Winter cover crop: contribution to sustainable No-till cropping systems in Uruguay.

Ing. Agr. Oswaldo Ernst

Departamento de Producción Vegetal. Facultad de Agronomía, Estación Experimental Mario Alberto Cassinoni, Universidad de la República, Ruta 3, km 363, Paysandú 60000, Uruguay.

Introduction

Driven by increasing grain prices, the area of grain crops in Uruguay increased substantially since 2002. Annual cropped area in Uruguay increased from 400 thousand to 2 million ha in 10 years, with soybean and wheat sown on 50 and 25% of the area, respectively. This large increase in cropped area was achieved by shifting the production systems from crop-pasture rotations to continuous annual cropping under no-till systems (Franzluebbers et al., 2014; Wingeyer et al., 2015). As a consequence of this shift, soybean and maize are sown now after a winter fallow (73%) or in a double cropping system following barley or wheat (27%) (DIEA 2015). We discuss effects of cover crop type, dry matter produced by cover crop and its terminate date on soil properties and grain production.

Quantifying the problem

The rapid decomposition of Soybean residues provide limitedsoil covert, increasing soil water erosion risk yet under no-till systems (Figure 1).

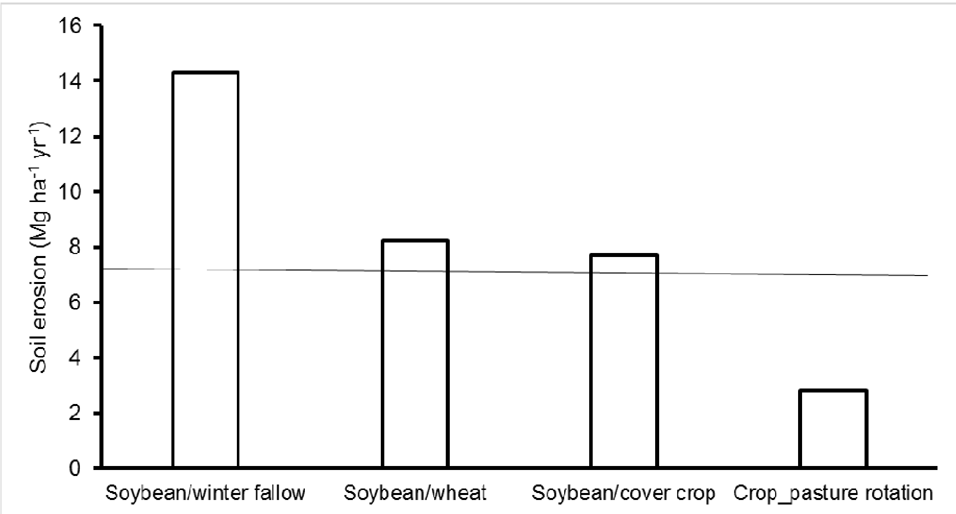

Figure 1. Estimated soil erosion under different cropping systems in Uruguay. (Clérici et al., 2004).

Note: Crop-pasture rotation: corresponds to 3yr annual crop followed by 3yr perennial pasture. Line indicates soil erosion tolerance.

Estimated annual soil erosion rates for soybean mono cropping systems are usually higher than soil loss tolerance under local conditions. Therefore, these systems may also affect soil organic carbon (SOC) storage in the medium and long term, leading to negative SOC balances (Clérici et al., 2004). Under such conditions, inclusion of winter annual cover crops is now mandatory in Uruguay (Hill et al., 2015).During the last two years, more than 35% of soybean was sown after a winter cover crop, being its objective, the soil erosion control.However, winter cover crop will be a solution only when its dry matter production is higher than 4 Mg ha^{-1} (Table 1).

Table 1. Estimated soil erosion (Mg ha^{-1} yr^{-1}) in a soybean-soybean sequence according to dry matter produced by a winter cover crop.(Siri Prieto, 2011).

