SCENARICE

Scenario assessment of sustainable rice production systems. Exploring plausible, probable and possible futures for sustainable rice production systems

ABSTRACT

the main objective of the SCENARICE project is to conceive, implement and appraise a methodological framework to assess the current situation and the future prospects for rice production systems at regional level. The project falls within the scientific field of integrated assessment of agricultural systems. In comparison with research already conducted in this field, our approach grounds its originality in (i) the extent of the scales of investigation (from the cultivated plot to the territory), (ii) in the participation of stakeholders engaged in rice production at farm and regional levels, (iii) in the “scenario” oriented process of evaluation and finally (iv) in the combination of different types of modeling and simulation techniques. A complementary objective is to explore and strengthen the synergies between four scientific fields or disciplines related to the integrated assessment: agronomy/crop modeling at plot scale, agronomy/farm and farming system analysis, remote sensing analysis (RS) and sociology/science of the stakeholder participation. Attempts to conduct such a multi-criteria, multi-scales and participatory integrated assessment of agricultural systems had already been conducted in the Camargue area, but without the use of crop models (and therefore not taking into account the sensitivity of cropping systems to climatic variability, for example), nor the use of remote sensing data to deal with the regional scale. The challenge in the Scenarice project is therefore to demonstrate the added value of the association of the different disciplines and methods related.

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GOAL

During the first year of the project, major efforts have targeted (1) to share the concepts and methods undertaken by the different disciplines and partners engaged in the project , (2) to elaborate a common framework for designing a more precise and coordinated plan for actions (3) to definitively choose the geographical areas where the case studies could be conducted in Italy, Madagascar and Sierra Leone (Camargue in France was already decided) (iv) to create collaborative platforms with stakeholders and other scientists in those areas and (v) to start the collect of data, to finalize the choice and start the development of the more relevant tools for implementing the integrated assessments in the various areas. During the second year of the project, we stressed on making operational the different tools developed in each WP while improving and detailing the exchange of information and complementarities between them.

ACTION

The WP1 is responsible of running simulations of rice cropping systems performances (as yields and other variables related to quantitative and qualitative aspects of rice productions) under different environmental (climate) and agricultural (cropping practices) conditions. For that purpose, we rely on two sets of models: the generic model STICS (developed in EMMAH, Avignon, France) and the rice specific model WARM and the generic simulator CROPSYST (the former developed and used in the Cassandra lab, University of Milano, Italy). STICS has been calibrated simulating for rice for both the Lomelina and Camargue region and other crops (notably wheat, Alfalfa) for the Camargue region, whereas WARM is specifically dedicated to rice and adapted to both Camargue and Italy, and CropSyst is calibrated to simulate wheat and maize in the Lomelina region in Italy. Concerning Rice, STICS can take into account nitrogen shortage and fertilization practices ; WARM does not take into account the impact of fertilizations on yield but allow to simulate cold induced spikelet sterility and the effects of climate on grain quality, as well as the impact of blast disease. We decided (1) to compare their outputs for the common variables they are able to simulate for rice in both Camargue and Lomelina areas and (2) to use their specificity as much as possible in order to get the most out of their complementarity. In 2014, the main focus was on the cross calibration of WARM and STICS for rice. Field data collected in the two case studies were shared between French and Italian rice partners to calibrate and evaluate model performances. The phenological development, the evolution of leaf area index (LAI) and the final value of aboveground biomass (AGB) and yield collected in the field experiments carried out in Camargue and Lomellina in the period 1984-2009 were compared to the model outputs. The available field data were split into three groups, basing on the different length of crop cycle of the rice varieties (indica and japonica with short and medium crop cycle length). This activity led to the development of parameter sets able to characterize the main group of varieties grown in the study areas. This activity allowed to further inspect the models behavior and to perform an in-depth evaluation of their performances. The good results achieved in this activity, that required massive exchanges of data and discussion between the French and Italian teams, lead us to plan the final simulations for the scenarios at the cropping systems in 2015.

