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Adopting irrigation advisory services for water footprint estimation to improving biodiversity conservation: a European survey

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Abstract. In many European regions the Irrigation Advisory Services (IASs) are adopted by farmers for sustainable irrigation practices. These tools are adequate to facilitate the adoption of environmental certification schemes, such as water footprint, which could improve the sustainability of production processes. As part of a survey conducted on 116 farmers among Italy, Greece and Croatia, it was possible to understand their level of awareness with respect to the certification systems in order to evaluate possible actions to be taken to increase awareness of their use. The results showed that farmers still have a certain unawareness with respect to the true added value, in economic terms.

Keywords: environmental certification, water footprint, decision support systems, agricultural extension services.
JEL codes: Q25.

1. INTRODUCTION

Food production at household level generally requires the use of genetic resources that are well adapted to the local environment, particularly in areas where the environment is harsh and other inputs are difficult to access. The conservation and sustainable use of genetic resources and access to genetic material allow farmers to improve and diversify food production and thus access to enough food. Biodiversity for food and agriculture improves the access of households to food in different ways (Ebert, 2014). First, contributes to raising agricultural production, increased agricultural production results in greater access of farm households to food, directly through subsistence production of food.

However, where access to other essential productive assets, such as land and water, is lacking, access to improved genetic resources alone will not improve access to food (FAO, 2017). This leads to impacts on biodiversity in wetlands and terrestrial systems that are dependent of the availability of water (Verones, 2017). According to FAO (2015, 2016), in 2012, 324 million hectares were equipped for irrigation worldwide. Furthermore, irrigated agriculture is responsible for around 70% of the world freshwater withdrawals (Ringler, Zhu T., 2015; WWAP 2009, 2015).

The expansion of irrigated agriculture and occurrence of drought caused by climate change, in the Mediterranean area denote that irrigation water demand will continue to increase in the future (WWAP, 2015). Moreover, the Mediterranean area has low water resources per habitant, and is thus considered a water-stressed area (Pereira, 2004; Mancosu, 2015).

In addition, further improvements in productivity will require higher use of irrigation, increasing the energy demand for moving water into the fields that can increase GHG emissions. (Mosier, 2001). Otherwise, more effective irrigation measures can enhance carbon storage in soils through enhanced yields and residue returns (Follett, 2001; Lal, 2004a).

In this framework comprehensive tools are therefore required to assess impacts of water use for irrigation needs on biodiversity. Thus, the adoption of adequate water accounting tools to measure or estimate water productivity and efficiency, and which supports the decision-making process at a technical and political level including consumption choices, is becoming crucial, improving at the farm level the water productivity (Rinaldi *et al*., 2011; HLPE, 2015; Ventrella *et al*., 2015).

In the agricultural sector, the demand for water can be affected by reductions in the availability of water for crops, forcing farmers to revise their approach in some cultivation cases with effects on biodiversity. In fact, adaptation measures to climate change may require the use of less water demanding crops.

Recently, a combination of the above mentioned factors have contributed to the development of Irrigation Advisory Services (IASs) at farm level, often of high technological value, for the rational use of water for irrigation. IASs help farmers to optimize crop productivity and cost effectiveness by providing them with irrigation scheduling information based on the actual crop development (Altobelli *et al.,* 2018), thus they are suitable management instruments to achieve a better efficiency in the use of water for irrigation.

Tools such as high-tech irrigation systems will play a key role in the future for the challenges that climate change will impose (Altobelli, *et al.* 2015). Earth Observation (EO) for agricultural water management is a mature technology and it is ready for being transferred to operational applications. Presently, some systems based on EO data are used in IASs and are recognized as useful tools for improving water management in agriculture. EO-based IASs provide new services for water managers and food producers at field scale, and a range of additional products for a sustainable irrigation management at district scale, especially for areas affected by water scarcity and drought. Such systems use EO datasets as the core information for the irrigation decision support systems that produce irrigation requirement maps at different scales: from farm to irrigation district up to the entire watershed. In addition, data on crop development and irrigation requirements are timely produced and distributed to farmers by information and communication tools (e.g. smartphones and e-mail). Moreover, recent studies initiated to investigate the potential of using EO technologies in the field of irrigation water management, through the assessment of crop water footprint (Dalla Marta *et al.,* 2015; Altobelli *et al.,* 2015).

The water footprint (WF) is a consumption-based indicator of freshwater use, accounting for the appropriation of natural capital in terms of the water volumes required for human consumption (Hoekstra *et al.,* 2009). It looks at both the water formed by rain infiltrated into the soil (green component) and the water formed by rainfall, thus water that escapes evaporation and can be found in rivers and aquifers (blue component). More specifically, the WF of crops is defined as the volume of water consumed for its production provided by natural soil water content (green) and by irrigation (blue). The proportion of blue and green water depends on many factors, including climate, soil type, crop and crop management, and irrigation practices.