	Dry matter produced by winter cover crop (Mg ha^{-1})		
	0	2	5
	Soilerosion		
Fallowperiod	12	3	1
Soybeangrowing	11	6	3
Total	23	9	4

Other potential benefits

Cover crop can provide additional advantages, including soil organic sequestration,nutrients recycling, soil N enrichment, soil porosity and water infiltration rate.

Inclusion of winter cover crops in soybean monocultures had a positive impact on SOC as compared to the control treatment. Carbon active pools and PMN showed higher sensitivity than SOC to detect changes due to management practices. The increase in infiltration rates after cover crops has two important beneficial effects, improving soil available water content and reducing soil water runoff (Table 2 and 3).

Table 2. Mean values soil variables measured at seeding date of soybean after eight years of oat, raigras or winter fallow. (Sawchik et al., 2012).

Cover crop	Organic carbon g kg^{-1}		Total nitrogen g kg^{-1}		Potential mineralizable nitrogen mg kg^{-1}	
	0-7.5 cm	7.5-15 cm	0-7.5 cm	7.5-15 cm	0-7.5 cm	7.5-15 cm
Oat	34.6 a	20.7 a	3.07 a	1.91 a	80 a	19 a

Raigras	34.0 a	20.7 a	2.93 a	2.03 a	69 ab	17 a
Fallow	29.2 b	19.7 a	2.63 b	1.90 a	40 b	11 b

Table 3. Mean values of soil physical properties in early fall (before soybean harvest) after eight years of oat, raigras or winter fallow. (Sawchik et al., 2012).

Cover crop	Bulk density 0-7.5 cm g cm^{-3}	Bulk density 7.5-15 cm g cm^{-3}	Macroporosity (%)	Infiltration rate mm h^{-1}
Oat	1.00 a	1.28 a	14.5 a	9.6 a
Raigras	0.99 a	1.25 a	13.8 a	8.3 a
Fallow	1.06 a	1.28 a	11.1 b	1.5 b

Positive effects of legume winter cover crop on corn yieldhave been attributed to an increase in soil N availability through a build up of soil organic carbon and N mineralization during decomposition. While legumes residues usually decompose faster than grasses, releasing inorganic N into the soil that becomes available for the following crop, when corn is sown after a gram winter cover crop in a no-till system, reduced spring $N\text{-}NO_3^-$ accumulation in soil due to N uptake by the cover crops generated by short-term N immobilization.

