PhD School on Agriculture, Environment and Bioenergy

(http://sites.unimi.it/dottorato_aab/)

(XXXIV cycle, 2018-20)

Project draft

1. Field of interest

Indicare il settore scientifico disciplinare: ***AGR-08***

2. Project title

Innovative and sustainable irrigation technologies and practices

3. Tutor (membro del Collegio dei Docenti): ***Arianna Facchi***

- Eventually: co-tutor/s: ***Claudio Gandolfi***

4. Relevance of the topic and state of the art:

Rice is the world's most important food crop, because it is a staple food for more than half of the world's population and the world demand for rice will increase by approximately 24% over the next 20 years [Nguyen and Ferrero, 2012]. Rice is cultivated over about 1,300,000 ha in Mediterranean countries [FAOSTAT, 2016]. Although in the Mediterranean region it is currently concentrated in specific areas, rice production has a great socio-economic and environmental importance due to the fact that it is an important staple food for some countries, for the high quality of rice produced, and for its role in the maintenance of biodiversity (many important rice areas are in river deltas, estuaries or coastal wetlands or, however, part of protected ecosystems such as the EU Natura-2000 network). The most important rice-producing EU countries are Italy and Spain in Europe (72% of the EU production; 345,000 ha).

Traditionally, rice is grown in paddies flooded from before sowing to before harvest, thus it requires much more irrigation water than non-ponded crops [Cesari et al., 2016; Cesari et al., 2017; Facchi et al., 2018]. Under flooded conditions, significant amounts of nutrients may be lost by leaching and runoff during the cropping season, with important implications on water quality [Katoh et al., 2004]. Like other important cereals, rice requires a great amount of chemicals, represented especially by fertilizers and pesticides, which can lead to water pollution in a peculiar environment like paddy. Water management has been recognized as one of the most important factors that affect greenhouse gas emissions from paddy fields; in particular, rice paddies are considered one of the most important sources of atmospheric methane (CH4), producing about 5-20% of the total emission from anthropogenic sources [USEPA, 2006] and approximately 30% of the global agriculture CH4 emissions.

Mediterranean rice agro-ecosystems are nowadays facing numerous problems, such as the need to integrate irrigation requirements with water resource availability, the protection of the environment, the need to ensure an adequate income for rice producers, the impossibility of being introduced in agricultural areas characterized by a limited water availability despite the fact that rice consumption in the Mediterranean basin is presently increasing, the lack of

specific studies conducted in Mediterranean countries taking into account environmental and socio-economic peculiarities of these areas. Due to these factors, the introduction of water management practices alternative to continuous flooding is highly required to enhance water use efficiency and safeguard environmental quality in Mediterranean rice agro-ecosystems. However, these practices must be tested and adapted to country-specific conditions.

5. Layout of the project (draft)

The PhD program will be articulated in the following tasks:

1. Collect and harmonize existing data regarding irrigation consumption and environmental impacts of rice cultivation in the main rice producing countries of the Mediterranean area (Year 1)

2. Identify major problems affecting rice production in Italy, and select the most appropriate irrigation solutions (technologies and practices); this task will be conducted through the involvement of the national rice research center, regional authorities, water managers, and private companies involved in the rice chain (Year 1)

3. Evaluate the effects of the selected irrigation options, through field experiments and agro-hydrological models. Water use efficiency and the overall impact of rice cultivation on the environment and on the on-farm economic balance will be quantified (Years 1, 2 and 3)

4. Upscale the on-farm water use efficiency and environmental impact of alternative irrigation management options to the irrigation district level (Years 2 and 3)

5 Define appropriate techno-economic, social and environmental impact indicators to evaluate the sustainability of the different rice irrigation options, identify the barriers to their adoption and propose actions to overcome the obstacles; this will be achieved by involving stakeholders identified at the beginning of the PhD project (Year 3)

6. Available funds (source and amount)

Ristec "Nuove tecniche colturali per il futuro della risicoltura" (Regione Lombardia, PSR Operazione 1.2.01, ottobre 2017), amount for DiSAA: 210,000.00 euro.
Progetti in fase di valutazione o scrittura: MEDWATERICE "Towards a sustainable water use in Mediterranean rice-based agro-ecosystems" (PRIMA); SorRiso "Introduzione della tecnica *Alternate Wetting and Drying* nella risicoltura lombarda" (Regione Lombardia Bandi Ricerca).

7. Literature (max 10 citazioni)

Facchi A., Rienzner M., Cesari de Maria S., Mayer A., Chiaradia E.A., Masseroni D., Silvestri S., Romani M., 2018. Exploring scale-effects on water balance components and water use efficiency of toposequence rice fields in Northern Italy. Hydrology Research, In press.

Cesari de Maria S., Bischetti G.B., Chiaradia E.A., Facchi A., Miniotti, E.F., Romani M., Rienzner M., Tenni D. Gandolfi C., 2017. The role of water management and environmental factors on field irrigation requirements and water productivity of rice. Irrigation Science, 35(1), 11–26. ISSN: 0342-7188. DOI https://doi.org/10.1007/s00271-016-0519-3.

Cesari de Maria S., Rienzner M., Facchi A., Chiaradia E.A., Romani M., Gandolfi C., 2016. Water balance implications of switching from continuous submergence to flush irrigation in a rice-growing district. Agricultural Water Management, 171:108–119. DOI: 10.1016/j.agwat.2016.03.018.

Katoh, M., Murase, J., Hayashi, M., Matsuya, K., Kimura, M., 2004. Nutrient leaching from the plow layer by water percolation and accumulation in the subsoil in an irrigated paddy field. Soil Sci. Plant Nutr, 50, 721-729.

FAOSTAT, 2016. FAOSTAT Online Database. Food and Agriculture Organization, Rome, 2016 (http://faostat3. fao.org) (accessed: August 2016).

Nguyen, N. V., Ferrero, A., 2006. Meeting the challenges of global rice production. Paddy and Water Environment, 4, 1-9.

USEPA 2006. Global anthropogenic non-CO_2 greenhouse gas emissions: 1990–2020, United States Environmental Protection Agency, EPA 430-R-06-003, 2006. Washington DC: US-EPA.