The ISO 14046, Water footprint, provides decision makers in industry, government and non-governmental organizations with means to estimate the potential impact of water use and pollution. More specifically, a water footprint assessment helps to assessing the magnitude of potential environmental impacts related to water; ways to reduce potential water-related impacts of products at various lifecycle stages; facilitates water efficiency and optimization of water management at product; provides scientifically consistent and reliable information for reporting water footprint results (www.iso.org).

In order to understand the real possibility of adopting EO-based IASs for deriving all the input data required by the WF assessment method, and use them for large-scale territorial certification tool to improving biodiversity conservation, a European survey was conducted among Croatia, Greece and Italy.

The main research questions that have been investigated to understand the opportunity offered by IAS for WF applications in order to preserve the biodiversity, have been oriented to understand the perception, the awareness, the attitude that farmers have towards the certification tools.

2. METHODOLOGY

The study was conducted between 2014 and 2015 in Croatia, Greece and Italy. A structured questionnaire was administered through face-to-face interviews among 116 farmers. Research has been divided into 2 phases. The questionnaire, that was translated into the original language for each country following a forward and backward translation process (English/language of each country) and pretested on a small sample of farmers (a total of 15), focus group, before the survey (Holmes *et al.*, 2017).

The results from preliminary focus groups conducted among farmers and different stakeholders (e.g. farmers' associations and land reclamation consortia) in each country, as a proper activity of the EURO-AGRIWAT COST Action, provided evidence about the importance of the certification for soil, water and biodiversity protection as well as sustainable practices by farmers (Altobelli *et al.,* 2019). The adoption of this methodology has been selected as it is proved to be a valid qualitative methodology also for investigating the psychological aspect of the interviewers (Migliorini & Rania, 2001). In particular, the sample was constituted by farmer groups and the questions related to benefits expected by farmers regarding the adoption of innovation in agriculture water management were addressed to understanding their perception of innovation in irrigation water management.

During the second phase, focus groups results were used to define a list of effects expected from the introduction of an innovation, environmental certification, into the farms. In this second step behavioural scales have been used to define the appreciation of the expected effects from the introduction in the agriculture holding of an innovation (Proietti, 2000). In our analysis, the respondent was asked to express his/her level of agreement/disagreement using a 7-Point-Likert-Scale ranging from: strongly disagree to strongly agree. The sum of the scores to the totalized answers from each individual interviewed gave the position (numerical value) of the attitude of the subject appearance / concept investigated.

During farmers interview was asked to express their level of attitude with respect to six specific issues. The first addressed to understand their level of knowledge with respect to the environmental certification. The second to assess the attitude towards the effects of the adoption of environmental certification on the production process of the agricultural company, and how it can be crucial for environmental quality. The third was aimed to know the attitude that farmers have of environmental certification and if adoption of certification systems determines an increase in terms of production costs. The fourth issue was related to understanding their point of view regarding opportunities or threats that environmental certification can have on the external pressure on farms from industrial sector or customers. Fifth issue was related to the opportunity that the environmental certification can have in terms of increasing the economic benefits, income, at farm level. Finally, six issue was related to the preferences regarding a specific environmental certification scheme. In fact, preliminary analysis of the existing eco-schemes related to agricultural products provided evidence on the lack of certifications related to natural resources as soil and biodiversity, as opposite to water (i.e. water footprint) and sustainable practices (see for instance organic production). To bridge this gap, during farmers interview was asked to express their preference for the certification of reduced soil impact, the certification of reduced water use (aimed to face water scarcity issues) and the certification of biodiversity conservation. In particular, the certification of biodiversity conservation refers to the implementation of a production process focused on protection of biodiversity. Soil and water certification refers to land conservation (mainly in terms of the quality of the soil) and the water saving in agriculture (i.e., water footprint certification, respectively). Sustainable production certification refers to a technically advanced form of agriculture that can preserve natural resources and the environment, and that is associated with lower input use and lower environmental impact, compared to conventional agriculture. Farmers were also asked to express their preferences for one other attribute related to the certification adoption, the typology of certification (private or public).

