Conservation Agriculture Worldwide, an Alternative to Agricultural Burning

Rolf Derpsch, ex No-till Consultant, Asuncion, Paraguay
rolf.derpsch@tigo.com.py

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What is Conservation Agriculture?

Permanent Cover - Cropping Systems for Sustainable Agriculture, based on three principles:

- Permanent soil cover
- Minimum soil disturbance = No-tilage
- Diversified crop rotations

(FAO, 2001)
What is No-tillage?
No-tillage is defined as a system of seeding crops into unttiled soil by opening a narrow slot, trench or band only of sufficient width and depth to obtain proper seed coverage. No other soil tillage is done.
No-tillage in Argentina (AAPRESID)
No-till soybeans into black oats in Brazil

(Derpsch, 1996)
No-till maize in Brazil

(Calegari, 2008)
About 80% of all crops are planted No-till in MERCOSUR - no burning!

(Derpsch, 2014)
All crops can be seeded in No-till systems

Onions in Colombia

Cassava in Paraguay

(Derpsch, 2001)
Potatoes in No-tillage after wheat in Colombia

(Birbaumer, 2000)
Recommended book on No-tillage in the Andes

GTZ
Chile is the only country in South America where they burn the stubble in the No-tillage system.

(Derpsch, 2007)
No-tillage at Carlos Crovetto’s farm in Chile

One of the few farmers that do not burn in Chile

(Crovetto, 2000)
South America

> 60 Million ha under No-till within circle

Burning has almost disappeared in agriculture with the introduction of No-tillage

(Derpsch, 2014)
Why Conservation Agriculture / No-tillage?
To stop soil erosion

(Derpsch, 1993)
To stop open burning in agriculture

(Derpsch, 2014)
Why CA / No-till?

To save fuel

<table>
<thead>
<tr>
<th>Method</th>
<th>Fuel Consumption (L diesel/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional tillage</td>
<td>42.3</td>
</tr>
<tr>
<td>Heavy disc harrow</td>
<td>34.3</td>
</tr>
<tr>
<td>No-till</td>
<td>13.9</td>
</tr>
</tbody>
</table>

No-till saves 66% fuel

*Sorrenson et al, 1984*
Soil Organic Carbon Affected by 10 Years of Tillage Systems

Why Conservation Agriculture / No-till?

Rio Grande do Sul State (BRAZIL) (Bayer, 1996)
Gaining Carbon

C sequestration into the soil

Loosing Carbon

C emissions to atmosphere

No-tillage improves soil quality and soil FERTILITY.

Tillage impoverishes the soil. Carbon is lost as CO2 to the atmosphere.

(Reicosky, 2005)
Organic C measured at Wooster, Ohio

Oldest NT experiment in US

Genuine No-till Corn – Soyb.

Sustainable

Not sustainable

(Warren Dick, ISTRO, 2006)
Crop residues are not a waste a product, they are a valuable resource and should not be burned, baled or carried away if agricultural sustainability means anything to us.

(Derpsch, 2010)
Stubble Over the Soil

The Vital Role of Plant Residue in Soil Management to Improve Soil Quality

Carlos Crovetto Lamarca

The grain is for man and the stubble is for the soil
Environmental sustainability is the central paradigm of the 21st century.

The UN post 2015 agenda is designed to firmly anchor the idea of sustainability in people’s minds.
Global overview of No-till adoption
Evolution of the area under No-till in the USA

No-Till Adoption in the U.S.
1994 - 2004

35.6 Million ha
15.7 Million ha

Fig. 2 No-Till Adoption in the U.S.
No-till adoption continues to steadily rise. This represents almost 23 percent of the nation's cropland.
Source: Conservation Technology Information Center

(CTIC, 2004)
Evolution of the area under No-till in Brazil


31,8 M ha in 2014

1990 - 1 Million ha

Fonte: EMATER-RS, EPAGRI-SC, EMATER-PR, CATI-SP, FUNDAÇÃO MS, APDC (Cerrado)
Between 1991 and 2004 Brazil doubled its grain production while cropped area grew by only 9%
Evolution of the area under No-till in Argentina

- 2005/06

27 M Há in 2014

(AAPRESID, 2006)
Grain production in Argentina increased by 164% 1988 - 2001

Grain production and area planted in Argentina

Grain production in Argentina increased by 164% 1988 - 2001

(Peiretti, 2002)
Adoption of no-tillage in Paraguay 1994 - 2010

31

2014  3 Mill. ha

Fuente: GTZ, 94/95/97/98/99 Estimats., 96 AAPRESID-CAPRAS, FMNCRS 2000 - 2010
### No-tillage in selected countries of the region

<table>
<thead>
<tr>
<th>Countries</th>
<th>Area under No-till (Mill. ha) 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>31,8</td>
</tr>
<tr>
<td>Argentina</td>
<td>27,0</td>
</tr>
<tr>
<td>Paraguay</td>
<td>3,0</td>
</tr>
<tr>
<td>Uruguay</td>
<td>1,1</td>
</tr>
<tr>
<td>Bolivia</td>
<td>0,7</td>
</tr>
<tr>
<td>Venezuela</td>
<td>0,3</td>
</tr>
<tr>
<td>Chile</td>
<td>0,2</td>
</tr>
<tr>
<td>Colombia</td>
<td>0,1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>64,2</strong></td>
</tr>
</tbody>
</table>