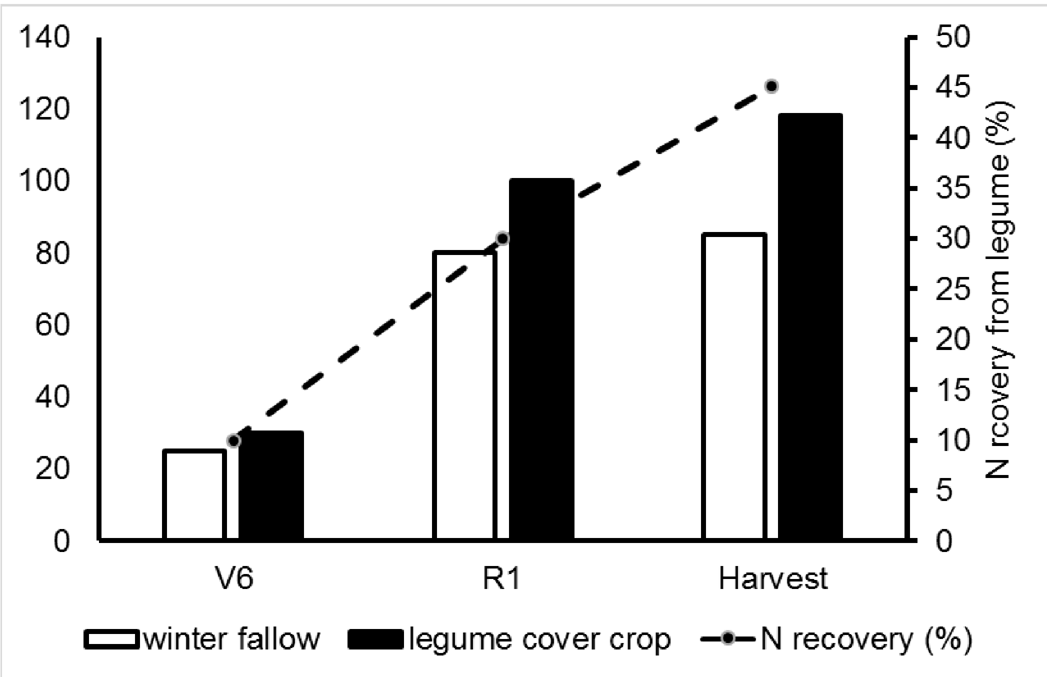

Figure 2. Corn N uptake after winter fallow or winter legume cover crop and apparent N recovery from legume residues. (Ernst, 2006).

Under Uruguayan weather conditions, an adjusted terminal date of cover crop-seeding period must be implemented in order to avoid reduced soil water and nutrients interfering with cash crops. This management practices appear more important to maize than soybeans, principally during dry spring.

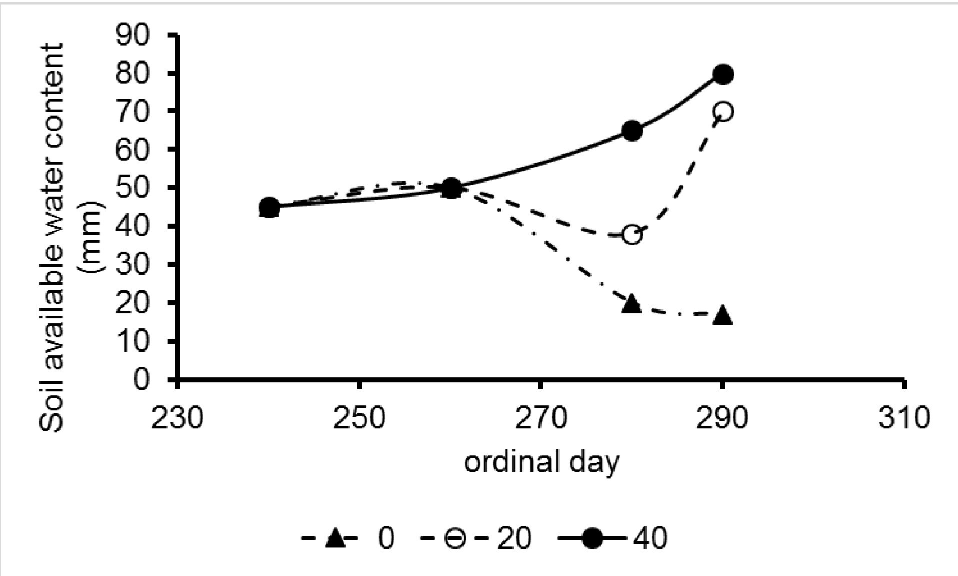

Figure 3. Soil water content (0-70 cm) at corn seeding date after three terminal date of a winter cover crop (raigras).

The effects of cover crops on soil moisture and cash crop production are depending on amount and distributions of precipitations, cover crops species and kill date, and soil type. During dry spring, cover crop depleted soil moisture content increasing the risk of cropping systems. With two months from cover crop killing date to corn seeding date cover crop did not deplete soil moisture at planting corn. Corn following grass cover crop yielded the same as following winter fallow but corn following legume cover crop yielded until 24% more than after grasses.

Winter cover crops is a fundamental component under continuous No-till systems implemented under commercial condition in Uruguay. The more relevant contribution is controlling soil erosion risk, but its contribution to sustainable agriculture includes other ecological services that must be correctly valuated.

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