3. RESULTS AND DISCUSSION

The majority of the respondents have a low level of knowledge about environmental certification, accordingly the 35% of farmers rated their level of knowledge as 2, while only 1% of the respondents selected 7 (maximum level of knowledge), and the 7% selected the option 6 (Fig. 1). Farmers did not consider environmental certification crucial for the environmental quality as the 17% of respondents selected option 1 and 23% selected option 2 (Fig 2). Most of the farmers argue that the environmental certification could increase the cost of production: the 46% of farmers liked option 1 and 3 while the 23% of respondents pronounced themselves neutral (Fig. 3). 27% of farmers were not sure that environmental certification decreases the external pressure, coming from customers, of their farm (Fig. 4). This result con-

Fig. 1. Level of knowledge with respect to the environmental certification.

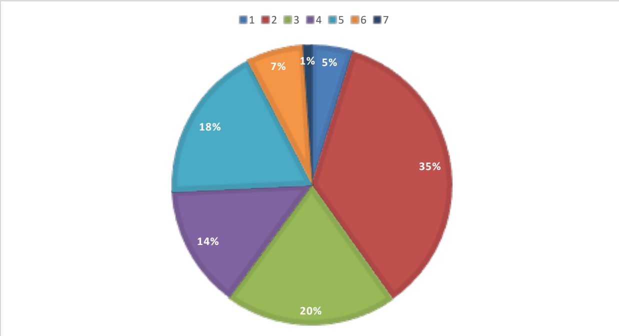


Fig. 2. Environmental certification crucial for environmental quality.

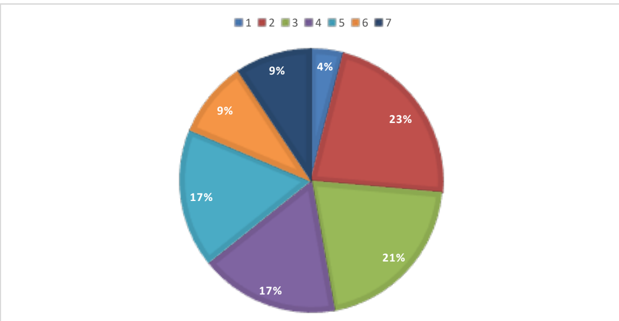


Fig. 3. Environmental certification increases the cost of production.

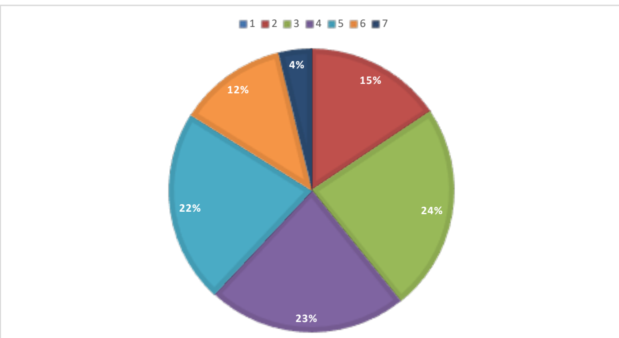


Fig. 4. Environmental certification decreases the external pressure on farm from industrial sector or customers.

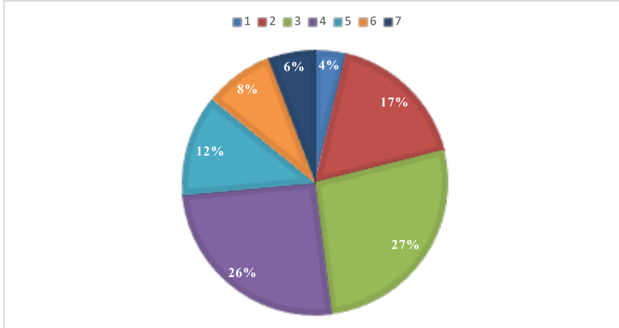


Fig. 5. Certification increases the economic benefits, income, at farm level.

