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Guest Editorial

Sustainable Management of Water Resources: Agricultural Sector and Environmental Protection

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Climate change has led to one of the most significant threats of recent decades, creating consequences on both environmental and human systems. According to the 4th Evaluation Report of the Intergovernmental Panel on Climate Change (IPCC), the physical effects of climate change such as rising temperatures, falling rainfall, frequent extreme weather events and limited availability of natural resources have a significant impact on the agricultural sector and its production, strongly influenced by the climate context in which they are produced.

Climate change induces new factors of uncertainty on the prospects of the agricultural sector showing increasingly irregular and unpredictable future conditions with an increase of exceptional events such as floods, periods of intense heat and consequently prolonged drought. The latter is the main responsible for production declines of agricultural production following the reduced availability of water resources.

Water scarcity and quality issues represent, in fact, in the current century, a problem in many parts of the world. They are a serious challenge to future food security and environmental sustainability. At the international level, the awareness of the agricultural vulnerability to climate change is increasing: G20 ministries are trying to tackle the negative impacts and to highlight the rule of the agricultural sector considering water and natural resources management. Ensuring sustainable and resilient agriculture will also allow achieving the objectives declared by the 2030 Agenda for

Sustainable Development and its 17 Sustainable Development Goals (SDGs), that countries adopted in 2015 (United Nations, 2015).

At the European Union level, Green Deal aims to inform, inspire and promote cooperation between people and observe their connections and its impacts: from national, regional and local authorities to businesses, trade unions, civil society organisations, educational institutions, and research reports and innovation, to consumer groups and people (citizens and communities), all should play a role in planning new climate and environment actions and ensure its sustainability (European Council, 2019; von der Leyen, 2019).

At the national level, agro-food production is one of the most important sectors for the national economy, but in the Mediterranean area, agriculture and food production are strongly impacted by scarcity of water and climate change.

Water sustainable management, especially concerning the changed climatic situation that is affecting our country, is a central theme that involves all the sectors and water uses, and mainly the agricultural one. Irrigation practice in Italy is of fundamental importance for agricultural production and the economy of our country.

Problems of water availability arise in areas with low rainfall and high population density, intensive productions or industrial activities. Droughts can occur during any season both in high and low rainfall areas, but the negative impacts of droughts are exacerbated where water resources are not properly managed.

In Italy, increases in the length and frequency of drought periods have been recorded during the last years, especially in northern regions. The reduction in precipitations has clearly affected the aquifers, that showed water retention values close to the historical minimum. In some Italian regions, a decrease of 60-70% of rainfall volumes during winter has been recorded. In addition, as reported by the National Observatory of Water Use, the amount of snow during winter has decreased, subsequently reducing the amount of snowmelt and therefore the overall water reservoirs. Cumulative precipitation values were lower than the typical seasonal average at the national level during the 2018-2019 winter. These factors, added to the growing pressure on agricultural systems, need to be combined with population growth in rural areas.

Therefore, water resources use sustainability and efficiency in the agricultural sector represents a key and important factor in guaranteeing the profitability of our farms and, at the same time, the protection of ecosystems and the territory.

From an economic, environmental and social point of view, it is important to guide the farming systems towards the conservation of resources in order to allow economic sustainability and ensure rural employment in marginal

agricultural areas. It needs to encourage the dissemination of new measures and methodologies in line with the objectives above described.

The Research Center for Agricultural Policies and Bioeconomy (CREA-PB) carried out many research activities related to the efficient and sustainable management of water resources, both at the national and international level, as a relevant element for guaranteeing environmental sustainability in the production process, including an increase in production and food security and the conservation of natural resources.

The Research Centre participates in many national coordination tables between agricultural and environmental policy, with attention to the issue of water resources and adaptation to climate change of the agricultural sector. The Research Centre collaborates with different public body and partners in order to support knowledge and innovation sharing for water resources-related policies and to provide scientific and technical support through projects related to water scarcity, sustainable water use and water management in agriculture.

