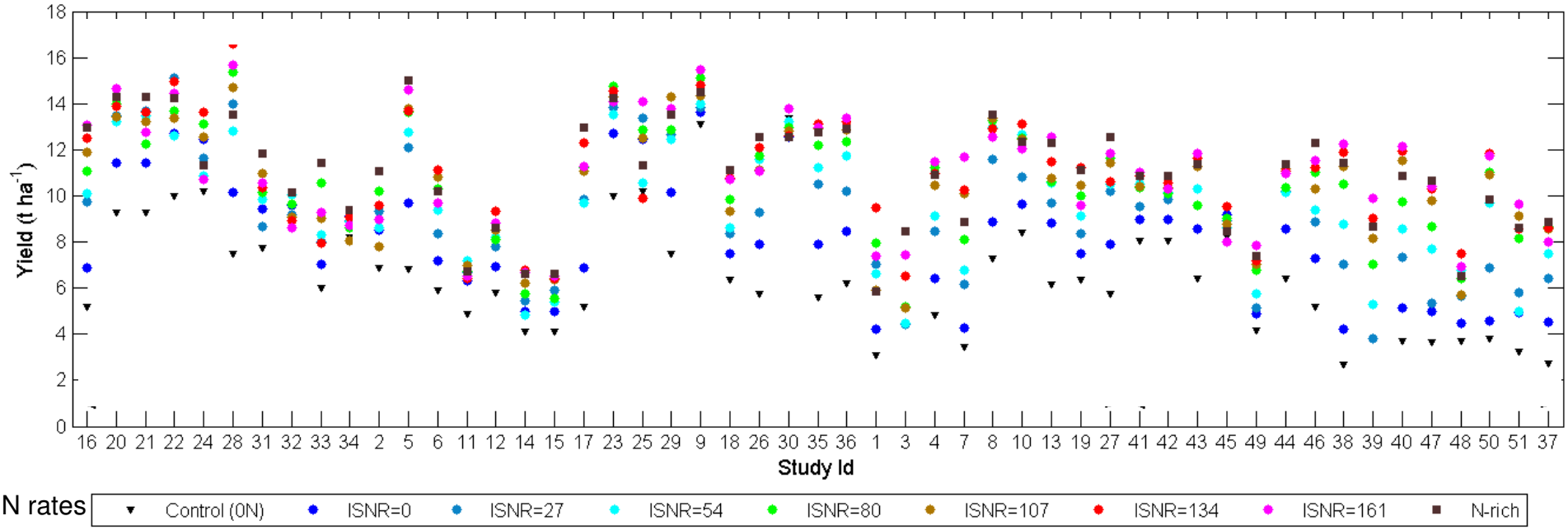



Abundant and Well-Distributed **Rainfall** (AWDR) = PPT * SDI



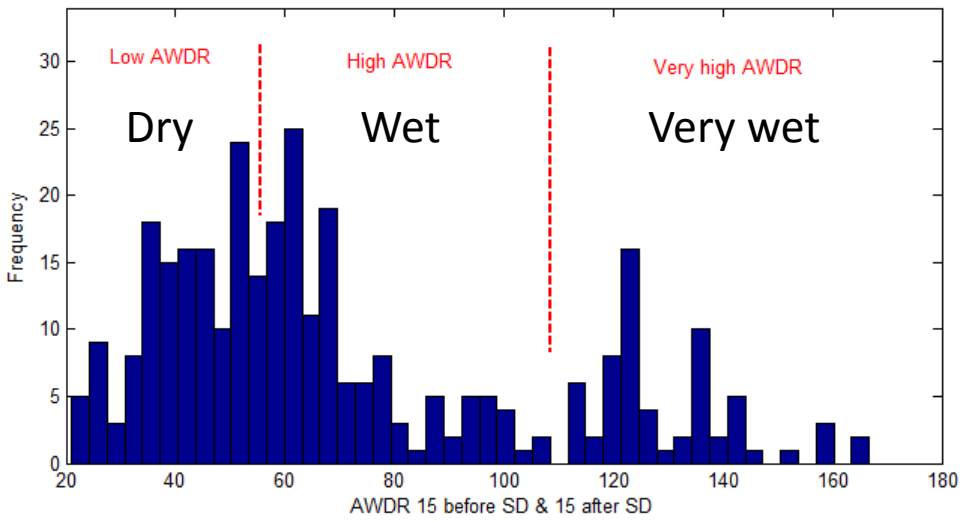

Tremblay et al. (2012). Agron. J. 104: 1658-1671

# Yield vs N rates across N.-A.

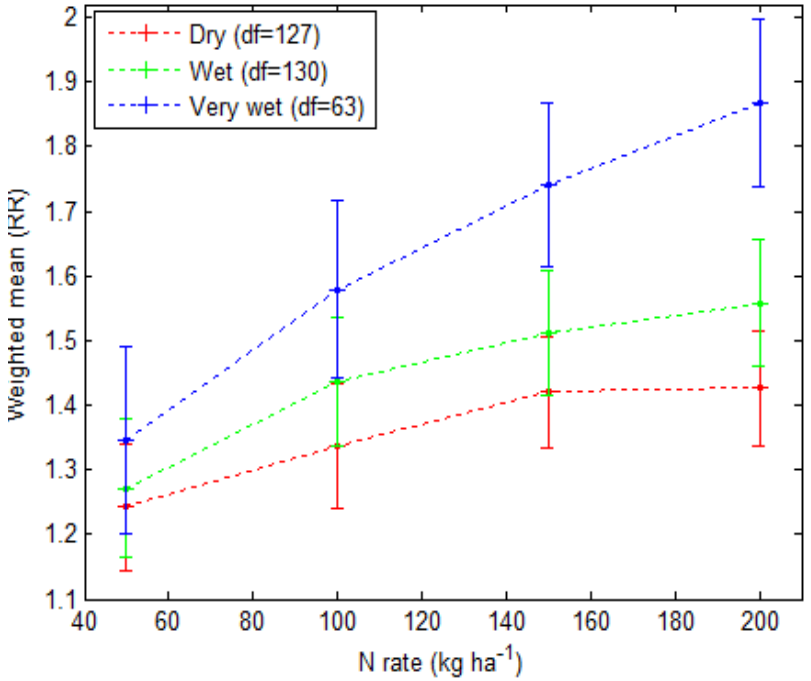



- Meta-analysis → the Soil texture * AWDR interaction is determinant for N rate effect on corn yield