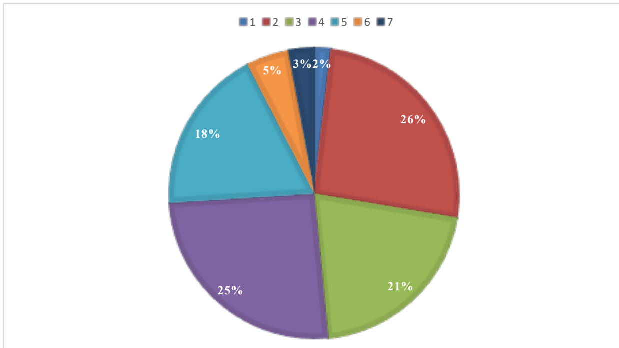
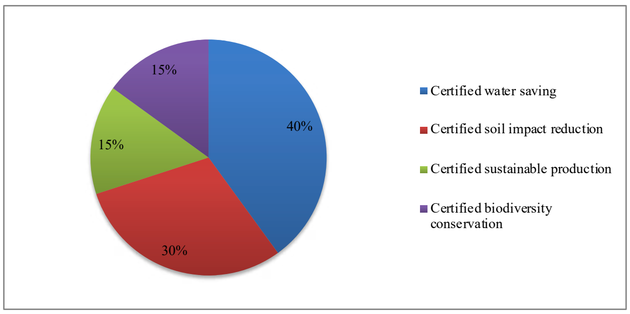
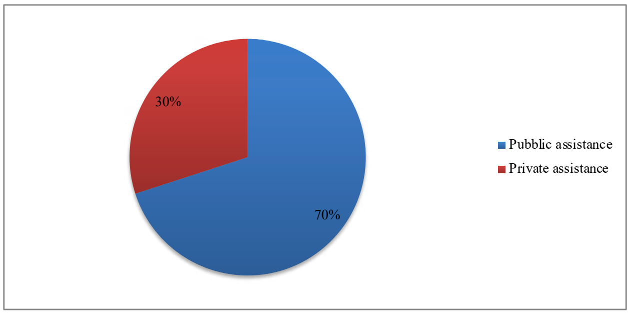


Fig. 6. Certification of environmental sustainability.



firms that farmers are not sure that the adoption of an environmental certification is the only tool, which can significantly reduce the environmental responsibility of companies with respect to the production process adopted in relation to consumers. To the respect of this question the 26% of farmers stated their neutrality while only the 17% gave a positive judgement (liking options 6 e 7). Lastly, almost the half of the farmers (47% liked option 2 or 3) claimed that environmental certification does not two aspects, as stated by Liu *et al.* (2018) and Altobelli (2019). Certifications related to biodiversity and sustainable practices are less preferred. Moreover, evidence in the current study shows that farmers are more willing to appreciate a public certification scheme compared to a private one. This evidence indicates that this is a potential area of interest for the public funding in the near future.

Fig. 7. Assistance on environmental sustainability certification.



4. CONCLUSION

The results of the investigation show that farmers are not completely aware about environmental certification. The lack of basic knowledge on these tools could explain why farmers are not so sure of their operation and why they consider environmental certification to be expensive, increasing their production costs. Furthermore, for farmers environmental certification is not the main and appropriate tool to increase environmental sustainability. Increasing concerns about sustainability in agricultural sector need more tailored certification schemes to satisfy users' preferences. However, there is a lack of knowledge about farmers' preferences for specific attributes of a certification and, as a result, its relative effectiveness in encouraging the adoption of sustainable practices. Knowledge is critical to increase farmer awareness of the environmental benefits of a certification scheme. Albeit our sample is not representative, the empirical results give interesting insights to both researchers and public-private promoters toward a more effective and more attractive design of eco-labels and environmental certification schemes.

The results of this survey also prove that beyond the maturity of certain certification systems, such as a water footprint, and despite having reached a very high level of reliability due to its estimation, there are many steps to be taken to increase farmers' awareness on the usefulness of environmental certification as a tool for safeguarding natural resources and biodiversity.

Results allowed deepening our knowledge about the possibilities offered by including the water footprint in the environmental certifications, and about which aspects are more important to increase their adoption in the agricultural context.

Furthermore, the importance of IASs for estimating the environmental impact due to the use of water in agriculture has also been highlighted by the obtained results.

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REFERENCES

Ebert A. (2014). Potential of underutilized traditional vegetables and legume crops to contribute to food and nutritional security, income and more sustainable production systems. *Sustainability*, 6: 319-335. doi: 10.3390/su6010319.

Altobelli F., Lupia F., Falanga Bolognesi S., De Michele C., D'Urso G., Vuolo F., Dalla Marta A. (2015) Crop Water Footprint: a methodological approach for its estimation based on Irrigation Advisory Services Data. Water Footprint application for water resources management in agriculture. *Italian Journal of Agrometeorology, special issue,* 110-116. ISBN 978-88-555-3329-4.

Altobelli F., Monteleone A., Cimino O., Dalla Marta A., Orlandini S., Trestini S., Toulios L., Nejedlik P., Vucetic V., Cicia G., Panico T., Cavallo C., D'Urso G., Del Giudice T., Giampietri E. (2019). Farmers' willingness to pay for an environmental certification scheme: Promising evidence for water saving. *Outlook on agriculture*, 48(2): 136-142. doi: 10.1177/0030727019841059

Altobelli F., D'Urso G., Del Giudice T. (2015). Irrigated Agricultural Systems In Italy: Demand And Supply Of Water Management Instruments. *Calitatea*, 16(S1): 65-71.

