Participatory scenarios' development and assessment for sustainable farming systems in Camargue, South of France.

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PARTICIPATORY SCENARIOS' DEVELOPMENT AND ASSESSMENT FOR SUSTAINABLE FARMING SYSTEMS IN CAMARGUE, SOUTH OF FRANCE.

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1 Introduction

In Camargue, South of France, rice cultivation plays a crucial role in desalinating the soils by being cultivated in flooded conditions and provisioning fresh water to the natural wet areas. Rice cultivation also generates employments in the rice chain and plays a crucial role in tourism sector by maintaining traditional landscapes. However, rice fields are a major source of pesticide losses (Comoretto *et al*., 2008) and most probably of greenhouse gas (GHG) emissions (Linquist *et al.*, 2012). Alternative farming systems, such as organic or low input systems, are expected to improve the sustainability of agriculture in the region (Lopez Ridaura *et al*., 2014). However, to engage actions to facilitate the development of such alternatives, policy makers and stakeholders need information about their sustainability in various possible future contexts (e.g. changes in policy, price of energy or inputs, etc.). Participatory scenarios development and their integrated assessment aim at providing information to the stakeholders about future sustainable farming systems (Delmotte *et al.*, 2013). In this paper, we present the application of such an approach in Camargue.

2 Materials and Methods

To generate such knowledge, we first developed four explorative and narrative scenarios for the future of agriculture in Camargue with key stakeholders from the regional natural park (defending stakes of nature preservation), the French Centre for rice development (promoting new rice cultivation practices) and an association of livestock breeders (defending traditional bull rearing activities). Three successive focus group sessions were organized, in order to: (i) identify the main current and future drivers of change on farming systems in Camargue, (ii) design and discuss the four scenarios and (iii) define the possible impacts of the scenarios on farming systems and the subsequent possible adaptation strategies for farmers and stakeholders.
Secondly, we assessed these scenarios using a multi-criteria methodology at farm and territorial scale (i.e. considering the whole cultivated areas of Camargue). We used a bio-economic optimization model, which identifies optimal crops' allocations under sets of objectives and constraints (Delmotte *et al.*, 2013). In this study, each of the four scenarios led to a specific set of objectives and constraints for the model, which were explored with a group of simulations, in order to assess trade-offs among different objectives and indicators: for example gross margin and labour at the farm level, and food production, GHG emissions, and pesticide use at the regional level. For each scenario, the parameterization step consisted in (i) considering only the drivers of changes that could be included in the model (e.g. not the livestock, and agrotourism activities), and (ii) quantifying remaining drivers, using existing databases, expert knowledge and bibliography.
We present below the results of one scenario designed by the stakeholders, compared with a baseline scenario (current situation) in term of crops allocations and performances.

3 Results and Discussion

The main drivers identified are related to economic, environmental and regulatory features (public subsidies, commodity prices, environmental regulations, climate change and water availability; Table 1).

Table 1. Characteristics of the Scenario 1: "Camargue is classified as a region with specific handicaps"

Main drivers of changes	**Scenario 1:** "Camargue is classified as a region with specific handicaps"
Public subsidies	- Modulated SFP (projection PAC reform) : 326€/ha to 387€/ha - Aid for the maintenance of organic farming 100€/ha - Agroenvironmental measures for : i/ploughing the rice straws : 74€/ha; ii/ sowing the rice in dry conditions : 66€/ha iii/including leguminous in rotations : 60€/ha - Compensatory allowance for permanent natural handicaps (due to salt pressure) : 150€/ha
Prices of commodities and market	- Current prices - Organic market : saturated when 20% of the Camargue is converted to organic farming
Climate Change	- Higher temperatures during rice cultivation : increase rice yields by 10%
Energy and inputs prices	- Prices of all inputs increased by 30% (water, energy, fertilisers, pesticides, seeds)