# Responses to N rates depending on **AWDR** groups (Quebec–Ontario Corn DB)

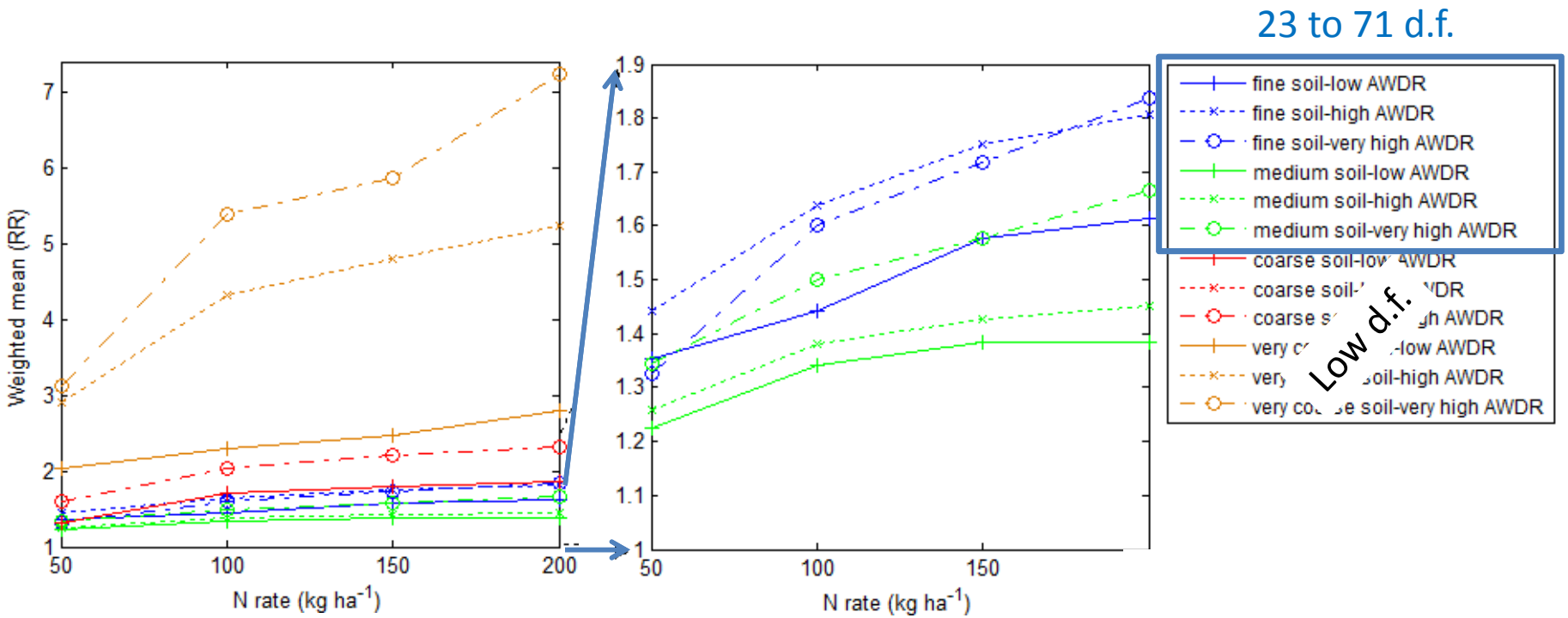



Not homogenous




AWDR in Tremblay et al. (2012): -15d/+30d
Downgraded to -15d/+15d for this Quebec-Ontario DB