Altobelli F., Lall U., Dalla Marta A., Caracciolo F., Cicia G., D'Urso G., Del Giudice T. (2018). Willingness of farmers to pay for satellite-based irrigation advisory services: A southern Italy experience. *The Journal of Agricultural Science*, 156(5): 723-730. doi: 10.1017/S0021859618000588.

Dalla Marta A., Nejedlik P., Altobelli F. (2015). Water Footprint application for water resources management in agriculture. *Italian Journal of Agrometeorology, special issue*, 110-116. ISBN 978-88-555-3329-4.

FAO (2011). Secretariat of ITPGRFA. Introduction to the International Treaty on Plant Genetic Resources for Food and Agriculture. Module I, Lesson 1, pp. 12. Available at http://www.itpgrfa.net/International/sites/default/files/edm1_full_ en.pdf.

FAO (2015). FAOSTAT. Rome, Italy: FAO. Available at http://faostat.fao.org

FAO (2016). AQUASTAT. Rome, Italy: FAO. Available at http://faostat.fao.org

FAO (2017). Biodiversity for food and agriculture - needs and possible actions. commission on genetic resources for food and agriculture. Rome, 30 January. 3 February 2017.

Follett R.F. (2001). *Organic carbon pools in grazing land soils*. In: The Potential of U.S. Grazing Lands to Sequester Carbon and Mitigate the Greenhouse Effect. R.F. Follett, J.M. Kimble, R. Lal (eds.). Lewis Publishers, Boca Raton, Florida, 65-86

Hoekstra A.Y., Chapagain A.K., Aldaya M.M., Mekonnen M.M. (2009). Water Footprint manual: state of the art 2009. Water Footprint Network enschede, the Netherlands.

Hoekstra A.Y. (2013). The water footprint of modern consumer society. Routledge.

Holmes E.A., Thomas P., Wiktor L., Adamowicz, Carlsson F. (2017). *Choice experiments. A primer on nonmarket valuation*, 133-186. Springer, Dordrecht.

IPCC (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II 10 and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. 11 IPCC, Ed. Gian-Kasper Plattner, Geneva. Available at http://www.ipcc.ch. (accessed 1st October 2019).

Lal R. (2004a). Soil carbon sequestration impacts on global climate change and food security. *Science*, 304: 1623-1627.

Liu T., Bruins R.J.F., Heberling M.T. (2018). Factors Influencing Farmers' Adoption of Best Management Practices. A Review and Synthesis. *Sustainability*, 10(2): 432.

Mancosu N., Snyder R., Kyriakakis G., Spano D. (2015). Water scarcity and future challenges for food production. *Water* 2015, 7: 975–992.

Migliorini L., Rania N. (2001). I focus group: uno strumento per la ricerca qualitativa. *Animazione sociale*, 2: 82-88.

Mosier A.R., 2001: Exchange of gaseous nitrogen compounds between agricultural systems and the atmosphere. *Plant and Soil*, 228: 17-27.

Pereira L.S. (2004). Trends for irrigated agriculture in the Mediterranean region: Coping with water scarcity. Eur. *Water* 2004, 7: 47-64.

Proietti T. (2000). Misurazione e scale attitudinali, in Analisi di Mercato. Dipartimento di scienze statistiche, Università degli studi di Udine. Available at: http://docplayer.it/2819119-Analisi-di-mercato-tommaso-proietti-dipartimento-di-scienze-statistiche-universita-diudine.

Vikas R., Bansal V., Thokchom D. (2019). Commission on genetic resources for food and agriculture.

Rinaldi M., Garofalo P., Rubino P., Steduto P. (2011). Processing tomatoes under different irrigation regimes in Southern Italy: agronomic and economic assessment in a simulation case study. *Italian Journal of Agrometeorology,* 3: 39-56.

Ringler C., Tingju Z. (2015). Water resources and food security. *Agronomy Journal,* 107(4): 1533-1538.

Ventrella D., Gliglio L., Charfeddine M., Dalla Marta A. (2015). Consumptive use of green and blue water for winter durum wheat cultivated in Southern Italy. *Italian Journal of Agrometeorology,* 1: 33-44.

Verones F., Fister S.P., Hellweg S. (2013a). Quantifying area changes due to water consumption in LCA. *Environ.Sci.Tecnhol*, 47(17): 9799-9807.

WWAP (World Water Assessment Programme) (2009). The United Nations World Water Development Report 3 water in a changing world. Paris: UNESCO and London: Earthscan

WWAP (World Water Assessment Programme) (2015). UNESCO. The United Nations World Water Development Report 2015: Water for a Sustainable World; UNESCO: Paris, France.