Rice yield under contrasting rice rotations systems in a temperate zone of South America.

I.Macedo; J.Castillo; N.Saldain; S. Martinez; G. Zorrilla; J.A. Terra.
National Institute of Agricultural Research (INIA-URUGUAY). Ruta 8, km 281, Treinta y Tres, Uruguay.

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Introduction

Uruguay rice productivity is one of the top in the world, showing a sustained increase from approximately 5 Mg ha^{-1} in the late 80´s to up to 8 Mg ha^{-1} in last yrs. Rice usually rotate with perennial pastures (mix of grasses and legumes) integrated with beef production systems. This allows farmers sustain high productivity, preserve natural resources, diversify incomes and minimize the use of pesticides and fertilizers (Deambrosi, 2003; Pittelkow et al., 2016). However, there are a persistent interest for farmers to intensify their production systems including other crops (soybeans and sorghum) and shorter productive pastures. The objective of this work is to evaluate the impact of alternative rotation systems on rice yield during the stabilization of a prospect long term experiment.

Materials and Methods

A field-scale long term experiment was installed in 2012 in a Natraquoll located in eastern Uruguay (33° 16' 23'' S; 54° 10' 24'' O; 22 MASL). It was used a basic design, in a randomized complete block with three replications and all phases of rotations presented simultaneously (Patterson, 1964). The experiment consists in 6 alternatives of rice rotation systems with contrasting soil use intensity. In this work, we analyzed four treatments: Continuous Rice (CR)(1yr); Rice-Soybean (RS)(2yr); Rice-Soybean-Rice-Sorghum (RSRSg)(4yr) and Rice-Rice-Permanent Pasture of tall fescue, white clover and birdsfoot trefoil (RRPP)(5yr); cover crops were sown in winter between cash crops in all rotations and pastures of RRPP were grazed with lambs. Crop management practices, including nutrients, pest and weeds control and cultivars seeded were chosen specifically for each rotation, and are not necessarily the same. Rice yield (13%H) was determined in each 1200 m^2 plot, using a combine and a wagon with a digital balance. Yield components were determined with 6 destructive samples (0.34 m^2 each) in each plot to estimate, plants m^{-2}, panicles m^{-2}, grains . panicles^{-1}, and seed size (g per 1000 seed). Two models were fitted, the first one to discount the cultivar effect using the 2014-15 data and the second one to estimate the rotations effect on rice yield and yield components using 2015-16 data.

Results and Discussion

The average rice yield for all seasons was 9450 kg.ha^{-1}. The highest yield was obtained in the 2015-16 season, when RSRSg reached the greatest yield for all seasons (Table 1). The coefficients of variations (CV) between seasons were between 7.6 and 12.9% for 2012-13 and 2013-14 seasons, respectively. For rotations CV were between 7.0 and 12.7% for RSRsg and CR, respectively.

Table 1. Mean rice yield (kg.ha^{-1}) for each year and rotation

Season	Rotation			
	CR	RS	RSRSg	RRPP

2012-13	8274	8656	9497	8684
2013-14	8283	9451	10432	8048
2014-15	10095	10203	10076	9085
2015-16	9349	10253	10594	9779
Average	9000	9641	10150	8899

Note: CR: continuous rice, RS: rice-soybean, RSRSg: rice-soybean-rice-sorghum, RRPP: rice-rice-permanent pasture.

There was a rotation effect on rice yield (p=0.0029) in the year of stabilization (2015-16). The CR had 14 % (8827 kg.ha^{-1}) lower yield than RRPP. No differences were found between RRPP and rotations that include other crops (RS and RSRSg). The highest yield was obtained in the RRPP rotation (10148 kg.ha^{-1}), followed by RSRSg and RS with 10017 and 9804 kg.ha^{-1} respectively (Figure 1).

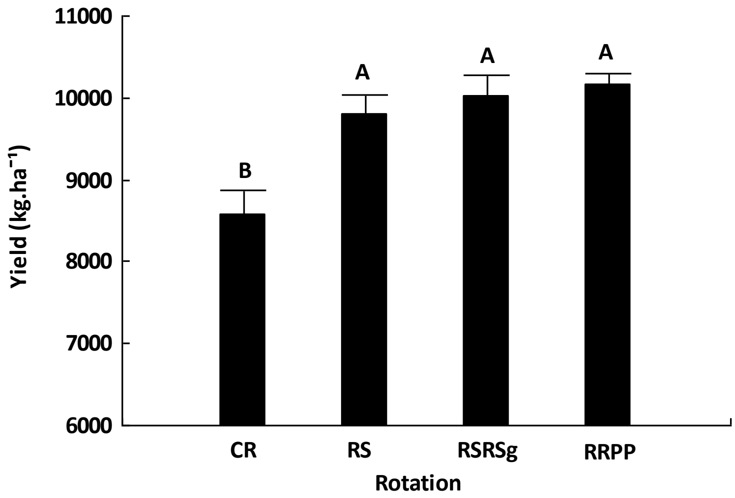

Figure 1. Rice Yield in CR: continuous rice, RS: rice-soybean, RSRSg: rice-soybean-rice-sorghum, RRPP: rice-rice-permanent pasture for the harvest 2015-16. Letters shows significantly statistical difference between treatments (Fisher, p<0.05).

Plants m^{-2} were related with yield (p=0.028); while the other yield components were no significant. The CR had 11% lower plants than the average of other treatments (142 plants m^{-2}).

Similar results were found by Xuan et al., 2011 were rotations with alternative crops (Mungbean and Maize) increased rice yield by 24-46% compared to rice monoculture. Crop rotation has some advantages compared with rice monoculture because disease, weeds and pest cycles are disrupted when diverse crop species are grown in sequence (Leighty, 1938; Kinloch, 1983 and Reeves 1984).

Conclusion

Our data suggest for non-degraded soils in temperate climates, managed historically with a rice-pasture rotation, like those prevalent in eastern Uruguay, no differences on rice yield are expected during the transition to more intensive rotations systems that include other crops. Nevertheless, rice yield in monoculture was depressed after 3 yrs. compared with other rotations including either pastures or alternative crops. Nutrient, soil properties, weeds, pests and diseases dynamics, which are under study in the experiment, will help to understand the processes related with yield responses during the transition and in the long term once rotations are stabilized.

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References

Deambrosi E (2003) Rice production system in Uruguay and its sustainability. Proceedings of the III International Conference of Temperate Rice, Punta del Este, Uruguay, INIA.

Kinloch RA (1983) Influence of maize rotations on the yield of soybean grown in Melodogyne incognita infested soil. J. Nematology 15:398-405.

Leighty CE (1938) Crop rotation. p. 406-430. In: Soils and Men. USDA Yearbook of Agriculture. U.S. Government Printing Office, Washington, D.C.

Patterson HD (1964) Theory of cyclic experiments. J. R. Statist. Soc. 26, 1–45.

Pittelkow, P., Zorrilla, G., Terra J., Riccetto, S., Macedo, I., Bonilla, C. Roel, A. 2016. Sustainability of rice intensification in Uruguay from 1993 to 2013. Global Food Security 9: 10-18.

Reeves TG (1984) Lupins in crop rotations. p. 207-226. In: Proceedings of the I11 Iriternational Lupin Congress. June 4-8, 1984, La Rochelle, France.

Xuan D, Guong V, Rosling A, Alström S, Chai B and Högberg N (2012) Different crop rotation systems as drivers of change in soil bacterial community structure and yield of rice, Oryza sativa. Biology and Fertility of Soils 48:217–225.