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No-Till Crop-Pasture Rotation Systems

Background

Results from the oldest long-term experiment in Latin America (1962, INIA-La Estanzuela, Uruguay) indicate that continuous cropping with conventional tillage resulted in soil degradation and lower productivity, but crop-pasture rotations significantly mitigated soil degradation due to tillage, increase productivity and diversify incomes (Diaz, 1992, Garcia-Préchac *et al*., 2004).

No-till technology was introduced to Uruguay in the early 90's and was rapidly widespread and adopted by farmers. Preliminary information from midterm experiments under no-till in Uruguay suggests that the integration of no-till and crop-pasture rotations reduce erosion to minimal (Garcia-Préchac *et al*., 2004); and mitigate lost (Terra *et al*., 2006) maintain (Salvo *et al*., 2010) or even increase SOC compared with initial conditions (Diaz and Duran, 2010).

One of these experiments evaluates different crop-pasture rotations under no till for grain and animal production. This field-scale study was installed in 1995 at the 'Palo a Pique' experimental unit of the National Agricultural Research Institute (INIA) in Treinta Tres, Uruguay (33°:15'36"S, 54°:29'26"W, 60-m elevation) on fragile soils (USDA III and IV soil use capacity). The site was a 72-ha field covered by regenerated native pasture vegetation after few years of cropping with soybeans (Glycine max) and barley (Hordeum vulgare L.) under conventional tillage (chisel plowing/disking) in the 80's. Soils at the site are Typic Argiudols and their main attribute in the 0-30-cm layer were clay, 220 g kg-1; sand, 390 g kg-1 ; SOC, 20 g kg-1, available P, 0.003 g kg-1; and pH (soil:water), 5.2. Mean annual rainfall and temperature at the site are 1350-mm and 17° C, respectively.

The experiment do not have synchronic replications, but all phases of the rotations are present simultaneously; hence there are 12 experimental units of 6-ha each. Beef cattle graze crops and pastures directly and machinery operations are performed similar to any commercial farm. Cattle stocking rates are adjusted based on seasonal forage production. Flexible rotational grazing systems are used in all treatments and each experimental unit is grazed during one week 8-10 times a year.

Hypothesis: no-tillage combined with crop-pasture rotations can increase productivity and sustainability of low use capacity soils (under tillage).

Objective: determine the environmental and productivity impact of four soil use intensities in a field scale no-till crop-pasture rotations experiment under direct grazing.

Rotations (1995-2005):

- **Continuous Cropping** (CC, paddock 11): 2 crops per year: double annual cropping of oats (*Avena sp*.) or annual ryegrass (*Lolium multiflorum Lam*.) for grazing in winter, and sorghum (*Sorghum bicolor L*) or foxtail millet (*Setaria italica*) for grazing, or silage/hay in summer
- **Short Rotation** (SR, paddock, 7 to 10): 2 years of double cropping and 2 years of pasture: two years like CC followed by a biannual pasture of ryegrass and red clover (*Trifolium pretense* L.).
- **Long Rotation** (LR, paddock 1 to 6): 2 years of double cropping and 4 years of pasture: two years like CC followed by a 4 yr perennial pasture including Tall Fescue (*Festuca arundinacea*) white clover (*Trifolium repens* L.), and birdsfoot trefoil (*Lotus corniculatus* L.)
- **Permanent Pasture** (PP,paddock 12): native regenerated pasture which was overseeded every 4-5 years with annual ryegrass, white clover, and birdsfoot trefoil.

In 2005, due to evident signs of agriculture production systems intensification and expansion to new areas, treatments were reviewed and experimental units were subdivided in order to attend this new scenario. The half of each plot (3 ha) maintained the original rotation with the same sequence of crops and pastures focused in forage production; the other half included grain crops maintaining identical the pasture phase of the rotation.

This new grain based rotations consisted in:

- **Continuous Cropping** (CC): 2 years double cropping rotation of: wheat (*Triticum aestivum*), grain shorgum *(Sorghum bicolor L)*, black oat and soybeans (Glycine max).
- **Short Rotation** (SR): 2 years of double cropping of grain oat, sorghum, black oat, soybeans and wheat seeded consociated with a pasture of 2 years of red clover.
- **Long Rotation** (LR): 2 years of double cropping of grain oat, sorghum, black oat, soybeans and wheat seeded consociated with a 4 yr perennial pasture including Tall Fescue, white clover and birdsfoot trefoil.
- **Permanent Pasture** (PP)**:** included tall fescue instead of ryegrass.

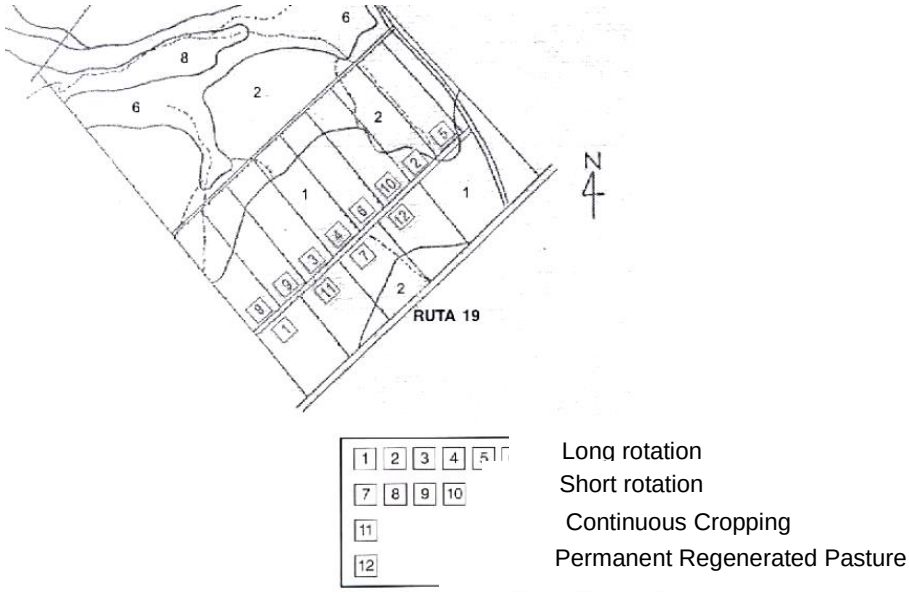

Figure 1. No-Till Crop-Pasture Rotation Systems Experimental Map (Summer 2017).

Table 1. Current Land Use.

PADDOCK	FORAGE CROPS ROTATION	GRAIN CROPS ROTATION	ROTATION
1	Improved pasture (2nd yr)	Improved pasture (2nd yr)	LR
2	Improved pasture (3rd yr)	Improved pasture (3rd yr)	LR
3	Improved pasture (4th yr)	Improved pasture (4th yr)	LR
4	Grazing Sorghum	Grain Sorghum	LR
5	Grazing Sudangrass	Soybean	LR
6	Improved pasture (1st yr)	Improved pasture (1st yr)	LR
7	Grazing Sudangrass	Soybean	SR
8	Improved pasture (1st yr)	Improved pasture (1st yr)	SR
9	Improved pasture (2nd yr) Grazing Oat	Improved pasture (2nd yr) Grain Oat	SR
10	Grazing Sorghum	Grain Sorghum	SR
11	Sudangrass (hey)	Soybean	CC
12	Improved Native Pasture	Improved Native Pasture	PP

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