CREA-PB is the responsible body of the SIGRIAN (National Information System for the management of water resources in agriculture), a WEB GIS database containing all the information concerning the use of water in agriculture (equipped areas, irrigated, supply sources, irrigation volumes taken, distributed, returned, costs etc).

Recently, CREA-PB is managing a National database of investment in irrigation and environment (DANIA) with a projects collection (financed and planned) for collective irrigation, complete with technical and financial data useful at different phase (planning and programming, financing, monitoring and evaluation).

CREA also quantified the drought phenomenon using the Reconnaissance Drought Index (RDI) that investigates droughts based on the relationship between precipitation and evapotranspiration. The last elaboration showed that during the 2006-2015 decade, events of agricultural drought were more frequent and severe in the Northern regions than in the South of Italy.

The CREA-PB activities aim to develop analyses and provide support in the processing of sector policies, monitoring their evolution and assessing their effects on the systems. They also aim to analyse the relationship between water and water resources policies, also in relation to the issue of innovation in the use of irrigation resources, all applied in the planning of irrigation investments.

To add new elements, actions and solutions to the water management in agriculture, CREA-PB launched a Call on the topic "*Sustainable management of water resources: agricultural sector and environmental protection*" to contribute to the issue of water resources use in irrigation sector and the problems related to the effects of climate change.

One of the main challenges of the sector is the pursuit of a greater degree of efficiency and sustainability in water irrigation management, in terms of quality protection and management improvement. Since water is a common good and used for different uses, the adoption of strategies and planning of targeted interventions must consider the multiplicity of subjects involved.

To understand if the Call covers most of the important topic related to water management, we need to refer to the Blueprint to Safeguard Europe's Water Resources. It is the EU Commission Communication that analysed the obstacles which hamper action to safeguard Europe's water resources and is based on an extensive evaluation of the water policy. The Blueprint emphasises key themes, which include: improving land use, addressing water pollution, increasing water efficiency and resilience, and improving governance by those involved in managing water resources. Its long-term aim is to ensure the sustainability of all activities that impact on water, thereby securing the availability of good-quality water for sustainable and equitable water use. This goal is already enshrined in the WFD in various ways. The Blueprint aim is to achieve the goal by identifying obstacles and ways to overcome them.

The response to the Call in terms of submitted articles was positive, despite the topic was rather narrow. Therefore, the special issue shows the articles presented at the invitation and selected for this special issue that, as we will see, covers the broad subject of the Call partially. For this reason, in our opinion, many issues remain to be explored.

Specifically, different key elements ranging from efficient water management, policy instruments for irrigation groundwater management, water efficiency in wineries to positive externalities related to irrigation are showed and studied. Finally, a technical note relating to an innovative project of the Tuscan-Emilian Apennines on the river Po was included, which presents new advanced systems designed to guarantee the safeguarding of the area.

The growing urbanisation and industrialisation and the water scarcity condition, also as an important consequence of climate change, requires, as known, continuous attention to the water use in agriculture. This condition entails a more efficient water resource management, with an improvement of water networks and the reuse of wastewater where farmers play a key role. In this direction, the paper "Water management: a way to achieve a more efficient irrigation system" by Siviero, Itimura de Camargo and Masoumi, takes inspiration from the current concern, regarding the water resource management, due to the transport of the water resource in the irrigation area of Arda, located in the province of Piacenza, highlighting the approach proposed by the Piacenza Reclamation Consortium for the water losses reduction in the irrigation network. The project concerns the replacement of the traditional open canal system with a new underground pipe system used only for irrigation, taking into consideration the

hydrogeological structure of the area and the aspects related to architectural and technical functional quality.

