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1 Introduction

The integrated assessment of farming systems and the ex-ante analysis of future agricultural scenarios commonly make use of simulation models reproducing the sub-domains of the agro-ecosystems(Delmotte, Lopez-Ridaura *et al.* 2013). In the ScenaRice project we propose to integrate the information produced by stand-alone tools and models (e.g., field data, farmers' interviews, remote sensing analysis, crop model results, expert-based rules, farming system typologies, optimization models) to assess at different levels of complexity and scales the consequences of possible evolutions of rice farming systems. Central to our approach is the development of future scenarios considering plausible changes in agricultural policy, technological development and climatic conditions. Then, the different tools and models provide information at different scales to assess these scenarios: the field, the farm and the region. We applied this combination of data source in case studies in the main Italian and French rice areas and to some extent, to case studiesinMadagascar and Sierra Leone. In this paper, we present the articulation of the different sources of information for the assessment of scenarios related to the evolution of the rice farming systems in Camargue, South of France.

2 Materials and Methods

The Camargue is a deltaic region in the South of France, characterized by low lands almost at sea level, and a mosaic landscape composed of natural and cropped area. Rice and wheat are the most important crops and their future in term of production level and presence in the area is threatened by multiple drivers, including climate change, economic and regulatory conditions. Four scenarios were developed through three workshops with representative of the main stakeholders of the region. These scenarios were then assessed using the different tools and data source above mentioned and detailed below. Remote sensing analysis of time series of MODIS satellite images allowed to estimates dates for the main agricultural management practices and phenological stages of rice and wheat based cropping systems(Boschetti, Stroppiana *et al.* 2009). This information has been used as inputs for the STICS (Coucheney, Buis *et al.* 2015) and WARM (Confalonieri, Rosenmund *et al.* 2009) crop models parameterized to reproduce the development and growth of the most cultivated rice varieties. The simulation outputs allowed assessing quantitative (e.g.,aboveground biomass and yield) and qualitative aspects (e.g., head rice yield, protein content) of rice productions and of the other main crops (notably wheat and alfalfa) at field scale. The outputs of crop models, combined with other existing databases and farmers interviews, served to (i) define agricultural activities being currently done in Camargue and that could be possible in the future (considering the scenarios developed), and (ii) to assess the potential performances of these activities (and their variability) under different climate change scenarios. Remote sensing also provided information about the land use(e.g. cultivated surface of winter and summer crops) at farm level for 13 consecutive years, to identify main current trajectories of change. We conducted multivariate analysis of databases (including the farm trajectories identified using remote sensing) to build farm typologies. Finally, a multiple goal linear programming model has been developed to assess the scenarios in term of trade-offs and combinations of resources allocation, regarding a set of indicators at farm and regional level including socio-economic and environmental indicators (e.g. pesticide use and green-house gases emissions)(Lopez Ridaura, Delmotte *et al.* 2014). The integration of all the data allowed the integrated assessment of future farming systems in the context of the four scenarios built together with local stakeholders.

3 Results – Discussion

The four scenarios developed with the main stakeholders of the region are related to the economic and regulatory conditions for the rice production and to the impacts of climate change, including also drivers such as the price of energy and inputs, regulations related to pesticide use and greenhouse gas emissions, and the development of organic

farming. In the communication, we will show the results obtained with the different tools and models at the field, farm and regional levels with examples taken from the different scenarios identified. Fig. 1 A presents the validation of the remote sensing analysis of wheat sowing dates, over 3 farms and 3 years. This analysis was extended to the whole region and for the 2001-2010 period, allowing us to analyze and understand the variability of wheat sowing date, notably in relation to the distribution of raining events in fall. From this analysis, we derived rules to determine potential wheat sowing dates to be used for simulations of climate change scenarios with the STICS and WARM crop models. Fig. 1 B shows the validation of the STICS crop model for the simulation of rice in Camargue, by comparing for multiple years observed and simulated yield variability. Both the STICS and WARM were used to simulate rice activities in Camargue, while STICS was used to simulate the other crops. Finally, fig. 1 C shows the impacts of the applicationof a given scenario on multiple indicators of alternative farming systems for a single farm, obtained from both an expert prototype and a bio-economic model. The bio-economic model was used to simulate the consequences of the four scenarios on the different farm types of Camargue (identified in the farm typology) and to upscale the consequences at the regional level, notably including indicators related to the supply-chain, the water quality, the greenhouse gas emissions or the feeding potential of agriculture in the region. These results will be presented in more details in the communication.

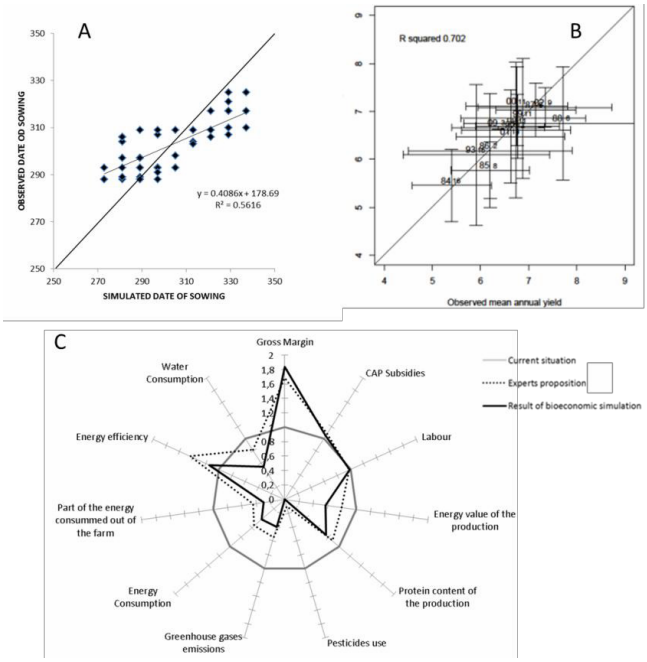

Fig. 1. A. Comparison of observed and simulated (estimated by remote sensing data analysis) sowing dates of wheat for three farms over three years in Camargue. **B.** Comparison of the variability of observed and simulated rice yield in Camargue with the STICS crop model for 11 different years. **C**. Comparison of three farming systems for one of the scenarios: the current situation, a prototype developed by experts and a farming system designed by the bio-economic model.

4 Conclusions

The integrated assessment of the evolution of farming systems in the future requires the mobilization of multiple sources of information, given the great uncertainty associated with changes in agricultural policy, technology and climatic conditions. In the communication, we will report in more details and on the basis of real cases the results of the combination of the different tools and approaches above mentioned, and notably the original combined used of remote sensing, crop models and bio-economic model, and highlight the added value for the integrated assessment of farming systems under scenarios notably related to climate change.

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