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PARTICIPATORY RESEARCH AS A KEY FACTOR FOR THE TRANSITION OF FARMING IN ORGANIC RICE

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Abstract: Italy is the largest producer of rice in Europe (with 1,466 kt in 2015 against 2,946.45 kt in the EU; FAOSTAT). Production is mainly located in the agricultural area of the Lombardy Po Valley, which is among the most productive agricultural areas in Italy. In these areas, agriculture is mainly based on monoculture and intensive systems, involving a heavy use of chemical inputs. In this agri-environmental context, Organic Rice Cultivation Systems (ORCS) described in this paper represent a novelty. Their establishment was kick-started by a bottom-up, farmer-driven innovation process, later supported by a more structured participatory breeding initiative. This paper analyses such initiative, which involves a multi-actor network and strives to support farmers' innovation through co-developing sustainable agronomic practices while on-farm testing and selecting of appropriate rice varieties. The process aims at facilitating the consolidation of ORCS to enable them to become a founding element of the transition to more sustainable solutions for cereal agriculture in the target area as well as others. The results described here highlight the strengths and weaknesses of this methodological approach.

Introduction: Organic and low-input agriculture has a long-standing history of collaboration between farmers and researchers involving farmer-led research and on-farm testing. Participatory research can play a key role in developing solutions readily adapted to real-world farming contexts, contributing to innovations by bringing different types of knowledge and experiences together. In recent years, a significant increase in organic farming areas has been occurring in Italy (ISTAT, 2019 ISBN: 978-88-458-1979-7). However, this growth has not been accompanied by a corresponding development of a research and knowledge transfer model capable of facilitating a more widespread transition from conventional systems. Such a transition remains strongly dependent on economic risks and hindered by the lack of recognised knowledge and widespread technical support on organic systems management. This is even more true in the case of organic rice in Italy.

Italy accounts for about half of the European rice production (FAOSTAT, 2016). Rice cultivation in concentrated in north regions (Po Valley), the most profit-yielding rural area of Italy, supported by high use of agricultural inputs and intensive mono-cropping systems, which result in a heavy environmental impact (ISPRA, 2018). In this context, organic rice farmers are pioneers, and the spread of organic farming follows a bottom-up dynamic of innovation, based on self- or mutual- help among these few pioneering farmers (Padel, 2001).
Farmers themselves start their own on-farm trials, testing agronomic protocols specific to their pedo-climatic conditions and farm management practices, and building seed systems to better respond to their needs in terms of genetic resources and social networks. Their actions are fully aligned with the objectives of European policies for the transition to a more sustainable and climate resilient agriculture, by reducing the level of water pollution and greenhouse gas (GHG) emission from rice fields. The research question here is whether the process can be supported and accelerated by implementing cooperation between farmers and research organizations, as advocated by participatory plant breeding, addressing the innovation needs of farmers through the sharing of information and expertise (Carolan, 2006; Ingram, 2008) (Ceccarelli et al., 2000; Ceccarelli and Grando 2007).
The present study shows the results and reflections obtained from a participatory research initiative carried out by a multi-actor network of farmers, researchers, and technicians, in order to identify the agricultural practices and varieties suitable to grow organic rice, testing them directly in the real-world farming environment.

Material and methods: A total sample of 50 organic rice fields were monitored over three growing seasons (15 in 2016, 22 in 2017 and 13 in 2018), and data collected on the productive performance (grain yield t/ha at 14% humidity) and the agricultural practices. The data-information-knowledge-wisdom approach (Ackoff,1989) was followed, gathering data through farmer interviews, carrying out field monitoring by participatory group and multi-actor plenary meetings (Orlando et al., 2020). Yield variability, sources of variability, successful crop management strategies and their constraints were explored.
Meanwhile in 2018, an on-farm evaluation of 17 local rice varieties was carried out on four farms to identify the most suitable rice varieties for organic and low input farming. The experiment was set up as an incomplete randomized trial on four organic farms. Fields were prepared following the most promising approaches as identified during previous activities: i) rice dry sowing at different depths (6 cm or 3 cm), followed by dry conditions combined with different intensity of mechanical weeding (two or four comb harrow passages), ii) broadcast seeding on cover crop plants, followed by biomass chopping (i.e. green mulching) and field flooding.
The trial 2019 was conducted using a partially replicated trial plot (single plots of 6 m2) with 16 non-replicated varieties and 6 varieties replicated 4 times. The total 40 plots were arranged in 4 rows and 10 columns. The technical monitoring of the plots considered some phenotypic habits as the ear height to plant height, the posture of the stem, the tillering and their susceptibility to the Fusarium spp and Pyricularia oryzae.
The participatory evaluation involved 32 farmers, technicians and researchers. It was conducted by scoring each plot from 1 (worst) to 5 (best).
The data collected were subjected to a combined variance analysis to ascertain not only the differences between entries, but also those between farms and interactions between farms and entries. The analyses were conducted with GenStat v 20 software.

