The SCAN DSS for side-dressed N rate in corn

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Our Vision
Driving innovation and ingenuity to build a world leading agricultural and food economy for the benefit of all Canadians.

Our Mission
Agriculture and Agri-Food Canada provides leadership in the growth and development of a competitive, innovative and sustainable Canadian agriculture and agri-food sector.
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 (...) application rates is the one BMP that reduces all forms of reactive nitrogen, even when the timing and method of application are not ideal.”

Profits & Environment: No Conflict

Data from Quebec (Giroux et al. 2009)
Similar results for N₂O (Van Groenigen et al. 2010)
EONR vary: Rates must be personalized

Sawyer et al. 2006

Tremblay, Gilles 2015
N rate, yield and EONR

Raun et al. 2009
Adapting N to season: being done?

• “Changing nitrogen fertilizer rate, (...), is usually easy to accomplish, but in practice is not done much. Some producers will alter nitrogen rate based on the previous crop, some will modify rate from year to year based on price signals, and others may adjust nitrogen rates based on varying yield potentials between fields. However, it is common for producers to use the same nitrogen rate for a given crop over all fields and from year to year.”
The « season »

Tremblay et al. 2012
Abundant and Well-distributed Rainfall: AWDR = amount * spread in time

Tremblay et al. 2012
50 N response trials sites across North-America

Tremblay et al. (unpublished)
N response trials: 242 Quebec, 80 Ontario

15 days before sidedressing and 30 days after
20 days before sidedressing and 12 days after

Maximum correlation with N rate effect on yield

Used in practice: -15 / +15 days
Available rainfall information in real-time

Nitrogen application date

-15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Actual rainfall
Forecast rainfall

Environment Canada

Environnement Canada

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

Dry  
Wet  
Very wet

AWDR -15d/+15d

![Graph showing responses to N rates depending on AWDR groups.](image-url)
Relative importance for **EONR**

**Important + THE MAIN reason for insurance rate application**

- Temperature (CHU)
- Drainage
- Sowing density
- Hybrid
- Economic ratio
- Yield goal
- Application method
- Source of fertilizer
- Rainfall
- Soil health
- Surface soil texture
- All-at-sowing or sidedressed
- Organic manure

Ever dared to check on several seasons?

- Important but no quantitative descriptor yet

In-season N: your best chance to adjust for rain

Are we collectively being distracted by non-limiting factors?

If so, what is the effect on the sector performance?

Important but easy to account for

CRAAQ, 2016
Yield vs EONR

Oklahoma

Quebec

Sawyer et al. 2006

Tremblay, Gilles 2013
Rain Makes Grain

• Rain comes **before** yield
• Cumulative rainfall available from weather services, or local weather stations
• Forecast rainfall available (+15 days)
• Relationships with other important factors can be derived
  – Soil texture
  – Organic manure
  – Etc...
Evidence-based, not Eminence-based

• Need of an objective, comprehensive understanding of critical relationships determining N effects on grain production
  – Including the ones based on location: soil + rain for personalization of the recommendations
  – Lots of data needed to achieve this
    • Meta-analyses of past trials + Big Data

• Need of DSS that will properly handle the critical parameters
Using Adapt-N to Improve N Use in Corn
Unexplored alternative: FIS

• Fuzzy inference systems
  – Used for automating stock exchanges
  – Landing airplanes
• Suited for decision-making in complex systems not completely understood
• Intuitive, straightforward, flexible and performant
• Decision-rules easy to implement
SCAN: Soil, Crop, Atmosphere for N

• DSS
  – FIS based
  – Soil texture + rainfall + previous crop + organic matter + economic ratio
  – Web-mapper (GoogleEarth type platform)
• Based on Tremblay et al. 2012
  – 50 N trials across North-America
• Upgraded with a DB of +300 N trials from Quebec and Ontario
Historical Qc-On trials available for calibration
SCAN: comparison trials 2013-2015
SCAN performances + improvements

- **2013**
  - Based on Tremblay et al. 2012
  - 16 rules: Soil surface texture * AWDR

- **2014**
  - Coarse textures added
  - Same 16 rules + weather forecasts by Env. Can.

- **2015**
  - Incorporation of meta-analysis results on Qc DB
  - 2 new rules: SOM, Previous crop
  - Adjustment for historical yield

- **2016**
  - *Optimization on the Qc-On DB*
  - *Improved rainfall forecasts*
  - *Soil texture on a continuous scale*

About 60 trials
Optimization on the Qc-On DB

- 122 trials
- RMSE = 9 kg N ha\(^{-1}\)
Connexion

Courriel

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Mot de passe

**********

Entrer

Créer son compte
Veuillez choisir une zone

Nom:
Latitude:
Longitude:
Superficie:

Options:

Valider les données météo

Prix anticipé du grain en $/tonne métrique:
Coût de l’azote (N) en $/tonne métrique:

Lancer SCAN

Mes zones de gestion

<table>
<thead>
<tr>
<th>Nom</th>
<th>Précédent cultural</th>
<th>M.O. (%)</th>
<th>Texture du sol</th>
<th>%argile</th>
<th>%sable</th>
<th>Rendement probable individuel (t grain/ha)</th>
<th>% Rendement probable individuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Champ LAC</td>
<td>Soya</td>
<td>2.5</td>
<td>Loam argileux</td>
<td></td>
<td></td>
<td>14</td>
<td>100</td>
</tr>
</tbody>
</table>

Données de base | Infos facultatives
Note: Simulation made at an unlikely side-dressing date, for the sake of the demonstration
Rapport de recommandation

La dose recommandée pour application en post-levée est de:

130 kg N/ha

Pour la zone de gestion Champ LAC
En date du 2016-07-29 à 14:54 HAE
Avec les paramètres suivants:

<table>
<thead>
<tr>
<th>Paramètres</th>
<th>Valeur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nom</td>
<td>Champ LAC</td>
</tr>
<tr>
<td>Précédent cultural</td>
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</tr>
<tr>
<td>Matière organique</td>
<td>2.5 %</td>
</tr>
<tr>
<td>Texture du sol</td>
<td>Loam argileux</td>
</tr>
<tr>
<td>Type de travail du sol</td>
<td>Conventionnel</td>
</tr>
<tr>
<td>Nombre d'années sans labour conventionnel</td>
<td>0</td>
</tr>
<tr>
<td>Rendement probable individuel</td>
<td>14 t grain/ha</td>
</tr>
<tr>
<td>% du rendement probable ind. selon l'état de la culture</td>
<td>100 %</td>
</tr>
<tr>
<td>AWDR (Version bêta seulement)</td>
<td>50</td>
</tr>
</tbody>
</table>
Key: Many trials over space and time

• A DSS can be produced relatively quickly
• Trials
  – Results + **context** (soil, weather, management)
    • Metadata
• Need a lot to make DSS robust and performant
• Please contribute data and metadata
• Mostly needed in DB
  – Diversity in seasons
  – Info on context of experiments conducted (metadata)
AAFC SCAN Task Force

• Nicolas Tremblay, lead
• Carl Bélec, agronomy, trials coordination and adoption
• Edith Fallon, instrumentation and weather data
• Lucie Grenon, agropedology
• Marcel Tétreault, field and lab work
• Philippe Vigneault, geomatics and remote sensing
• Effigis GeoSolutions (Yacine Bouroubi and Julie Surprenant)

• René Audet, agricultural meteorology
• Myriam Lafrenière-Landry, coordination and administration
• Stéphane Gariépy, coordination
Thank you

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