For the WP3, two main objectives were assigned : (1) to provide to WP1 with spatial and inter-annual data in terms of cultural practices that can be inferred from satellite images (the most important being the variability of dates of sowing at the regional level, data that is crucial for crop modeling and almost impossible to obtain in the existing database) and (2) to supply WP2 with regional land use data (over several following years) in order to improve our knowledge about the spatial repartition of crops in the studied areas, to infer the main crop rotations at the farm level to improve the accuracy of farm typologies, notably by taking into account in the models, the trajectory of the farms. These activities were conducted in 2014 for the Camargue region, for which other sources of data were available for calibration and validation of the remote sensing models.
These two main activities were therefore developed in parallel. First, satellite images were computed for the 2001-2013 period. After a selection of images to avoid cloud contamination, algorythm of remote sensing were run for these images in order to identify the main crop in each pixel, for each year. Pixels with a low risk of error of crop classification were then selected to run algorythms to identify the date of sowing. Intra year variability was then obtained for both rice and wheat. As the intra and inter year variability of date of sowing of rice is very low (most of the fields are sown within 2 weeks around the first of May), the accuracy of the remote sensing approach was limited. On the contrary the intra and inter year variability of the date of sowing of wheat is very high, due to constraints related to the weather and soils in fall. The validation of the results by a comparison of the dates obtained by remote sensing for a selected number of farm for which farmers' interview were held, showed a great level of accuracy. We therefore decided to extend this analysis of date of sowing for the wheat crop only. The intra and inter year variability of date of sowing was therefore retrieved for the above mentioned period, and the data are being analyzed to be transferred to WP1 for the simulations of the wheat activities. In particular, an analysis of the effect of climate on the date of sowing will be conducted in 2015 in order to derive some rules for sowing dates estimations based in climate data, what will be needed to run cropping system models under climate change scenarios. Regarding the second objective, the same images were analyzed at a finer level. Exchanges with WP2 allowed identifying some rules for merging fields within each farm that had the same cropping patterns in the past (in a GIS layer) to get clusters of fields for which the scale correspond to a few pixels in the satellite images. Then, per clusters, remote

sensing was done to retrieve the land use for the 13 consecutive years, in order to be able to analyze the land use changes at the farm level. These data were produced at the end of 2014 and they are being analyzed to be used for improving the farm typology in 2015.

RESULTS

In 2014, the WP2 stress on two major tasks :
(1) In the Camargue study case we worked on developing, with the stakeholders, scenarios of change for the agricultural systems, identifying the main drivers acting and exploring the possible futures and the way farmers could adapt ; in the meantime we also improve and broaden the data base of agricultural activities in order to be able to take into account new activities (crops) or new organizations as a farmers' response to these changes (CAP reform).
(2) In Lomellina, data about the farming and cropping activities were gathered and analyzed in preparation of activities to be held in 2015: the development of scenarios, and the use of models for the integrated assessment of these scenarios. Stakeholders were contacted to organize early in 2015 a workshop for scenario development.
(3) In Sierra Leone, preliminary works related to the implementation of the Scenarice framework were conducted during a three month stay of post-doc Andrea Porro in the Makeny region. A survey was used to get data about the cropping and farming system. More than hundred farmers were interviewed, and the data were recorded in a database.

The analysis of this database led to the description of the diversity of cropping activities, as well as to a proposition of a first classification of the farming systems. The next step originally planned was to work on developing the scenarios, however, the Ebola outbreak prevented the continuation of the activities of Scenarice in Sierra Leone for now.
(4) In 2014, activities in Madagascar were conducted through the work of Clementine Maureaud (master thesis within the Scenarice project) who spent more than three months in the Ambohibary region. She received the support of Cara Raboanarielina (AfricaRice) who hosted Clémentine 3 weeks at the headquarter of AfricRice in Cotonou.

PERSPECTIVES

(Benin) prior to her stay in Madagascar and then visited Clémentine in Madagascar; as well as of Eric Penot (CIRAD) who was based in Madagascar during Clémentine's stay. The activities conducted in Madagascar consisted in pursuing the application of the methodological framework developed within the project for the participatory development of scenarios by select farmers and stakeholders to identify and evaluate possible adaptation strategies to climate and other global and local changes. Based on the farmers' interviews conducted in 2013 to understand the current systems and constraints to create a farm typology, focus groups were held to identify the main drivers of change and develop four scenarios notably related to climate change, existing infrastructure, access to market, and labor availability. These scenarios were then applied in the context of four farms selected to represent each significant farm typology noted in the study site. Together with the farmers, for each scenario, some adaptation strategies (e.g. new varieties, crop management, diversification of production, water control in the valley) were selected and further assessed using a farm model to simulate the impacts on relevant indicators for the farmer. This application is being finalized in 2015 by a new stay of Clémentine Maureaud in the Ambohibary region.

The project is reaching its final stage, during which the complementarities between the different methods developed in each team and WPs will show their added values for the integrated assessment of agricultural systems. During this last year of the project, we are also progressively putting efforts on communicating our results and publishing our work in international conference and peer reviewed journal. With two conferences already planned and 5 papers being under development, we should ensure a satisfying communication of our results.