Facing the glyphosate-resistance issues scenario – Impacts on agrochemicals and application technologies

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Highlights
• Brazilian agriculture;
• Glyphosate resistant or tolerant weeds in Brazil;
• Markets for agrochemicals, biopesticides and tank mix adjuvants;
• Adoption of agricultural technologies driven by the weed resistance scenario;
• Challenges and opportunities: chemicals, tank mix adjuvants and application technology.
Brazilian agriculture
• Brazil: total area of 850 million hectares;

• 150 million hectares available for agriculture (18% of the country area);

• 2018: Brazilian agriculture uses 74 million hectares (50% of the available area).
### Brazilian Agriculture: 74 Million Hectares

- **Main crops**
  - Soybeans: 35,821,400 ha
  - Corn: 16,824,600 ha
  - Sugarcane: 10,229,800 ha
  - Common beans: 3,014,100 ha
  - Coffee: 2,197,000 ha
  - Wheat: 2,042,400 ha
  - Rice: 1,759,000 ha
  - Cotton: 1,562,800 ha
  - Orange: 510,000 ha

Sources: IBGE/CONAB/UNICA/MAPA (2019)
Glyphosate resistant or tolerant weeds in Brazil
Glyphosate resistant or tolerant weeds in Brazil

Sources: http://www.weedscience.org and Lucio et al. (2018)
• *Conyza* spp., goosegrass, *Commelina* spp., and *Ipomoea* spp. infested between 40.8% and 49% of the areas planted with soybean throughout Brazil;

<table>
<thead>
<tr>
<th>Weeds (Sybeans)</th>
<th>Area (ha)</th>
<th>% Soybean area</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Conyza</em> spp.</td>
<td>16,207,463</td>
<td>49.0</td>
</tr>
<tr>
<td>Goosegrass</td>
<td>13,725,290</td>
<td>41.5</td>
</tr>
<tr>
<td><em>(Eleusine indica</em> (L.) Gaertn.)</td>
<td>13,725,290</td>
<td>41.5</td>
</tr>
<tr>
<td><em>Commelina</em> spp.</td>
<td>13,612,643</td>
<td>41.2</td>
</tr>
<tr>
<td><em>Ipomoea</em> spp.</td>
<td>13,497,259</td>
<td>40.8</td>
</tr>
</tbody>
</table>

Source: *Lucio et al.* (2018)
Agrochemicals market - Brazil
Agrochemicals Market in Brazil

Source: SINDIVEG, 2017
Agrochemicals Market in Brazil

- **Insecticides**: 27%
- **Fungicides**: 28%
- **Herbicides (selective)**: 20%
- **Herbicides (non-selective)**: 15%
- **Seed treatment**: 6%
- **Others**: 4%

Source: SINDIVEG, 2017
Soybeans: 52%

- Coffee: 3%
- Fruits: 3%
- Cotton: 7%
- Sugarcane: 12%
- Corn: 10%
- Others: 13%

Source: SINDIVEG, 2017
Cost of chemicals in 2017 (US$/ha)

Use of chemicals in 2017 (US$/t of agricultural products)

Agrochemicals Market in Brazil

EIQ – Environmental Impact Quotient

Source: Velini & Carbonari (2019)
Number of new products registered in Brazil

* 74 new products: January and February, 2019.

Source: MAPA (2019)
Biopesticides market - Brazil
Number of new low toxicity products (e.g. biopesticides)

Brazilian market for biopesticides:
- 2017: US$ 80 millions
- 2018: US$ 122 millions (+77%)

Sources: MAPA e ABCBio (2019)
Tank mix adjuvants market - Brazil
Brazilian agriculture - potential market for tank mix adjuvants

*(conservative forecast)*

<table>
<thead>
<tr>
<th>Main crops</th>
<th>Crop area (Million ha)</th>
<th>Number of applications(^{(1)})</th>
<th>Potential area(^{(2)}) (Million ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybeans</td>
<td>35.8</td>
<td>6.8</td>
<td>243</td>
</tr>
<tr>
<td>Corn</td>
<td>16.8</td>
<td>4.2</td>
<td>71</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>10.2</td>
<td>3.3</td>
<td>34</td>
</tr>
<tr>
<td>Common beans</td>
<td>3.0</td>
<td>7.0</td>
<td>21</td>
</tr>
<tr>
<td>Coffe</td>
<td>2.2</td>
<td>5.0</td>
<td>11</td>
</tr>
<tr>
<td>Wheat</td>
<td>2.0</td>
<td>5.5</td>
<td>11</td>
</tr>
<tr>
<td>Rice</td>
<td>1.8</td>
<td>5.1</td>
<td>9</td>
</tr>
<tr>
<td>Cotton</td>
<td>1.6</td>
<td>24.0</td>
<td>38</td>
</tr>
<tr>
<td><strong>Total potential area (Million ha)</strong></td>
<td></td>
<td></td>
<td><strong>437</strong></td>
</tr>
</tbody>
</table>

