POSSIBLE BREAKTHROUGHS CONSERVATION AGRICULTURE

Conservation agriculture is a set of principles,[1] whose adoption depends on time and space considerations. There are three fundamental principles in conservation agriculture:

> Reduced tillage (i.e. minimum or no-tillage). This increases the biotic activity in the soil. In the long term, it improves soil structure, resulting in improved infiltration and water retention capacity of the soil.

> Diversified crop rotations. This reduces pest pressure and keeps the soil nutrient balance stable. Incorporating nitrogen-fixing legumes in the rotation reduces the need for external fertilizer inputs.

> Keeping a permanent vegetative cover on the bare land. This helps reduce the erosive impact of rain and wind, reduces evaporation, and enhances the structure and fertility of the soil. This can be achieved either by leaving crop residues on the land or by planting a cover crop.

[1] Jones et al. 2006

ANNEX J

Description

Key benefits of conservation agriculture:

- Reduced tillage keeps biotic community intact, improving biotic activity in the soil. In the long term this improves soil texture and structure, resulting in improved infiltration and soil water retention capacity.
- Crop diversification through rotations reduces pest pressure and keeps soil nutrient balance stable. Incorporating nitrogen-fixing legumes in the rotation reduces nitrogen fertilizer applications. A 10-year study of 18 medium and large farms in two regions of Paraguay shows that fertilizer and herbicide input dropped by 30-50% under conservation agriculture.
- Maintaining an organic matter mulch cover on the soil surface during both growing seasons creates a micro-climate with:

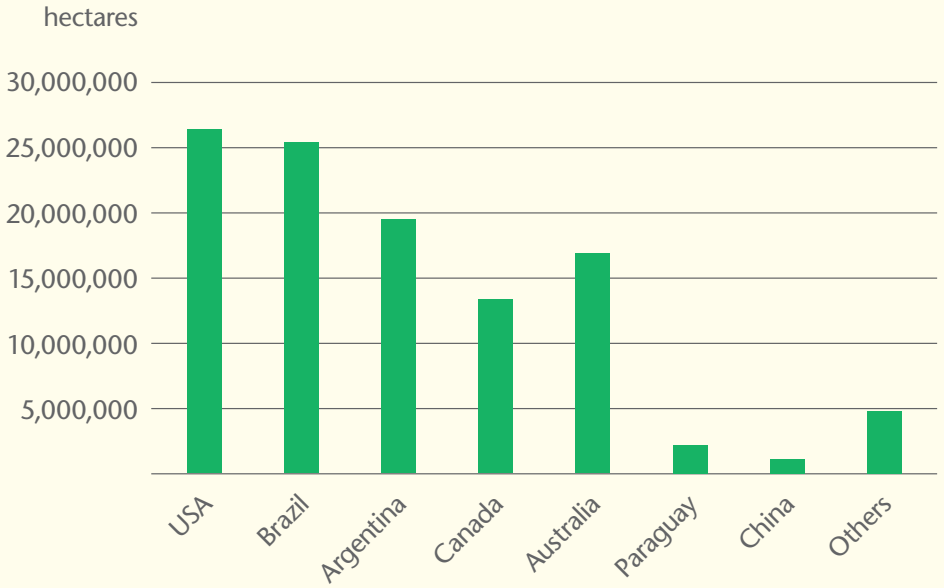
  i) Increased temperature, allowing earlier maturing of crops and reducing frost events;

  ii) Reduced evaporation losses;

  iii) Reduced soil erosion. A 17-year average study in Brazil showed that the adoption of a no-tillage system decreased soil erosion in maize and soybean systems from 3.4-8.0 to 0.4 t/ha.[2]

Key numbers of the potential impact of no tillage systems on smart resource use are summarized in figure 1 below.

Figure 1
Global coverage of no-tillage systems



Source: Derpsch et al. 2010

[2]Derpsch et al. 2010

Geography

Areas under no-tillage have expanded globally at an annual rate of 6%. From an area of 2.8 million hectares in 1973-74, the area has grown to 72 million hectares in 2003 and to more than 110 million hectares in 2009.[3] Almost 50% of this growth has taken place in South America, with Argentina and Brazil making up a large share. The global area under no- or reduced tillage is given in figure 1.[4] The uptake of conservation agriculture in Europe, Asia, and particularly in sub-Saharan Africa is modest compared to the rest of the world.

