Key agronomic factors affecting the success of Conservation Agriculture in the irrigated cropping systems of the Bajio (Mexico)

Agricultural landscape in the Bajio

The smallholder farmers of the Bajio face serious threats to the sustainability of their agriculture such as decreasing profitability of cereal farming, dwindling availability of irrigation water and degradation of soil fertility.

Conservation Agriculture (CA) constitutes a very attractive alternative as it promises to bring about instantaneous reductions in production costs, savings in irrigation water and gradual improvements of soil fertility.

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Problems with residue management & irrigation under NT

- Most farmers prefer to burn or bal their residues since they lack the knowledge, experience and proper equipment for practicing NT with residue retention. Poor residue management under NT induces uneven emergence and low plant stands.
- Most farmers apply high doses of irrigation water (20-30 cm / ha / irrigation, and 60-80 cm / cycle are common), as a result of the cracking nature of the Bajio Vertisols, poor leveling and lack of proper socio-economic incentives for saving water. Water logging is common under these circumstances, especially if residues are left in place.
- Farmers furthermore claim that residue retention tends to make furrow irrigation more difficult since their presence may prevent timely cut-off of water entry in the furrows and may cause water to circulate randomly among adjacent furrows.

Towards successful management of No-Tillage in the Bajio

Large amounts of residues are typically produced.

A participatory research / development project called ASOSID was launched in 2001 (Triomphe et al., 2003) to promote large-scale CA adoption in the Bajio. It emphasizes the following aspects:

- Large-scale diffusion of available NT technology,
- Development and local adaptation of generic CA principles or current NT technology.

Excessive amounts of water are commonly applied even under NT.

Table 1: List of key NT technologies being tested in the Bajio, Mexico.

Technology being tested	Objectives / Issues being addressed	Years necessary to obtain results
Full vs. partial residue retention	How best to manage large quantities of residues; quantify impact on soil fertility over time	3 to 5
Diversification of rotation (introduction of leguminous and oleaginous crops)	Better residue turn-over, reducing pests and diseases, improving soil fertility, introducing crops with low water requirements, looking for more profitable crops & rotations	3 to 10
Planting on permanent beds	Reduce seed and fertilizer rates, reduce water use, controlled traffic	3 to 5?
Better irrigation management	Reduce water use by decreasing depth of water applied, intervals between irrigation or number of irrigations	3 to 5?
Reduced N fertilizer rates	Reduce production costs and environmental pollution	3 to 5

Table 2: Selected results obtained with the use of NT technologies in the Bajio, Mexico

Variable	NT with100% residues	NT after baling	NT after burning	Conventional Tillage
1. Results with commercial barley production, winter 2001-2002				
Total production costs (US $/ha)	550	n.a	500	670
Estimated Yield (t/ha)	6.5	n.a	5.8	5.7
Net return (US $/ha)	470	n.a	420	230
2. Water use (m3 / ha)				
Commercial wheat, 2001-2002	5,582	n.a	6,556	n.a
Experimental barley, 2002-2003	3,503	n.a	n.a	5,834

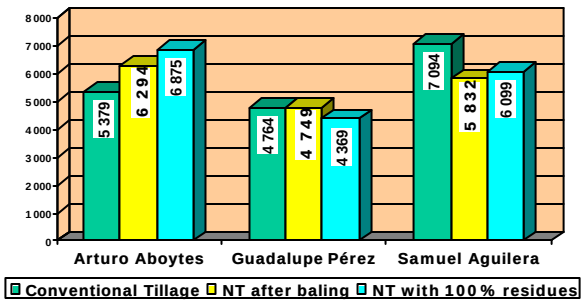

Figure 1: Experimental Barley yield (kg/ha) with 3 levels of residue retention in the Bajio, México, 2002-2003.

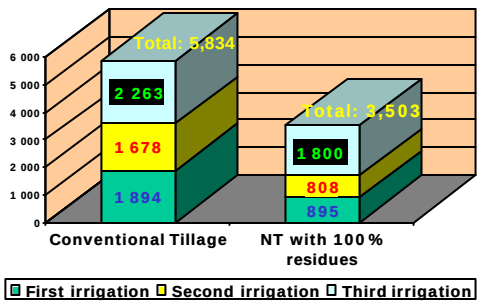

Figure 2: Water use (m3/ha) in experimental barley with 2 levels of residue retention in the Bajio, México, 2002-2003.

Preliminary results obtained (2001-2003):

- NT allowed a reduction in overall barley or wheat production costs while maintaining or even improving slightly the yields, translating into sharp increase in net returns per ha (Table 1).
- Uneven residue distribution led to poor results under NT (Figure 1).
- Planting only 2 rows on top of the bed allowed good yields with low seed rates (Table 3).
- NT with residues also appeared to allow significant savings in water use (Table 2, Figure 2).

Table 3: Barley yield and yield components with different seed distribution and seed rates in the Bajio, Mexico, 2002-2003

Experiment	Variable	Conventional planting	Double furrow (low density)
Arturo Aboytes Cultivar: Esperanza Seed rate: 150 y 75 kg/ha	Estimated Yield (t/ha)	6,875	4.522
	Nº of spike/m2	387	211
	Nº of grains/spike	42	51
	Weight of 1,000 grains (g)	43.0	42.6
Guadalupe Pérez Cultivar: Esmeralda Seed rate: 126 y 72 kg/ha	Estimated Yield (t/ha)	4.764	4.809
	Nº of spike/m2	343	272
	Nº of grains/spike	36	45
	Weight of 1,000 grains (g)	38.3	39.7
Samuel Aguilera Cultivar: Esperanza Seed rate: 134 y 76 kg/ha	Estimated Yield (t/ha)	6.099	6.351
	Nº of spike/m2	370	380
	Nº of grains/spike	43	46
	Weight of 1,000 grains (g)	38.5	36.0

Vigorous sorghum growth under NT with full residue retention.

Maize planting under NT on standing barley residues.

Perspectives

Conservation Agriculture contributes effectively to increasing profitability of cereal farming and to reducing water consumption in the Bajio.

Conceptual and practical training of farmers and extension as well as quality technical assistance to farmers will be key for achieving CA adoption over a short time frame (5 years).

Devising innovations in irrigation management and nitrogen fertilization constitute additional ways of ensuring the future sustainability of the Bajio agriculture. Innovations will also be needed in the organizational arena.

Achieving active farmer participation and leadership is of paramount importance to ensure the success of the corresponding efforts.

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