\(^{(1)}\) Average number of applications per season in each crop (ProHuma, 2018).

\(^{(2)}\) Potential area if only one adjuvant is included in each tank mix (crop area x No. of application).

Sources: ANTUNIASSI, IBGE, CONAB, UNICA, MAPA, PROHUMA
## Evolution of the adjuvante market

### Brazilian agriculture - potential market for tank mix adjuvants

*(optimistic forecast)*

<table>
<thead>
<tr>
<th>Main crops</th>
<th>Crop area (Million ha)</th>
<th>Number of applications(^{(1)})</th>
<th>Chemicals in the tank mix(^{(2)})</th>
<th>Potential area(^{(3)}) (Million ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybeans</td>
<td>35.8</td>
<td>6.8</td>
<td>2.9</td>
<td>696</td>
</tr>
<tr>
<td>Corn</td>
<td>16.8</td>
<td>4.2</td>
<td>2.5</td>
<td>177</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>10.2</td>
<td>3.3</td>
<td>1.9</td>
<td>64</td>
</tr>
<tr>
<td>Common beans</td>
<td>3.0</td>
<td>7.0</td>
<td>2.7</td>
<td>57</td>
</tr>
<tr>
<td>Coffe</td>
<td>2.2</td>
<td>5.0</td>
<td>2.0</td>
<td>22</td>
</tr>
<tr>
<td>Wheat</td>
<td>2.0</td>
<td>5.5</td>
<td>2.8</td>
<td>31</td>
</tr>
<tr>
<td>Rice</td>
<td>1.8</td>
<td>5.1</td>
<td>2.6</td>
<td>23</td>
</tr>
<tr>
<td>Cotton</td>
<td>1.6</td>
<td>24.0</td>
<td>2.9</td>
<td>109</td>
</tr>
</tbody>
</table>

**Total potential area (Million ha)** 1,179

\(^{(1)}\) Average number of applications per season in each crop (ProHuma, 2018).

\(^{(2)}\) Average number of chemicals in each tank mix (ProHuma, 2018).

\(^{(3)}\) Potential area if one adjuvant is included per chemical in each tank mix (crop area x No. of application x No. of chemicals).

Sources: ANTUNIASSI, IBGE, CONAB, UNICA, MAPA, PROHUMA
Adoption of agricultural technologies driven by the weed resistance scenario
Adoption of new technology

Total area of GMO crops (million ha)

<table>
<thead>
<tr>
<th>Country</th>
<th>Area (million ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>80</td>
</tr>
<tr>
<td>Brazil</td>
<td>60</td>
</tr>
<tr>
<td>Argentina</td>
<td>40</td>
</tr>
<tr>
<td>Canadá</td>
<td>20</td>
</tr>
<tr>
<td>India</td>
<td>10</td>
</tr>
</tbody>
</table>

Adoption of GMO crops (%)

<table>
<thead>
<tr>
<th>Country</th>
<th>Adoption (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>95</td>
</tr>
<tr>
<td>Brazil</td>
<td>90</td>
</tr>
<tr>
<td>Argentina</td>
<td>90</td>
</tr>
<tr>
<td>Canadá</td>
<td>90</td>
</tr>
<tr>
<td>India</td>
<td>85</td>
</tr>
</tbody>
</table>

Source: ISAAA (2017)
<table>
<thead>
<tr>
<th></th>
<th>1998</th>
<th>2013</th>
<th>2016</th>
<th>2028</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total production (t)</td>
<td>31 millions</td>
<td>86 millions</td>
<td>114 millions</td>
<td>156 millions</td>
</tr>
<tr>
<td>Soybean area (ha)</td>
<td>13 millions</td>
<td>30 millions</td>
<td>34 millions</td>
<td>42 millions</td>
</tr>
<tr>
<td>Yield (t/ha)</td>
<td>2.4</td>
<td>2.9</td>
<td>3.4</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Source: CONAB (2016)
Adoption of new technology