Results: Yield outcomes were highly variable in time and space (ranging from 0 t/ha, i.e. failed harvest, to 7.1 t/ha, i.e. yield similar to conventional farming). The main elements likely to be determining such a variability are:

i) Individual farmers' know-how related to how to best adapt management practices to his/her specific pedo-climate conditions.
ii) farmers' ability and readiness to apply in an accurate and timely manner those agronomic practices required by the experiment (organic cropping systems tend to be highly susceptible to small changes in management practices).
iii) the numerous variables that influence how the weed seed bank in the soil expresses itself in terms of weed growth in each season (i.e. one of these variables is also the choice of the crop rotation).

The two most effective management strategies for weed control (in terms of favouring higher yields) were identified, one based on weed mechanical control, and one on enhancing physical and chemical competition mechanisms between the weeds and the cover crop. Both involve innovative aspects compared to the conventional management, such as sowing rice at a certain depth, waiting longer before flooding or sowing on the cover crop and flooding the resulting green mulch. Notwithstanding the great variability, a gradual improvement in yield was observed in all farms during the three-year study (mean =2.85 t/ha, st. dev. = 1.77 in 2016; mean = 4.61, st. dev. = 1.13 in 2018). This trend suggests that organic rice farming in Italy is a young phenomenon with the potential to improve and consolidate over time, thanks to continuing experimentation, bottom-up innovation and knowledge sharing. In this context, the development of varieties suitable for low-input systems is a rather unexplored aspect that could provide an additional advantage towards the improvement of this new system, particularly in terms of increases and stabilization of yields.

The preliminary results of the variance analysis on the varieties tested indicate that for most of the measured phenotypic characteristics - the exception being susceptibility to Pyricularia oryzae and Fusarium - there are significant differences not only between accessions but also within the same accession between farms.
The interaction between farms x varieties, which was significant for the height, cob length and disease tolerance parameters, is of special interest for genetic improvement, because it underlines the importance of specific adaptation in organic and biodynamic rice cultivation. Therefore, this aspect was further analyzed with the use of the biplot, which allows describing both the effects of the varieties and the interaction between varieties and locations (farms) as well as analyzing the relationship between traits.
Finally, another result which has great relevance to legitimizing participatory research approaches, is connected to consistency between the quantitative yield data and the assessments made by farmers in the field: the participants proved to be very skilled in recognizing the most productive varieties across the four farms.

Discussion: The application of a system of mutual learning, based on an equal relationships between researchers and farmers and the adoption of a participatory and decentralized approach was successful in developing innovative cultivation techniques, adapted to the context of organic rice farms. The research led to identify a few initial promising agronomic practices that contributed to increasing yields and reducing their variability, which however remains strongly influenced by the farmer's know-how and his/her capacity to manage complex agro-ecosystems. The implications are far reaching as the heterogeneity of organic rice cultivation systems may not be addressed by a single, widely applicable agronomic approach or centralized breeding process nor by a centralized seed system in which broadly adapted varieties circulate. On the other hand, the participatory approach is complex to apply, since it is affected by the openness and propensity for collaboration of the participants and a greater unpredictability related to the human component of the endeveaur. This can turn into both a strength and a weakness for the outcomes of the process and may cause the need for more time to consolidate results.

Disclosure of Interest: None Declared

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