Extreme weather events and agriculture: Identifying and characterizing key impacts to corn and soybeans at the regional scale

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Extreme weather and agriculture
Generic weather extremes

a) Maximum consecutive dry days

b) Simple day intensity index of P

c) Very wet days (≥95th percentile)

d) Heavy P days (≥10 mm)

Source: Vincent and Mekis (2006)
Crop-specific weather extremes
Climate data

- Quality controlled gap filled data for daily min and max temperature and daily precipitation from 1961 to 2010. (Sources: EC, Schroeter and Associates)

- High resolution downscaled daily temperature and precipitation data for an ensemble of 12 models used in CMIP5 under RCP 8.5 from 2011 to 2035. (Source: Pacific Climate Impacts Consortium)

Source: Giorgi and Fransisco 2000
Indicator development

- Extensive literature review (close to 100 sources reviewed)
- Expert consultations (AAFC, OMAFRA)
- Crop tolerance thresholds to T and P conditions at various phenological stages were identified
- Yield loss percentages associated with threshold exceedance were studied
## Corn-specific indices

<table>
<thead>
<tr>
<th>Index name</th>
<th>Definition</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor seeding conditions</td>
<td>Weekly precipitation 30% greater than weekly mean precipitation (between April 23 and May 20)</td>
<td>weeks/year</td>
</tr>
<tr>
<td>Early flooding</td>
<td>Weekly precipitation 30% greater than weekly mean precipitation with 1 to 780 accumulated CHUs</td>
<td>weeks/year</td>
</tr>
<tr>
<td>Pollination drought</td>
<td>CDD &gt;10 with 1,301 to 1,600 accumulated CHUs</td>
<td>annual occurrence (Yes or No)</td>
</tr>
<tr>
<td>R2 (blister) drought</td>
<td>P&lt;45mm with 1,601 to 1,825 accumulated CHUs</td>
<td>annual occurrence (Yes or No)</td>
</tr>
<tr>
<td>R3 (milk) drought</td>
<td>P&lt;45mm with 1,826 to 2,000 accumulated CHUs</td>
<td>annual occurrence (Yes or No)</td>
</tr>
<tr>
<td>Early killing frost</td>
<td>Tmin &lt;=-2°C with 2,165 to 2,475 accumulated CHUs</td>
<td>days/year</td>
</tr>
<tr>
<td>R4 (dough) drought</td>
<td>P&lt;8mm with 2,001 to 2,165 accumulated CHUs</td>
<td>annual occurrence (Yes or No)</td>
</tr>
<tr>
<td>Fall killing frost</td>
<td>Tmin &lt;=-2°C with 2,476 to 2,600 accumulated CHUs</td>
<td>days/year</td>
</tr>
</tbody>
</table>
Soybean-specific indices

<table>
<thead>
<tr>
<th>Index name</th>
<th>Definition</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soybeans:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor seeding conditions</td>
<td>Weekly precipitation 30% greater than weekly mean precipitation (weeks between May 7 and June 10)</td>
<td>weeks/year</td>
</tr>
<tr>
<td>Spring killing frost</td>
<td>Tmin &lt;0°C 26 to 50 days after seeding</td>
<td>days/year</td>
</tr>
<tr>
<td>Early flooding</td>
<td>Precipitation 30% greater than weekly precipitation 25 to 45 days after seeding</td>
<td>weeks/year</td>
</tr>
<tr>
<td>Cool nights</td>
<td>Tmin &lt;10°C for 5+ days 45-55 days after seeding</td>
<td>annual occurrence (Yes or No)</td>
</tr>
<tr>
<td>Warm nights</td>
<td>Tmin&gt;=24°C 55 to 100 days after seeding</td>
<td>days/year</td>
</tr>
<tr>
<td>Mid-season flooding</td>
<td>Precipitation &gt;90mm 60 to 80 days after seeding</td>
<td>annual occurrence (Yes or No)</td>
</tr>
<tr>
<td>Pod filling drought</td>
<td>Precipitation &lt;10mm 81 to 95 days after seeding</td>
<td>annual occurrence (Yes or No)</td>
</tr>
<tr>
<td>Early killing frost</td>
<td>Tmin &lt;-1°C between 90 and 100 days after seeding</td>
<td>days/year</td>
</tr>
<tr>
<td>Extreme heat</td>
<td>Mean Tmax&gt;33°C 95-120 days after seeding</td>
<td>days/year</td>
</tr>
<tr>
<td>Fall killing frost</td>
<td>Tmin &lt;-1°C 101 to 110 days after seeding;</td>
<td>days/year</td>
</tr>
<tr>
<td>Seed development drought</td>
<td>P&lt;5mm 96-115 days after seeding</td>
<td>annual occurrence (Yes or No)</td>
</tr>
</tbody>
</table>
Results (Corn)

Weeks per year

- n/a
- < 1.1
- 1.1 - 1.2
- 1.21 - 1.3
- > 1.3

Weeks per year

- n/a
- < 2
- 2 - 2.2
- 2.21 - 2.5
- 2.51 - 2.8
- > 2.8
Results (Corn)

Pollination drought, 1961-1985

Pollination drought, 1986-2010

Pollination drought, 2011-2035

Blister stage drought, 1961-1985

Blister stage drought, 1986-2010

Blister stage drought, 2011-2035

Occurrence (times)

n/a
0 - 1
2 - 3
4 - 5

Occurrence (times)

0
1 - 3
4 - 6
7 - 9
10 - 15
Results (Corn)
Results (Soybeans)
Results (Soybeans)
Further research directions

• Refine indicators by incorporating soil moisture and evapotranspiration calculations in formulas
• Analyze indicator performance using historic production data
• Conduct a more in-depth analysis using future projections data
• Apply methods in other regions using different crops
Thank you!