Resistance is driving changes in application technology:

• Formulations, tank mixes and adjuvants: good practices for the management of weed, deseases and insects;

• Sprayers: PWM, patch spraying and direct injection systems;

• Nozzles: low drift and “3-D” nozzle systems.
Challenges and opportunities: chemicals, tank mix adjuvants and application technology
Challenges

Sources: Unesp, H H Ramos/IAC

Ulisses Antuniassi - UNESP
Challenges for application technology and adjuvants:

- Increase field capacity;
- Low volume applications and tank mixtures;
- Improve quality of chemical control;
- Hard to kill/reach targets;
- Biopesticides;
- Reduce environmental impact;
- Reduce drift;
- Pollinators;
- Resistance;
- Regulatory issues;
- Training and extension.

Source: UNESP
Spray volume
Ground spraying - Mato Grosso - Brazil

Average spray volume

Source: UNESP/Botucatu - Projeto IPP (2018)
Spray drift
• Federal regulation on buffer zones for aerial applications;

• IBAMA (Brazil equivalent to the EPA in the US) is using AGDRIFT for environmental impact studies;

• Adjuvants (Drift Reduction Agents) are becoming strategic for the perspective of new chemicals approve.
Training and extension
• Extension programs targeting spray drift started early 2000’s;
• Dow AgroSciences: focus on 2,4-D (planning for Enlist);
• Training and extension based on research data;
• Good practices on application technology.

Source: UNESP
Regulatory issues
Regulatory issues

• Adjuvant registration used to be slow and high cost;
• Several manufacturers were marketing their adjuvants as “fertilizers” to avoid the registration process;
• A “task-force” was set up to discuss the problem (adjuvant manufacturers, the chemical industry and the academy), but no solution was found;
• In 2016 the Ministry of Agriculture ended the adjuvant registration process;
• There are discussions about the idea of setting up something similar to the “CPDA” in Brazil.
What chemical and adjuvant industry in Brazil is doing now?
Chemical industry:

New products and new formulations of existing products:

- Pre-Emergent herbicides;
- Ready mix products:
  - Paxeo (diclosulan + halaxifen-methyl);
  - Enlist Duo (2,4-D + glyphosate);
- Low drift and low volatility formulations:
  - Enlist Colex D;
  - Xtendimax VaporGrip;
Chemical industry:

New products and new formulations of existing products:

- New formulation of contact fungicides:
  - mancozeb
  - copper oxychloride
  - chlorothalonil

- Benchmarking of tank mix adjuvants
  (mainly for new 2,4-D and dicamba formulations).
Adjuvant industry:

- Several new adjuvants were released last year (in-can and tank mix);
- New formulations for existing tank mix adjuvants (updating components);
- Market focus on natural products, emulsions and surfactant based adjuvants;
- All-in-one adjuvants are still a trend, but there is a lot of R&D on new adjuvants with specific features:
  - Rainfastness;
  - Uptake;
  - Drift;
  - Volatility
  - Compatibility.
Adjuvant industry:

- Research (R&D and marketing data) for chemicals and adjuvants;
- Joint projects with Universities and private research companies;
- Physical and chemical properties (mainly stability and compatibility in tank mix);
- Droplet sizing;
- Wind tunnel trials for physical drift;
- Field trials.
“Spray chamber”

Droplet sizing (UNESP/Botucatu-SP - Brazil)

Source: UNESP
Wind tunnel (UNESP/Botucatu-SP - Brazil)
Significative interaction (nozzle x spray solution): $F = 93.70$ ($p<0.0001$)

<table>
<thead>
<tr>
<th>Nozzle</th>
<th>CVI</th>
<th>GA</th>
<th>AD IA</th>
<th>AIXR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4-D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,4-D + gly 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,4-D + gly 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,4-D + gly 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Difference between solutions (%): 90.1 40.0 83.6 57.0

Source: AgroEfetiva/UNESP Botucatu
Conclusions
• Resistant weeds became a good opportunity for the industry;

• Lots of challenges for the agrochemicals, biopesticides and tank mix adjuvants industry;

• Brazilian Market is receptive to new adjuvants right now;

• Application thechnology became serious bussiness in Brazil.
Thank you!

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