# Responses to N rates depending on **texture * AWDR** subgroups



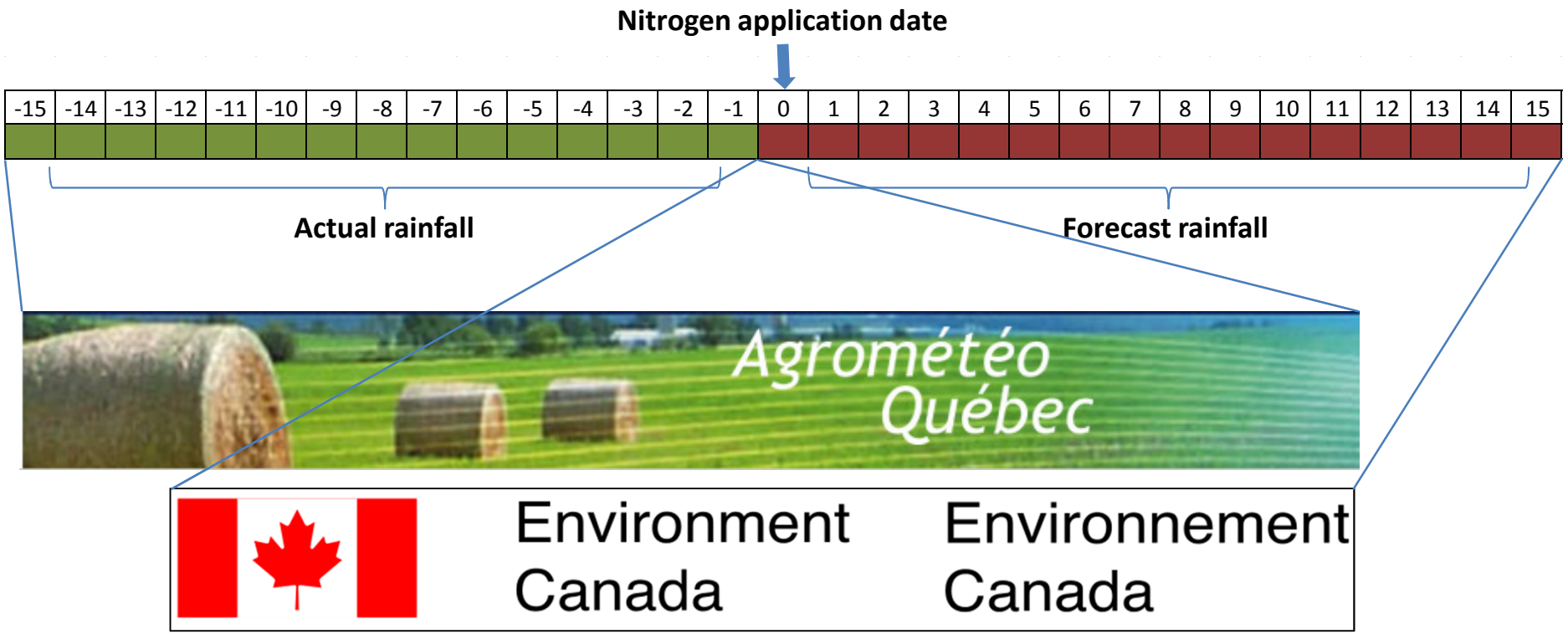

- (Fine + medium) * AWDR subgroups still not homogenous
- Not enough data to decline all « previous crops, tillage systems sub-sub-groups »

