DOCUMENT OF THE MEASURES OF ADAPTATION AND MITIGATION TO THE CLIMATE CHANGE IN THE EBRO DELTA PADDY FIELDS

Deliverable corresponding to Actions B4 and C2

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Different strategies to reduce GHG emissions from rice fields in Ebro Delta have been tested over the course of the LIFE EBROADMICLIM, in particular within Actions B4, B5 and C2.

The multivariate analyses conducted with data obtained from action B4 allowed us to identify the major variables governing GHG emissions and subsequently, to identify which of them could be good candidates of agricultural mitigation practices.

The following are the recommended measures to be implemented, which are under different degree of definition: some of them need either upscaling field trials to provide site-specific guidelines to farmers (AWD) or more field experiments to test its mitigation capacity (delaying straw incorporation) or long-term experiments to assess C sequestration (organic manure and straw input) .

1. **Water-management based mitigation measures during the rice-growing season: alternate wetting and drying and mid-season drainage**.
   We tested the mitigation capacity of two water-management based mitigation measures, alternate wetting and drying (AWD) and mid-season drainage (MSD), and the impact on grain yield. These two mitigation measures have been studied in different rice agrosystems yielding contrasting results on both the effectivity in reducing CH_4 emissions and impact on grain yield. The varying results suggests that their implementation need to be tested at a regional or even local scale in order to adapt it to site-specific conditions and optimize its efficiency.
   The implemented AWD consisted in alternating drainage and flooding periods: the irrigation was cut when water level reached approximately 7 cm; thereafter fields were left drain up to -20 cm deep below the soil surface and then re-flooded again. This procedure is repeated over the vegetative stage. <u>The results indicated that the implementation of AWD up to -20 cm deep reduced CH_4 emissions by 90% without compromising rice grain yield.</u> We would then recommend the implementation of AWD in Ebro Delta rice fields as a mitigation strategy provided more field trials are conducted to take the agronomic and environmental variability of rice fields in Ebro Delta i.e. soil texture, water availability, field size, etc. into account This will allow the definition of guidelines adapted to site-specific conditions that will guarantee a safe and optimum AWD implementation.
   The implementation of MSD was also tested but the poor growth of the rice in that field, not motivated by MSD implementation, prevented the evaluation of this system. However, given the good results obtained with the implementation of AWD, which has a higher stress-inducing capacity to the crop, we hypothesize that <u>MSD can be safely implemented in Ebro Delta conditions in terms of yield impact</u>, although its mitigation capacity remains to be quantified. Therefore, more field trials should be conducted to assess the mitigation capacity and impact on grain yield under different rice cultivation conditions in Ebro Delta.
2. **Injection of sediments to adapt to relative sea level rise and organic manure (chick slurry) to optimize C budget (GHG emissions vs C sequestration).**

The management and enhancement of soil organic carbon (SOC) is important for sustainable agriculture as it can enhance carbon sink capacity of the soil and so mitigate GHG emissions. Fertilization with organic manure has been proven to improve soil organic carbon in soils in the long-term although it can also promote emissions of CH_4 and CO_2. The time span of our experiment could not assess the effect of organic manure, in particular chicken slurry, but it could quantify the effects on CH_4 emissions in the short run.

The presence of iron in the sediments outcompete methanogenic activity by favouring of iron reducers microorganisms and so resulting in less CH_4 production and emissions. Taking advantage on the fact that the sediments from the water treatment plant, which could potentially be injected in the rice fields, can be rich of iron, we tested the effect of high iron concentration on GHG emissions.

The overall results indicated that organic fertilization increased CH_4 emissions but when organic manure was applied with iron-rich sediments, CH_4 emissions were levelled off at those obtained in mineral fertilization. This result, despite not being conclusive, opens a promising option for the use of sediments as mitigation measures for greenhouse gas emissions that should be further studied. If this trend is confirmed, it will be possible to recommend the use of organic manure combined with iron-rich sediments to mitigate GHG emissions by enhancing C sequestration and avoiding increases in CH_4 emissions.

3. Straw management at post-harvest

The results from B4 action showed that straw incorporation induces large emissions of CH_4, representing ca. 60% of total emissions. At the same time, straw return provides agronomic and environmental benefits such as enhancing C sequestration, soil fertility and soil biodiversity. The trials conducted in this project did not mean to study the effects of straw management on GHG emissions. However, the relevance of this practice revealed in this project led us to stress the need of further studies to find out straw management strategies to optimize carbon balance so that the benefits of crop residue return could be maintained, notably C sequestration, while minimizing CH_4 emissions. The important role of temperature on CH_4 emissions observed in this project lead us to hypothesize that delaying of straw incorporation from October to December could be considered as a mitigation measure. Its impact on global warming potential should be tested at a mid or long term.