Intensification alternatives to rice-pasture systems: energy use efficiency

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Introduction

Agricultural ecosystems provide the food, fiber and fuel needed for population.

Achieve high efficiencies and low energy consumption are necessary to achieve sustainable systems.

Rice in Uruguay has historically rotated with pastures.

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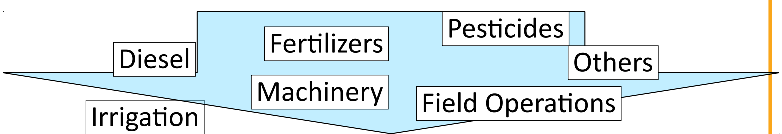
Objective

The aim of this study was to evaluate different intensification ways on energy return on investment (EROI), energy input (EI) and energy output (EO) for four rotation systems.

Material and Methods

Figure 1. Uruguay landmark and LAC map and an aerial picture of the rice-based long-term experiment rotation systems.

- Data from a field scaled long term experiment conducted since 2012 corresponding to harvest 2015-2016 and 2016-2017 were used.
- Life cycle analysis methodology was used, study boundaries were gate to gate and functional unit was MJ ha-1 of rice grain, soybean grain and meet production.



Year	1		2		3		4		5		6	
ROTATION	S-S	F-W	S-S	F-W	S-S	F-W	S-S	F-W	S-S	F-W	S-S	F-W
1) continuous rice (RC)	Rice	cc	Rice	cc	Rice	cc	Rice	cc	Rice	cc	Rice	cc
6) rice-soybean (R-S)	Rice	cc	Soybean	cc	Rice	cc	Soybean	cc	Rice	cc	Soybean	cc
3) rice-short pasture (R-PS)	Rice	Permanent Pasture			Rice	Permanent Pasture			Rice	Permanent Pasture		
4) rice-longt pasture (R-PL)	Rice1	cc	Rice2	Permanent Pasture							Rice1	cc

Rice grain

Meat production

Soybean grain

Figure 2. Rotation systems, inputs used, and main output products evaluates in the long-term experiment

Results

Table 1. Mean values ± standard deviation and number of replicate (n) of physical production of rice grain, soybean grain (kg ha^{-1}) and pastures dry matter; and estimated beef production kg $(ha\ yr.)^{-1}$

Rotation*	Rice	Soybean	Forage	Meat
R -PL	10,103 ± 943 (12)		6,636 ± 678 (18)	294 ± 30
R -PS	10,276 ± 792 (6)		5,159 ± 1,169 (6)	221 ± 50
R-S	10,512 ± 534 (6)	2,868 ± 797 (6)		
Rc	9,741 ± 572 (6)			

*R –PL: rice and long pastures; R –PS: rice and short pastures; R-S: rice and soybean; Rc: continuous rice.

Table 2. Energy information expressed in MJ (ha yr^{-1})for mean value and standard deviation of invested energy and produced energy in different rice rotation systems.

Rotation	Energy input	Energy output
R -PL	10,607	64,540 ± 2,309 D
R –PS	14,500	80,697 ± 6,117 C
R-S	15,153	109,803 ± 11,279 B
Rc	26,117	149,158 ± 8,765 A

Values followed by the different letter are significant different for a P<0.05

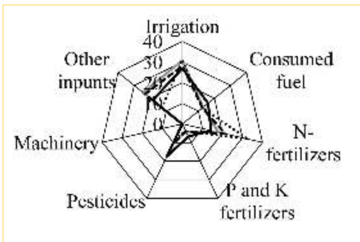


Figure 3. Distribution of energy invested in four rice production systems expressed in percentage unit. Continuous rice (RC, black points); rice-soybean (R-S, black line); rice, and short time of pastures (R-PS, segmented line) and rice long pasture (R-PL, grey line).

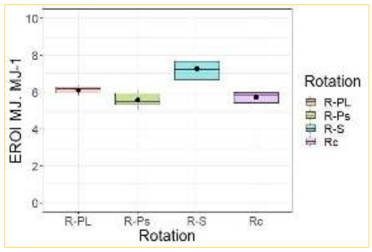


Figure 4. Energy return on investment (EROI) expressed in MJ MJ^{-1} in different rice rotation systems. Continuous rice (RC); rice-soybean (R-S); rice and short pastures (R-PS) and rice and long pasture (R-PL).

Conclusions

Include shorter pastures or realize rice monoculture as a way of rice-pasture intensification implied a decrease in energy efficiency, only rice rotating with soybean improve the energy efficiency. However, R-PL was the system that had the lowest energy inputs, which it makes more sustainable system in terms of energy.

Acknowledgments

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