Constraints to the adoption of conservation agriculture by farmers in sub-Saharan Africa[5] range from access to inputs such as herbicides, trade-offs in the use of crop residues (mulching vs. livestock feeding), to increased labor requirements for weed suppression if herbicides are not available.[6] A range of small-scale cultivation techniques, such as seed drills and weeders, are now on the market, removing some of the bottlenecks.

[3]FAO AQUASTAT 2009 in Derpsch et al. 2010, [4]Derpsch et al. 2010, [5]Giller et al. 2011, [6]Giller et al. 2009

Energy

- Energy benefits are gained through reduced needs for mechanized labor, less fuel consumption and less agrochemicals use
  - Fuel savings of 27% in no-tillage soy-maize systems in Brazil;[7]
  - 30-50% less herbicide and fertilizer use;[8]
  - In South America, 70% energy savings with no-till over conventional;[9]
  - Studied conservation tillage systems in Europe needed 137 kWh/ha on average compared to 213 kWh/ha for conventional tillage.[10]
- Better water management through pivot irrigation systems coupled with no-till has reduced energy in irrigation.

Water

- No-tillage systems and cover crops increase soil organic matter content and soil water retention capacity
  - Run-off losses in a no tillage system in South America reduced water use from 990 m^3/ha/year to 170 m^3/ha/year;[11]
  - Runoff reductions of 40-70% possible.[12]

Productivity

- Crop intensity is 33-100% higher in no-tillage compared to conventional systems.[13]
- Soybean production increased 10% in no-tillage over conventional systems.[14]
- Maize and soybean production increased 27% and 30 % respectively in Brazilian no-tillage over conventional systems.[15]
- Maize and soybean production in no-tillage systems is 88% and 56% higher respectively than in conventional systems.[16]
- 15% lower yields observed in maize and spring barley[17] shows context-specific implementation and effects of conservation agriculture.

[7]Pieri et al. 2002, [8]Derpsch et al. 2010, [9]Ibid, [10]Jones et al. 2006, [11]Derpsch et al. 2010, [12]Jordan and Hutcheon 1997, [13]Beck et al. 1998, [14]Clay 2004, [15]Pieri et al. 2002, [16]Derpsch et al., 2010, [17]Jones et al. 2006

Climate change

- In southern Africa, no-tillage systems sequestered 11 t/ha/year of CO_2[18]
- In Brazil no tillage systems of maize-lablab and maize-castor bean increased soil carbon contents by 47% and 116% respectively.[19]
- Yet the carbon sequestration potential of conservation agriculture has to be studied and thoroughly proven.[20]
- A study by Ogle et al.[21] suggests that observed decreasing soil carbon contents under no-tillage practices depend on decreased carbon inputs resulting from decreasing yields in humid-cold regions.
- There are also claims that no-till has greater adaptation potential than mitigation: no-till carbon sequestration is difficult to quantify and to include in the carbon market as huge areas would be needed for beneficial remuneration.[22] Direct incentives for agriculture's mitigation activities seem a better option. The government or other responsible authority would have to set rules for eligible practices and payment amounts.[23]

Costs and benefits

- Farm operation costs go down as the need for inputs decreases. Higher yields also mean greater resource-use efficiency and larger profits.
  - In Nebraska, USA, the use of pivot irrigation in combination with no-tillage has brought irrigation energy savings of US$ 35-58/ha.[24]
  - In large mechanized soy and maize farms in Brazil, total weed control costs decreased from US$ 208 to US$ 184/ha.[25]
- A 9-year study of small farms in Paraguay with a manual labor force reported a reduction in labor costs of 12% per farm and an increase of net farm income of up to 77%/farm/year.[26]
- Cost reductions of 40-50% with no-tillage.[27]

[18]Derpsch et al. 2010, [19]Ibid, [20]Baker et al. 2007; Govaerts et al. 2009, [21]Ogle et al. 2012, [22]Gattinger et al. 2011, [23]Horowitz and Gottlieb 2010, [24]Pryor,2009, [25]Clay 2004, [26]Pieri et al. 2002, [27]Jones et al. 2006

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