(Kassam et al., 2014)
Global overview of No-till adoption

World total is estimated at > 155 Million ha
(Numbers in Million ha and % adoption by region)

(Kassam et al., 2014)
Evolution of the area under no-tillage in the USA and MERCOSUR (Brazil, Argentina, Paraguay, Uruguay) in Million ha

Million ha

- **MERCOSUR**
  - 1987: 0.67 Million ha
  - 1997: 4.05 Million ha (59 fold incr.)
  - 2004: 39.6 Million ha (59 fold incr.)

- **USA**
  - 1987: 23.7 Million ha (5.8 fold incr.)
  - 1997: 18.6 Million ha
  - 2004: 39.6 Million ha

(Derpsch, 2005)
Main barriers that had to be overcome

- Knowledge on how to do it (know how)
- Mindset (tradition, prejudice)
- Availability of adequate seeding machines
- Availability of suitable herbicides and cover cropping systems to control weeds
- But it is also necessary that the government puts the right policy in place

These barriers had to be overcome by politicians, public administrators, farmers, researchers, extension agents & university professors.
CONCLUSIONS

• CA is spread over 155 M ha across all continents (11% of global cropland), an increase of 24% since 2010, and continues to spread at an annual rate of 10 M ha.

• Originally it was a farmer’s driven process, but attention is increasingly paid by donors, national and international development organizations, and increasingly by governments.

• CA is getting recognized more widely as an approach for sustainable production intensification that offers enhancement of productivity with ecosystem services and improved resilience, and climate change adaptability and mitigation.

• Further policy and institutional support is needed for faster adoption AND for safeguarding quality of CA to ensure environmental services.

(Kassam et al, 2014)
CONCLUSIONS

- Conservation Agriculture has shown to be an efficient tool in reducing burning in agriculture.

(Kassam et al, 2014)
No-tillage is the most important technology adopted in the MERCOSUR countries in the last 50 years. Zero tillage reversed soil degradation, allowed an expansion of agriculture into marginal areas, boosted farmers' profitability, and increased the sustainability of agricultural systems.

(Eckboir, CIMMYT, 2000)
Thank you for your attention!

Here you can find more information about No-till

www.rolf-derpsch.com

Rolf Derpsch
Consultant
No-tillage and
Conservation Agriculture
rolf.derpsch@tigo.com.py
Almost all advantages of the No-tillage system come from the permanent cover of the soil.

(Derpsch, 2012)
Generation and return of adequate amounts of biomass (>8 – 10 t/ha/year dry matter) is crucial to succeed with the No-tillage System in South America.
Population of Earthworms Affected by Tillage System

Parana State (BRAZIL)  Derpsch et al., 1986
Biological activity

Population of Arthropods Affected by Tillage System

Parana State (BRAZIL)  

Derpsch et al., 1986

<table>
<thead>
<tr>
<th>Soybean / Wheat</th>
<th>Soybean / Cover crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>40</td>
</tr>
<tr>
<td>40</td>
<td>30</td>
</tr>
<tr>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Arthropods per 300 cm$^3$
Soil temperature under bare and straw covered soil

Bare soil exposed to the sun

Soil covered with residues

(Dirceu Gassen, 2011)
Soil Water at Field Capacity (0.033 MPa) of an Oxisol as Affected by 4 Years of Tillage Systems

Parana State (BRAZIL)

Sidiras et al, 1982
Biological activity

Population of Earthworms Affected by Tillage System

Parana State (BRAZIL)  Derpsch et al., 1986
Population of Arthropods Affected by Tillage System

Parana State (BRAZIL)

Arthropods per 300 cm³

- Soybean / Wheat
- Soybean / Cover crop

Derpsch et al., 1986
No-tillage without or with too few plant residues on the soil surface will result in poor crop and root development and yields below those in conventional tillage.

(Wall, P., CIMMYT, 1999, Bolivia)
(Sayre, K., CIMMYT, 2006, Mexico)
No-tillage without plant residues on the soil surface will result in poor crop and root development and yields below those in conventional tillage.

(Wall, P., CIMMYT, 1999, Bolivia)

(Sayre, K., CIMMYT, 2006, Mexico)
Comparison of zero tilled rainfed maize with and without crop residues on the soil surface

Zero Till without Residues          Zero Till with Residues

(Sayre, K., 2006)
Comparison of the effect of residue retention versus residue removal on zero tilled rainfed maize yields for the maize-wheat rotation in the highlands of Mexico (average yields from 1996 to 2004)

(Sayre, K., CIMMYT, 2006)
Comparison of average returns above variable costs per ha (Mexican Pesos) for zero tilled rainfed maize in the maize-wheat rotation with residue retention versus residue removal from 1996 to 2004

(Sayre, K., CIMMYT, 2006)
Effect of Ground Cover on Yield (Wheat)

Tarata, Cochabamba, Bolivia  Altitude 2500m

Average annual rainfall 500 - 650 mm

Grain Yield (t/ha)

- No Cover
- 2 t/ha
- 4 t/ha

(Wall, P., 1999)
Wheat yields with different tillage treatments and seeding methods, Cochabamba, Bolivia, 1995/96 (Wall, 1999).
Thank you for your attention!

