Sustainable Intensification Pathways in Uruguayan Rice Systems

G. Zorrilla[1], J. Terra[2]

[1]National Institute for Agricultural Research – INIA Uruguay gzorrilla@inia.org.uy
[1]National Institute for Agricultural Research – INIA Uruguay jterra@inia.org.uy

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EXTENDED ABSTRACT

Introduction

Rice is one of the main products of Uruguayan agriculturally based economy. It is a well integrated agribusiness completely devoted for export, with more than 95% of annual crop being sold to more than 50 countries. With only 170.000 ha seeded each year and an average yield of 8 Mg ha^{-1}, one of the highest actual yields per hectare registered worldwide (GYGA, 2016), Uruguay ranks 7th among global rice exporters (FAO, 2016). Uruguayan rice is recognized by the market for its high quality, obtaining premium prices among long grains. Furthermore, rice usually rotates with perennial pastures (mix of grasses and legumes) integrated in animal production systems for beef and wool, a sustainable system with relatively low agrochemical inputs and reduced environmental impacts.

Nevertheless, rice farmers struggle for reasonable economical returns due to high production costs and low international grain prices. In a country with an open economy and without any kind of subsidies, the only option is a continuous effort on improving rice sector own competitiveness. This task is being undertaken by joint initiatives of the private and public actors, along the whole Uruguayan rice chain. Higher yields, lower costs, improved and market oriented grain quality, clear and comprehensible sustainability principles, low environmental footprint are some of the interconnected goals, not only for actual production but also for new technical guidelines for a sustainable intensification road. This paper reviews some of the main actions on this matter.

Sustainable Intensification Pathways

Yield Potential and Yield Gap of Uruguayan Rice – for many years yield potential of rice crop in Uruguayan agro climatic conditions was subject of debate, with some people saying that farmers were reaching a biophysical yield ceiling when obtaining 10 Mg ha^{-1} in their fields. In 2016 these values were estimated, modeled and mapped in a joint effort of INIA and the University of Nebraska, Lincoln, applying the methodology and protocols developed by GYGA (www.yieldgap.org). Results showed an average yield potential of 14 Mg ha^{-1} for the different Uruguayan rice regions, a country mean actual yield of 8 Mg ha^{-1} and an exploitable yield gap of 3 Mg ha^{-1}, indicating that it would be possible to continue improving rice yields and close the existing exploitable yield gap (Carracelas et al., 2016).

Breaking the Yield Barrier – A joint project among INIA, the Rice Farmer´s Association (ACA), and the Rice Millers Association (GMA), partially funded by National Agency for Research and Innovation (ANII) was launched in 2013, to explore how much extra yield could be obtained integrating known technologies including improved varieties. The aim was to check if combining available crop management options there were chances to increase up to 10% the leader farmer´s yields. The best 40 famers of the Eastern region of the country were identified and personal surveys were performed with each one. A

"standard leader farmer crop management" was extracted from this data and two-year farm field experiments were run during 2014-15 and 2015-16 seasons, contrasting this management package with other improved alternatives proposed by the project technical team. Preliminary results indicated that even the standard best farmer´s management could reach up to 12-13 Mg ha^{-1} when properly applied and some of the proposed improvements were able to increase yields by 10% over those values (Deambrosi et al., 2016). During 2016-17 field scale validations with improved management are being tested with farmers.

Sustainable Development Solutions Network (SDSN) – This is a United Nation´s initiative to mobilize global scientific and technological expertise promoting practical problem solving for sustainable development, including the design and implementation of the Sustainable Development Goals (SDGs). Under Group 7 of the SDSN: "Sustainable Agriculture and Food Systems" (http://unsdsn.org/what-we-do/thematic-networks/sustainable-agriculture-and-food-systems/). Uruguayan Agriculture (including rice) has been selected as pilot case together with United Kingdom and China. Backcasting exercises are being currently developed with the aim of identifying a sustainable pathway plan for the rice sector that accurately reflects market projections and the needs and goals of the different actors. Those findings will be integrated into the Uruguay-calibrated T21 model in order to better understand the potential trade-offs and synergies between the various subsectors of Uruguay's agricultural sector.

Sustainability of Rice Intensification in Uruguay – A specific study was done during 2014-2015 to draw the sustainability indicators of rice production in Uruguay from 1993-2013, a period of significant intensification. National rice production and crop management records were used to estimate energy, nitrogen, water, and carbon footprints and agrochemical contamination risk for the rice phase of typical rice-pasture rotations in Uruguay. Results suggest that improvements in crop management can have substantial, positive impacts on resource-use efficiencies, yields, and environmental indicators. At the same time, higher N fertilizer rates and the sporadic use of insecticide applications posed increased environmental risk, representing potential areas of concern. The vertical integration of Uruguay's rice sector, which facilitated the rapid adoption of improved agronomic practices and the growth of a high-value export market, demonstrates it is possible to boost food production while addressing environmental impacts (Pittelkow et al., 2016).

Monitoring Environmental Footprints – Since 1996 several projects co-executed by INIA, Rice Farmer´s Assoc., Millers Assoc., National University and LATU have been monitoring agrochemical residues in soil, water and grain in different regions and basins. Results are almost always below international standards and no relevant contamination has been identified so far. Carbon footprint has been calculated for the entire rice agribusiness chain, and results show that 78% of emissions come from the field crop and that more than 90% corresponds to methane. These studies have been the basis for a Good Agricultural Practices Guide released in 2013 and with a new version underway. (http://www.aca.com.uy/wp-content/uploads/2014/07/GUIA_DE_BUENAS_PRACTICAS_marzo_2013.pdf). Greenhouse gas emissions are also being studied with the aim of identifying agricultural practices that allow reduction of yield-scaled global warming (Tarlera et al., 2015).

Rice Rotations Long Term Experiment - This experiment was installed in 2012 in Paso de la Laguna Experimental Station to evaluate the sustainability of contrasting rice rotations systems. It includes the study of crops and pastures management and productivity, economic performance, dynamics of pests, weeds and diseases, nutrient balance, soil

quality indicators and GHG emissions. The 12 ha experiment is expected to run for at least 20 years and has six contrasting rotations, with 3 replications in space and with all phases of each rotation present simultaneously. The most intensive rotation is continuous rice, while in the other extreme is a classical 2-yr rice/3-yr pastures rotation. The other four rotations are intermediate combinations of rice, pastures, and other crops (soybean and sorghum) all managed with conservation tillage. The experiment is stabilizing in its fifth year and it will be the main platform for research on sustainable intensification in the immediate future (Macedo et al., 2016).

Discussion

Uruguayan farmers have enough room for increasing yields as estimated by Yield Gap analysis and considering preliminary results from Breaking Yield Barrier Project. Sustainability indicators show a good environmental performance up to now, with some concerns on few variables related with N rates increase and sporadic use of insecticides. The main challenge ahead is to identify sustainable intensification pathways for the whole rice rotation system, improving production and profit, and at the same time preserving or improving environmental indicators and natural resources. The SDSN project, the Rice Rotation Long Term Experiment and new efforts to develop well balanced and recognized sustainability indicators will help guiding and monitoring this evolution for decision makers and the rice sector.

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