Under the scenario "Camargue is classified as a region with specific handicaps", conversion to organic agriculture and legumes incorporation in rotations seems to respond to the increase of inputs and energy prices and Single Farm Paiement (SFP) decrease (Fig.1 A&B). Legumes cropping is promoted by the creation of a specific agro-environmental measure (AEM), at the expense of rice and cereals. Although efficient regarding to gross margin and to reduce fertilizers inputs, rice straw incorporation and rice dry sowing and corresponding AEM are not chosen by the model as best options for such context of changes (Fig.1 B). In this scenario, the alternative agricultural activities lead to a reduction on GHG and particulate emissions, and a reduction in energy and water consumption (Fig.1 C).
Under this scenario, rice and cereals production volumes decrease, (Fig.1 C) which may weaken the supply chains and local processing industries. The large increase in fodder production volumes may have a negative impact on fodder prices, except if, according to stakeholders, farmers shift to export their fodder. To reduce the risk of a strong fodder price decrease, decisions makers can seek on support the livestock sector, to ensure a larger local market for this production. Better crop-livestock integration systems (such as pastured cover-crops) should also be supported in this case by public policies. Such policies can be justified by the positive impact of these fodder-based systems on environmental externalities. The adaptations to this scenario of changes also lead to a decrease in energy value of the production (Fig.1 C), i.e. fewer people can be fed by the Camargue crop productions. However, the energy efficiency remains constant due to less energy consumption. Others simulations show that intermediate adaptations, with less fodder acreages and more rice and cereal acreages, can generate different trade-offs between crop and livestock systems, and between socio-economic performances (such as labour and energy value of the production) and environmental performances. These result, as well as results at farm scale will be exposed in the final presentation.

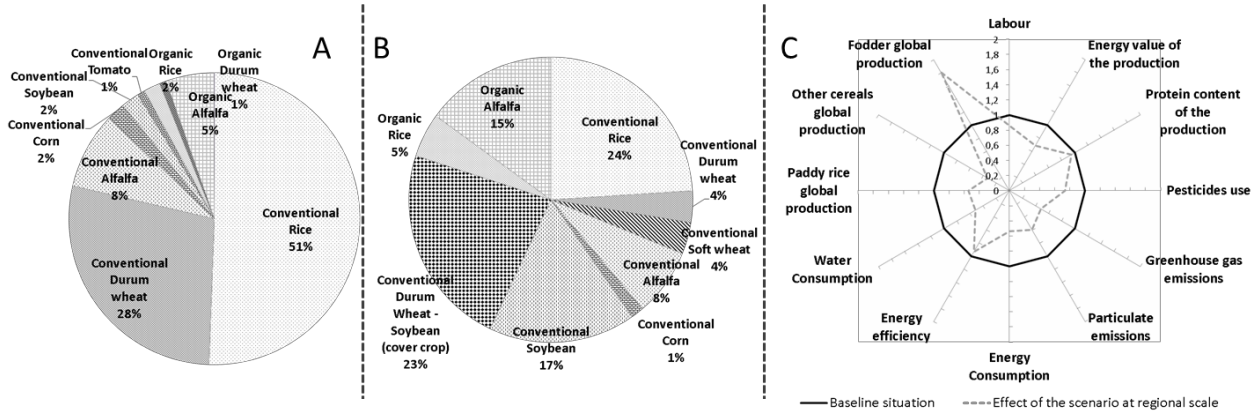

Fig. 1. Crops allocations at regional scale for baseline situation (A) and under scenario 1 (B1), and Comparison of performances for the baseline and the simulated scenario at regional scale (C)

4 Conclusions

The next step of this work, which will be exposed in the final presentation, is to compare the crops allocations and performances under the four scenarios of changes. These four scenarios are sufficiently contrasted to highlight robust adaptations under different contexts of changes. The participatory development and integrated assessment of scenarios is expected to (i) help the identification of sustainable adaptations in farming systems at both farm and territory scale, (ii) favor cooperation and negotiation by collectively stimulating knowledge, sharing opinions and exploring trade-offs between several objectives, and (iii) highlight territorial specificities to help local adaptation of public policies.

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