Here you can find more information about No-till

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Rolf Derpsch
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No-tillage and
Conservation Agriculture
rolf.derpsch@tigo.com.py
“A matéria orgânica é a Deusa dos nossos solos e por isso temos que reverenciá-la”

Nonô
<table>
<thead>
<tr>
<th>Country</th>
<th>% of No-till adoption</th>
</tr>
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<tbody>
<tr>
<td>USA</td>
<td>25%</td>
</tr>
<tr>
<td>Argentina</td>
<td>90%</td>
</tr>
<tr>
<td>Brazil</td>
<td>70%</td>
</tr>
<tr>
<td>Paraguay</td>
<td>80%</td>
</tr>
<tr>
<td>Uruguay</td>
<td>80%</td>
</tr>
</tbody>
</table>
Burning pasture, courtesy Theodor Friedrich
Open burning is a serious problem all over the world

Burning in China and in Kazakhstan, courtesy of Theodor Friedrich
Agriculture in the Chaco in the 70’s and 80’s
No-till soybeans in Paraguay

(Derpsch, 2000)
No-till sugar cane into Crotalaria juncea

Brazil
CONTENT

- Introduction - burning and conventional tillage
- How do we define No-tillage (NT)?
- And Conservation Agriculture (CA)?
- Why Conservation Agriculture / No-till?
- Global adoption of NT/CA
- Final remarks
What is low-tillage?

If it is some kind of reduced tillage operation than very little of it, if any is used in South America
Sustainable development

The Brundtland Commission of the United Nations 1987 report, “Our Common Future”, defined sustainable development as one that “meets the needs of the present generation without compromising the ability of future generations to meet their own needs”.
Conservation Agriculture (CA) is based on three principles

- Continuous minimum mechanical soil disturbance = permanent No-tillage
- Permanent organic soil cover
- Diversified crop rotations including cover crops (to help moderate possible weed, disease and pest problems)

*(FAO, 2001)*
What is Conservation Agriculture?

The basic elements of CA are: very little or no soil disturbance, no burning, direct seeding into previously untilled soil, crop rotation and permanent soil cover.

CA is now widely recognized as a viable concept for sustainable agriculture due to its comprehensive benefits in economic, environmental and social sustainability.

(FAO, 2002).
At the beginning they ignore you, then they laugh at you, next they fight you and finally you win.

Mahatma Gandhi
Main barriers that had to be overcome

• Knowledge on how to do it (know how)
• Mindset (tradition, prejudice)
• Availability of adequate seeding machines
• Availability of suitable herbicides and cover cropping systems to control weeds
• But it is also necessary that the government puts the right policy in place

These barriers had to be overcome by politicians, public administrators, farmers, researchers, extension agents & university professors.
No-till cover cropping systems are working under all kind of environments:

- From the Equator, e.g. Kenya, Uganda to 50º S, e.g. Argentina, or 65º N, e.g. Finland
- From sea level to 3000 m, e.g. Bolivia, Col.
- Soils from 90% Sand, e.g. Australia, Brazil, to 85% clay, e.g. Brazil (Oxisols, Alfisols)
- From 250 mm of rain, e.g. Western Australia to 2000 mm, e.g. Brazil, or 3000 mm Chile (Derpsch & Friedrich, 2008)
No-tillage works all over the world!

but I have a special soil, No-tillage will not work on my farm!
Reasons why adoption has been so intensive in South America

- Efficient and economic erosion control
- Appropriate knowledge was available in the region
- Widespread use of gmcc (> OM, weed suppression, etc.)
- Consistent positive messages by all, little contradictions
- NT only conservation agric. techn. being recommended
- Aggressive farmer to farmer extension, no secrets!
- Publications with practical information available
- Economic studies with system approach available
- There have been no mayor forces against the system
- S. A. farmers have to be competitive in the global market, no subsidies. Subsidies hamper creativity of farm.
Conditions for a successful adoption of No-till

1. Make sure you use a proper seeding technology
2. On degraded soils consider a transition through reduced tillage
3. Produce enough crop residues and ensure even distribution
4. Ensure systemspecific weed control
5. N application should adapt to the different nutrient dynamic
6. Perform systematic and continuous monitoring of the fields
7. Apply diversity to your rotations
8. Take advantage of the experience of other farmers
9. Develop creativity and improve the system constantly
10. Have a positive attitude towards problems.
   All problems are challenges to be overcome!

(Derpsch, 2013)
This has been the reality of farming in SA in the past

Open burning of crop residues
Open burning was a common practice in conventional agriculture all over South America until the 1970’s and 1980’s

(Derpsch, 1977)
Conventional tillage and its consequences
We need to stop open burning

(Crovetto, 1996)