Quebec – Ontario Corn DB

# Rainfall data is a need

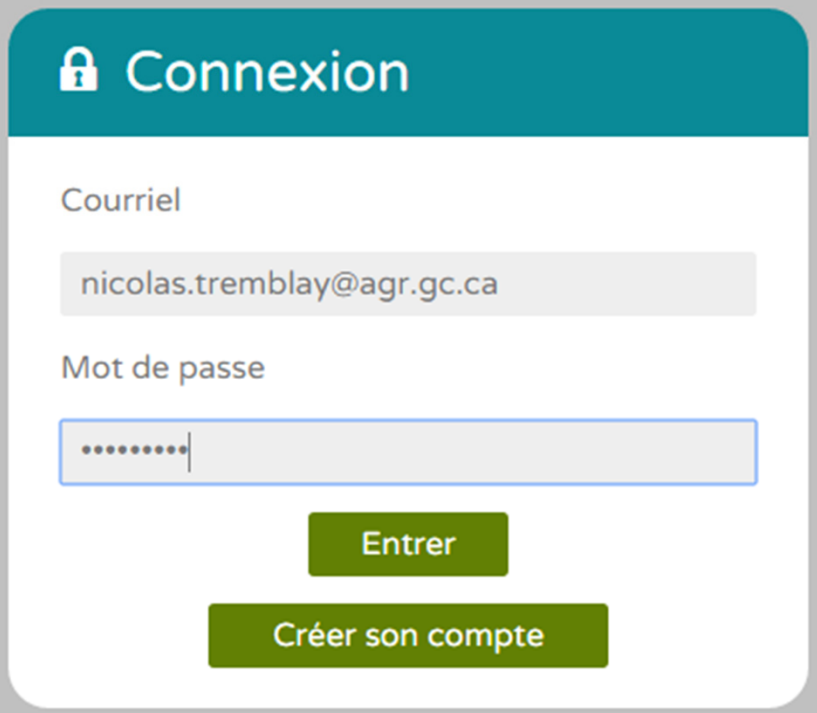
- "There is a great need to **use rainfall data to explain the results of N response trials** and integrate rainfall data into N fertilizer recommendations. Currently, **rainfall data are not considered in N fertilizer recommendations** for corn, although rainfall profoundly influences the magnitude of yield response to N fertilizer and the percentage of N loss from the soil and fertilizer"
  - Kyveryga and Blackmer (2012). Agron. J. 104: 1284-1294.
  - THE source of uncertainty that motivates « insurance rates » applications
- Cumulative + historical averages
  - Adapt-N DSS
- Stochastic
  - Dumont et al. (2015). European Journal of Agronomy 65: 10-17.
- Forecast
  - Asseng et al. (2012). European Journal of Agronomy 38: 66-73.

# Source of AWDR data in Quebec



# web YOSCAN

- Decision-support system for N sidedressing in Quebec
- Based on meta-analyses
- Fuzzy inference engine




- Tested
  - 2013 to 2015 inclusive
  - Improves N rate selection over grower's practice
    - Same yield with less N; More yield with more N
  - Gets closer to actual economically optimal rate

- Rules
  - Soil texture * AWDR; SOM; Previous crops; Tillage system
  - Adjustment for historical yield of the field

# SCAN Task Force

- Agriculture and Agri-Food Canada **Nicolas Tremblay**, lead
- **Carl Bélec**, agronomy and trials coordination
- **Edith Fallon**, instrumentation and weather data
- **Lucie Grenon**, agropedology
- **Marcel Tétreault**, field and lab work
- **Philippe Vigneault**, geomatics and remote sensing

- **René Audet**, agricultural meteorology
- **Stéphane Gariépy**, transfert coordination
- **Myriam Lafrenière-Landry**, transfert coordination and administration

- Effigis GeoSolutions (**Yacine Bouroubi** and **Julie Surprenant**)

# Meta-analyses and Big Data

## Meta-analyses of DB

- Past trials
- Metadata
- Benefits
  - Relevance (by grouping)
  - DSS opportunities outside mechanistic models
- Challenges
  - Availability of data and metadatasets (often lost)
  - Standardization
  - Interoperability
    - E.g. match soil with rain maps

## Big Data

- Sensors
- Contexts of acquisition
- Benefits
  - Relevance (by grouping)
  - DSS opportunities outside mechanistic models
- Challenges
  - Availability of data and metadatasets (private?)
  - Standardization
  - Interoperability
    - Layers don’t fit

# Research Data Alliance

- rd-alliance.org
  - Accelerate progress for global data sharing and increase data-driven innovation
- Interest Groups
  - Agriculture Data
  - Data Rescue
  - Metadata
  - Geospatial

It is a necessity to gather and analyse data and metadata from a diversity of conditions in order to derive management practices that will correspond to user's context and be adopted.

# Questions?

Nicolas.Tremblay@agr.gc.ca