Another typical point of the management of the common goods concerns the excessive exploitation of groundwater for irrigation purposes. The paper "Policy instruments for irrigation groundwater management an assessment of farmers' stated preferences" by Giannoccaro, Sardaro, De Vito, Roselli, de Gennaro has analysed some policy options in order to address this problem through a survey carried out in Puglia on a representative sample of 187 farmers, selected in the main irrigated areas. The main survey result shows farmers' preference for increasing the supply of wastewater and improving control of rural areas.

The Apulian region is also the protagonist in the paper "The technical efficiency of Apulian vineyards with different supply systems of the irrigation water" by Sardaro and La Sala, aimed at measuring and comparing the technical efficiency of the wineries located in northern Apulia and characterised by three different water supply irrigation systems: 1) groundwater use through private wells; 2) irrigation water use through collective water networks; 3) irrigation water use through private wells and collective water networks. The aim is to understand if and how different irrigation water supply systems interact with the use and management of inputs, providing useful information to policy makers in order to develop adequate policy strategies focused on the preservation of environmental resources, as well as its positive externalities. The Apulian area is characterised by a significant need for water resource for irrigation, however, presenting high inefficiency levels of the collective water networks that force most of the regional farms to use groundwater, with a consequent deterioration of the resource quality, but also of the soil and crops characteristics. In order to promote sustainable supply methods for water irrigation, it is necessary to know the effects that current water supply systems have on the economic performance of farms.

The document authored by Zambotti "Saving water, protecting the environment: A new model for agriculture in Val di Non", illustrates the rules used for agriculture and the environmental protection in the province of Trento, also presenting the complex ongoing research aimed at finding a new balance between the quality preservation of the watercourses in Val di Non and the growing water demand for local agricultural production. The need to provide an adequate water supply for agriculture conflicts with the need to guarantee minimum flow levels in local waterways, as well as to maintain an adequate quality of running water. The proposed solution focuses on the need to connect existing irrigation infrastructures. Thus, it aims at building an integrated irrigation system that covers the entire Val di Non and includes irrigation networks, basins and pumping stations, with

the involvement of several stakeholders who provide specialised agricultural services, ranging from plant protection and pest management to insurance against the risk of spring frost, to job protection, processing, storage and marketing of products. In this context, with the support of local research centres, irrigation cooperatives and the administration of the Autonomous Province of Trento, an innovative model of economic efficiency is going to be built.

Finally, the latest paper "On positive externalities from irrigated agriculture and their policy implications: an overview" by Natali and Branca, provides an overview of the direct, indirect and potential benefits of water use in agriculture by identifying and evaluating the positive social, environmental and ecological effects related to the irrigation practice from an economic point of view, observed and attributed to five categories of contributions: 1) irrigation return flows for the recharge of groundwater; 2) biodiversity and wildlife habitats; 3) aesthetic and cultural values of the landscape; 4) recycling and conservation of nutrients; 5) improvement of health, nutrition and living conditions.

The special issue ends with the description by Paglione and Bertozzi, of an innovative project, the Burana Land-Reclamation Board which operates on a district of approximately 250,000 hectares between the Secchia Panaro and Samoggia rivers, coinciding with the water catchment area of the Panaro river and Burana-Po di Volano, from Tuscan-Emilian Apennines in the Po. Its main activities concern the conservation and safeguarding of the land, with particular attention to water resources and their use, ensuring the water drainage from the urban centres and agricultural areas and also water supply in the whole area to ensure the irrigation service and to cope drought. The project was deemed worthy of attention as a joint example of innovation and sustainability that, through the use of innovative and environmentally friendly techniques, improve the management of water resources.

Compared to the European Commission project, the issues addressed with this work respond to most of the key themes, as shown in the following table.

Land Use and Ecological Status	Chemical Status and Pollution	Water Efficiency	EU Waters Vulnerability	Crosscutting Solutions
	X	X		X
	X	X	X	X
		X		
		X		X
X		X	X	X

Other topics, albeit important and related to the sustainability and the efficiency of irrigation water management, like water policy, water pricing and the integration between agricultural and water policy and management are not included in the works presented to the Call.

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