The No-till path during the last 20 years in Argentina

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1. We started with no-till to reduce soil erosion...
...because this was a serious problem for our farmers!!
Physical Degradation
Intensive tillage destroys the biological and ecological integrity of the soil system (Reicosky, 2004).

Wind and water erosion, are a consequence of conventional tillage and cause contamination of the water resources.

A higher CO$_2$ emission due to tillage increases the greenhouse effect (Adapted from Moraes Sa, 2004).
2. Then...
we realized that more water was available...
...and that, with the adoption of no-till,
the “water economy” was changing.

That water had to be used by the farmer!!!
<table>
<thead>
<tr>
<th>Month</th>
<th>No-Till transpiration</th>
<th>No-Till evaporation</th>
<th>Conventional Tillage transpiration</th>
<th>Conventional Tillage evaporation</th>
<th>Rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>May</td>
<td>0</td>
<td>0.8</td>
<td>0</td>
<td>2.5</td>
<td>7.2</td>
</tr>
<tr>
<td>June</td>
<td>3.0</td>
<td>0.4</td>
<td>2.6</td>
<td>2.7</td>
<td>3.9</td>
</tr>
<tr>
<td>July</td>
<td>5.0</td>
<td>0.1</td>
<td>3.8</td>
<td>0.8</td>
<td>4.0</td>
</tr>
<tr>
<td>August</td>
<td>3.7</td>
<td>0.1</td>
<td>2.9</td>
<td>0.6</td>
<td>1.6</td>
</tr>
<tr>
<td>September</td>
<td>0.6</td>
<td>0.2</td>
<td>0.4</td>
<td>1.0</td>
<td>3.6</td>
</tr>
</tbody>
</table>

**totals**

- **No-Till**: 12.3 in. + 1.6 in. = 13.9 in.
- **Conventional Tillage**: 9.7 in. + 7.6 in. = 17.3 in.

**Source**: Aapresid
Crop Rotation Intensity
(D. Beck, 1996)

- Put the *stored water* in NT to work
- Less fallow and *more* water used by *crops*
- Climate, soil, latitude
- Appropriate intensity *reduces risks*
- *Native* vegetation is the best indicator of the appropriate intensity
What to do to improve the rainfall water use efficiency?

 ✓ Cover the soil with crop residues in an homogeneous and durable way

 ✓ Maintain a stable structure, mainly in the first inches on the soil profile
3. New regions could be brought into production with NT, so this allowed an expansion of our agricultural area.
Increased cropped area
No-Till evolution in Argentina (1977-2005)

Source: AAPRESID (2005)
4. Carbon dynamics were modified: NT alone was not enough for increasing the C levels, we needed to think on crop rotation intensification, balanced fertilization, etc...
The soil organic matter is considered the most important simple indicator to define the soil quality

*Larson & Pierce, 1991*

OM is a key component in NT

*Moraes Sa, 1993*
Organic N in a no-till field and conventional tillage after 10 years

mg N 100g\(^{-1}\) dry soil

The highest proportion of the OM increase comes from the labile fractions

Source: Moraes Sá
Crop Rotation

Planned and ordered crop sequence with the objective:

- Maximize productivity,
- minimize risks,
- and preserve the involved resources.
Fertilization of the crop rotation

- Balanced fertilization
- Higher yield response in the rotation
- Nutrient residual effects
- Balance immobilization-release
- Soil biological activity
Management to increase Soil Organic Carbon
Paustian, 1997

- Reduce or eliminate tillage
- Rotations with corn, grain sorghum, pastures.
- Include permanent gramineae and legumes
- Increase time of soil covered with vegetation
- Increase production and return residue to the soil
  ✓ No Till
  ✓ Crop Rotation
  ✓ Diversity
  ✓ Intensity
  ✓ Fertilization
5. A new paradigm started with Nitrogen, because in NT, N dynamics are modified and more "biological" N is available for crops, but difficult to quantify.
Biological Nitrogen Fixation with legumes
Inoculation and PS fertilization in soybean

AAPRESID-Nitragin-Rizobacter-ASP 2004/05

4 sites: Santa Fe and Buenos Aires Provinces

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Grain Yield (bu/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>47</td>
</tr>
<tr>
<td>Inoculated</td>
<td>50</td>
</tr>
<tr>
<td>PS</td>
<td>54</td>
</tr>
<tr>
<td>Inoc. + PS</td>
<td>57</td>
</tr>
</tbody>
</table>

Grain yield (bu/ac)
Cover crops: Hairy vetch (*Vicia villosa*)
Why hairy vetch?

Because no-till conceptually evolves.

Crop rotation intensification and diversification.

Transform water in dry matter: zero fallow + increase the size of the water storage tank.

Soil covered with residues and presence of live roots.

Nutrient cycling and deep water utilization.

Improve Carbon, Nitrogen and Organic Matter balances.

Lorenzatti, 2008
How much N can hairy vetch add to the system?

- 80 to 90 lb N/ac. to the following corn crop. Ebelhar et al., 1984. Agron. J. 76:51-55

- 67 to 112 lb N/ac. to the following corn or grain sorghum. Blevins et al., 1990. Agron. J. 82:769-772.

