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Editorial

The Cutting Edge on Advances in ICT Systems in Agriculture †

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Modern agriculture has to shoulder the burden of a plethora of challenges associated with demographics, climate change, and natural resources depletion [1], as well as challenges associated with a new socio-technical framework [2,3]. Therefore, there is a need to increase the effectiveness of agricultural practices and sustainability performance. Current breakthrough technologies are capable of strengthening agriculture for addressing rising needs worldwide. Information and Communication Technology (ICT) has become an integral element of Agriculture 4.0. ICT is a concise term for describing any device, software, application, or network that allows for data collection, exchange, and communication [4]. An illustrative instance of how ICT is incorporated in modern agriculture is provided in Figure 1. The procedure begins by collecting the required data from the field ("Sensors" Phase). Once the data have been gathered, a crucial process is the extraction of important information from them ("Data" Phase). Subsequently, this information is exploited during decision-making for management operations ("Decision-making" Phase). Finally, the essential actions are taken in the field ("Action" Phase) based on the decision-making, and then, this cycle of processes starts again.

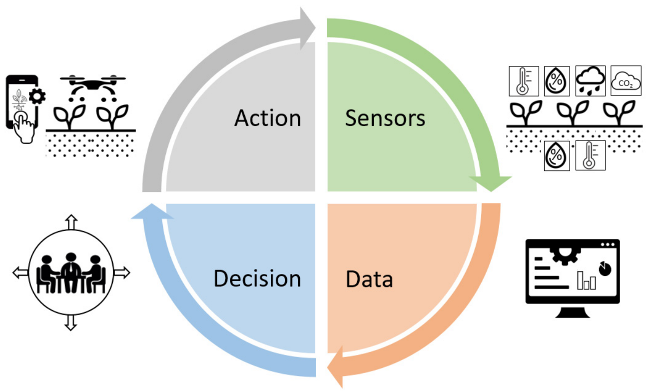

Figure 1. The four phases of modern agriculture through exploiting ICT.

The object of this editorial is to summarize the innovative approaches of applying ICT in agriculture, as presented at the 13th International Conference of the European Federation for Information Technology in Agriculture, Food and the Environment (EFITA). Overall, 45 works were presented and classified into one of the aforementioned phases depicted in Figure 1.

Regarding the phase associated with sensors, two review studies were presented on the use of modern technologies for monitoring the impact of wind on trees and forests [5], and the combination of the Internet of Multimedia Things, precision agriculture, and agrifood [6], indicating gaps in these fields. Furthermore, Arink et al. [7] utilized visible and near-infrared spectroscopy for a non-destructive quality assessment, while Hahn et al. [8] investigated the use of inductive and capacitive sensors against trunk dendrometer measurements towards optimizing water use. Filintas [9] presented a soil moisture depletion model for maize crops, whereas Hoxha et al. [10] developed a management decision tool for aromatic and medicinal plants based on GPS and historical inventory data. Kateris et al. [11] developed a new image-based technique for weed mapping in vineyards, considering the height of weeds at the inter-row path of vineyards, and Bataka et al. [12] used statistical methodology to compare open-source with industrial weather stations. Tasiopoulos et al. [13] proposed a methodology based on satellite images and machine learning, for accurate flood extent maps, and Aguilar and Cháves [14] focused on teaching–learning strategies at the University of Costa Rica, as a means of supporting geomatic concepts and tools. Finally, Tagarakis et al. [15] acquired kinematic data from wearable sensors during a human–robot field experiment, aiming to identify human activity signatures.

The second phase that pertains to data analysis was the subject of seven papers. Specifically, Mietzsch et al. [16] summarized the recent developments of AGROVOC, a multilingual thesaurus of the Food and Agriculture Organization of the United Nations (FAO). In [17], the quality of the digital infrastructure in agriculture was assessed, as well as issues preventing its adoption in the USA and Germany. Sáenz et al. [18] identified drought periods in Ecuador in 2001–2018, while Stratakis et al. [19] integrated ambient intelligence technologies for two precision agriculture applications. Additionally, Lallas et al. [20] proposed an ontology supporting the monitoring of the illegal wood trade, whereas Common Greenhouse Ontology was developed in [21] by considering domain experts and existing ontologies. Lastly, a system was developed for calf body weight estimation based on depth images in [22].

The phase related to decision-making concerned the majority of the presented papers. In particular, a decision support system to study the spread of *Ailanthus altissima* in particular Greek agro-ecosystems was proposed in [23], while a simple decision support system for soybean yield was presented in [24]. A survey on the Greek business contribution to the 17 Sustainable Development Goals was conducted in [25], and factors affecting ICT adoption constituted the matter of [26]. Additionally, a study by Jablanovic [27] pertained to the benefits of ICT investments in China, while Chiem et al. [28] dealt with the reasons affecting the adoption of rice contract-farming policies. Moreover, machine learning algorithms were utilized in three studies. These algorithms were used for (a) grape ripeness estimation [29], (b) predicting the daily prices of sugar and corn in Brazil [30], and (c) crop water availability mapping in the Danube Basin [31]. Based on circular economy concepts, Tagarakis et al. [32] proposed an integrated system via implementing smart farming tools, while Crovella et al. [33] highlighted a key element towards this transition, namely the collaboration between farmers and stakeholders. Silva et al. [34] proposed a data-driven framework for multi-hazard risk mapping in agriculture, whereas in [35], an automatic monitoring system for rainwater harvesting was proposed. Gigot et al. [36] implemented a methodology for wheat production, and Cicuéndez et al. [37] dealt with the identification and modeling of the gross primary production. Finally, Filintas et al. [38] investigated the effects of two irrigation and fertilization treatments on cotton yield and seed oil.

The studies related to action were those of Hahn et al. [39] and Alexandropoulos et al. [40]. In the former, a remotely controlled seawater fertilizer extraction system was developed, whereas the latter evaluated 15 farm-scale greenhouse gas-based decision support tools based on a number of criteria.

Finally, nine studies were classified as addressing cross-cutting themes. Specifically, Spykman et al. [41] and Gabriel and Gandorfer [42] focused on society's opinion of the use of digital technologies in agriculture. The requirements for adopting blockchain technology and digital technologies by small and medium farms were investigated in [43] and [44], respectively. The role of modern technologies in the implementation of sustainable agriculture was studied in [45], while recommendations for future research pertaining to Earth observation for agricultural applications were presented in [46]. A survey on the importance of interfaces and middleware in agriculture was conducted in [47]. Finally, two studies focused on the molecular and phenotypic diversity of indigenous oenological strains of *Saccharomyces cerevisiae* [48], as well as kiwifruit genotypes and cultivars evaluation for susceptibility to four strains of *Pseudomonas syringae* pv. *actinidiae* (Psa) biovar 3 [49].

In summary, the 45 studies presented at the 13th EFITA conference brought together engineers, scientists, technicians, academics, and industry people for the sake of exchanging knowledge and ideas on the state-of-the-art and future of ICT use in agriculture. As a concluding remark, ICT has the potential to be the driving force towards strengthening agriculture to meet the growing demands for food in a sustainable manner. However, finding ways to facilitate the adoption of new agri-technologies should be prioritized by focusing on farmers' education and information, while socio-economic factors that affect their assimilation in the field must be considered.

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