- The accumulation and N contribution via hairy vetch as a cover crop was higher with the late burning (2 weeks). Same trend in corn grain yield planted after the cover crop. Sainju and Singh, 2001. Agron. J. 93:878-886.
6. We need to think that we are farmers that are managing an offer of environmental resources (nutrients, water, light, CO$_2$, etc).
TRADITIONAL AGRICULTURE

Modification of the environment (soil)

Plant Yield potential

SUSTAINABLE AGRICULTURE

Adaptation of the plant and the technology

Environment Sustainable production potential

Source: Gil (2005)
No-tillage

RESIDUES ON THE SURFACE

ORGANIC MATTER
dynamics and distribution

POROUS SYSTEM
geometry and stability

BALANCE of RADIATION

BALANCE of WATER

BALANCE of ORGANIC MATTER

R. Gil, 2005
I. The more energy received by a crop, the more water it can transpire, and the more CO₂ it can fix.

II. The biomass production is closely related to the transpiration and the CO₂ fixation.

- To capture the greatest part of the water resource.
- To utilize and exchange efficiently the water for the CO₂ at the stomata level to produce photosyntates.
- To convert efficiently the asimilates in a hasvetable form: forage or grain.

Source: R. Gil 2006
The dilemma

“The humanity faces today a dilemma with no apparent solution, between the ghost of the lack of food for an increasing demand in quantity and quality, or a destruction of the natural resources needed to produce them”.

[Logo] Aapresid

[Logo] Certified Agriculture
II– The no-till system
Consequences

- 96% less soil erosion.
- 66% less fuel use.
- Maintenance or improvement of the organic matter.
- Higher water use efficiency.
- Increase in soil fertility.
- Lower production costs.
- Higher production stability and higher yield potential.

TANGIBLE BENEFITS FOR THE FARMER
II– The no-till system

Benefits, beyond the farmer

- Better soils
- Less competition for drinkable water (strategic resource)
- Higher water quality (lower erosion and contamination risk)
- Better atmosphere, positive impact in the climate change
- Lower pressure on more fragile areas (by an increase in yields)
- Possibility of producing in more fragile areas without the known risks of Conventional Tillage (CT).

**BENEFITS TANGIBLE FOR THE SOCIETY (EXTERNALITY)**
Objectives:

- To provide tools for a professional agronomical management, by the ordered registry of information and the analysis of the soil quality and efficiency indicators.

- To show to the rest of the society how are the production processes and its impact on the environment, allowing to capture the value of the positive externality that the CA makes in it.
Components:

- Principles & Criteria:
  - RTRS, RSB, ISGA, RTSP, FSC, FAO

- Management indicators:
  - in the soil
  - resource use efficiency

- Good Agricultural Practices Protocol (GAP’s)
III– Productive and environmental quality management system in CA (QMS/CA)

Potential uses

1. Associated to the agronomical management:
   - Decision making in ag management (crop rotations, fertilization strategies, etc).
   - Analysis of the evolution of the impact management in the system (time).

2. Associated to existing business or easily accessible
   - Land rental: as a requirement of the owner or as a differentiation tool.
   - Real estate (History agronomically certified).
   - Credit evaluation (environmental and production balance).
   - Tax reductions.

3. Associated to new businesses
   - Business by contract with companies that can segregate products (Ex: foods, biofuels, seeds)
   - Country brand (or provinces):
     Better price, access to preferential markets.
Certified Agriculture

It is the production alternative that better combines the interests – many times confronted – of reaching a production:

- Economically viable for farmers.
- Environmentally sustainable.
- Socially accepted.
- Energetically efficient.
Certified Agriculture

A commitment that Aapresid, as organization assumes, to contribute to the increase of the wellbeing of the local and global society, in the conflict solution Productivity vs. Environment.
Thank you!!!!

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www.aapresid.org.ar/english
For most of the people, agriculture is a synonym of TILLAGE.
No-Till Adoption Benefits

- greater stability and yield increase
- increase in cropped area
- lower production costs
NEW AGRICULTURAL AREAS

No-till

Variety  RR Soybean

expansion of the agricultural boundaries

In 1995/96: 6.000.000 ha
In 1999/2000: 9.000.000 ha
Today: 16.000.000 has
Rate increase since 1995 was 1.000.000 ha
WATER LOSS DUE TO TRANSPERSION AND EVAPOTRANSPIRATION NO-TILL AND CONVENTIONAL TILLAGE

<table>
<thead>
<tr>
<th>Month</th>
<th>No-Till</th>
<th>Conventional Tillage</th>
<th>Rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>transpiration</td>
<td>evaporation</td>
<td>transpiration</td>
</tr>
<tr>
<td>May</td>
<td>0</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td>June</td>
<td>76</td>
<td>10</td>
<td>64</td>
</tr>
<tr>
<td>July</td>
<td>124</td>
<td>3</td>
<td>95</td>
</tr>
<tr>
<td>August</td>
<td>92</td>
<td>2</td>
<td>72</td>
</tr>
<tr>
<td>September</td>
<td>15</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td><strong>totals</strong></td>
<td><strong>307</strong></td>
<td><strong>41</strong></td>
<td><strong>242</strong></td>
</tr>
</tbody>
</table>

**Total Water Loss**

- No-Till: 348
- Conventional Tillage: 433
No-Till evolution in Argentina (1977-2005)

Source: AAPRESID (2005)
Organic N in a no-till field and conventional tillage after 10 years

The highest proportion of the OM increase comes from the labile fractions

Source: Moraes Sá
Inoculation and PS fertilization in soybean

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Grain yield (kg/ha)

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Inoculated</th>
<th>PS</th>
<th>Inoc. + PS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3205</td>
<td>3373</td>
<td>3683</td>
<td>3833</td>
</tr>
</tbody>
</table>

Aapresid

Agricultura Certificada

La evolución de la SD
How much N can hairy vetch add to the system?

• 90 to 100 kg N/ha to the following corn crop. Ebelhar et al., 1984. Agron. J. 76:51-55

• 75 to 125 kg N/ha to the following corn or grain sorghum. Blevins et al., 1990. Agron. J. 82:769-772.

• The accumulation and N contribution via hairy vetch as a cover crop was higher with the late burning (2 weeks). Same trend in corn grain yield planted after the cover crop. Sainju and Singh, 2001. Agron. J. 93:878-886.