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Editorial

Precision Agriculture: Strategies and Technology Adoption

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Citation: Rodrigues, G.C. Precision Agriculture: Strategies and Technology Adoption. *Agriculture* **2022**, *12*, 1474. https://doi.org/10.3390/agriculture12091474

Received: 8 September 2022
Accepted: 13 September 2022
Published: 15 September 2022

The adoption of digital technologies in the agricultural sector has been the focus of research in the last few years, assessing the benefits of using electronic devices, robots, sensors, automation and IoT to improve farming sustainability. This is commonly associated with Precision Agriculture (PA). The International Society of Precision Agriculture defines PA as "a management strategy that gathers, processes, and analyses temporal, spatial and individual data and combines it with other information to support management decisions according to estimated variability for improved resource use efficiency, productivity, quality, profitability and sustainability of agricultural production" [1]. However, PA and related technology adoption is rarely immediate. The purpose of this Special Issue was to publish high-quality research and review papers that cover the definition of strategies that may promote the adoption of PA, assessing the adoption rates, bottlenecks for adoption, adoption promotion, strategic plans, and incentives. The Special Issue covers nine peer-reviewed research papers and one systematic review paper.

The first study [2] aimed to investigate the yield of maize hybrids subjected to variable-rate seeding and in differentiated management zones (MZs), based on yield maps from previous years, elevation, and soil apparent electric conductivity (ECa). Seven maize hybrids at five seeding rates were, therefore, evaluated. Each MZ was defined using a K-means clustering algorithm to delimit homogeneous sub-regions and variables (field parameters or characteristics) that were stable over time. Results show that the different MZs obtained from yield maps, altitudes, and ECa were able to cluster regions with different soil textures, ECa, and nutrient concentrations, indicating that the technique used to define the MZs is rather efficient and can be used for the management of inputs and respective rates. The study allowed the authors to conclude that, based on farm experimentation, the management by variable-rate seeding in differentiated management zones is a low-cost technique that can reduce input application costs and optimize yield according to the site-specific potential of the field.

The authors of the study proposed, in the second research article [3], a novel model for managing farms that could also define other agricultural processes—the Reference Standard Process Model for Agriculture (RSPMA). Based on the standard process model for IT governance (COBIT), RSPMA aims to facilitate the integration of technology in agriculture, mostly in the areas of IT governance, software development, and business process management. Adopting the Delphi technique, the authors concluded that, for most elements, the model should be implemented in agriculture. However, further research is advisable, supported by pilot sites, to validate the proposed approach.

The third paper [4] focused on the analysis of the influence of parameters of a spraying system designed for unmanned aerial vehicle (UAV) spraying application on the spraying quality. The experiment was based on a Box–Behnken response surface method. To assess the hypotheses, a customized platform was built by the authors for simulating the flight of UAVs. Four-factor three-level factorial tests were conducted to assess the interaction of four spraying parameters. Results showed that the deviation between the predicted comprehensive score and the actual value was less than 6%, which indicated that the response surface method for the working parameters of the application system was reasonable and feasible. The author concluded that, based on the achieved results, the design may contribute to the optimization of spraying systems for UAV spraying applications.

In the studies described in the fourth article [5], the authors tried to evaluate agronomic performances and crop yields shaded agro-photovoltaic (APV) system and to compare them with crops grown in the open field condition, such as rice, onion, garlic, rye, soybean, adzuki bean, corn, and intercropped corn and soybean. Results of this study indicated that there was statistically no negative impact of the APV system on the forage yield of rye and corn, suggesting that forage crops under the APV system were suitable crops to produce forage yield for livestock. However, rice yield was significantly reduced under the APV system; legume crops and vegetables in this study did not show consistent statistical results in two years. The authors concluded that employing APV systems, which provide 30% of the shading rate of a crop-cultivation environment, allows agriculture and renewable energy to cooperate for the purpose of maximizing the potential resources of energy and biomass of forage crops such as rye and corn.

In the fifth article [6], the authors observe the tendencies in the adoption of precision agriculture technologies (PAT) in Ukraine, with a specific focus on cooperatives as a valuable tool of social and solidarity economy helping to achieve progress in local rural development. To this end, the technology acceptance model, which simulates how users perceive and use new technology, has been adopted on a theoretical basis. The authors concluded that the use of modern technologies in domestic fields depends on the ability of manufacturers' partners to correctly show a clear algorithm for the implementation of a particular innovation and to prove the feasibility and effectiveness of modern methods. Results also revealed a statistically significant relationship between the intention to use PAT and its actual implementation. Thus, we can conclude that the adoption of PAT can be predicted by the intent of the co-operators to use PAT. Finally, the study allowed the authors to conclude that Ukraine is on the way to transforming its agro-complex and promoting the strategic development of precision agricultural systems.

The sixth article [7] aimed to provide a systematic review that explored the emergence and utilisation of agricultural technology (AgTech) in secondary schools globally. The reviewed studies were selected in order to address one of three major objectives: (a) to determine or increase teacher knowledge of AgTech; (b) to evaluate the effectiveness of AgTech professional development; and (c) to evaluate the effectiveness of AgTech classroom activities. Authors adapted the Preferred Reporting Items for Systematic reviews and Meta-Analyses protocol in order to provide a transparent method for literature selection for analysis. Reputable scholarly sources were identified and screened to determine eligibility according to keywords and inclusion criteria. Relevant studies were retained for detailed analysis and an analytic matrix was established. Results of the systematic review show that the utilisation of AgTech in secondary school agricultural education programmes across the globe is limited. The authors concluded that the key areas to address teacher knowledge development include improvements to the pre-service teaching curriculum at tertiary.

The study presented in the seventh article's [8] main objective was to determine the most predictive Vegetation Index (VI) for grape-quality zoning, among three different VIs normalized difference vegetative index (NDVI), normalized difference red edge index (NDRE), and optimized soil-adapted vegetation index (OSAVI). For that, the authors monitored three different grapevine growth stages at two small commercial vineyards (0.33 ha and 0.65 ha) planted with *Vitis vinifera cv.* pinot noir, in order to prove the efficiency of the VIs in commercial vineyards for selective harvesting and to allow the production of different wine types. An economic analysis of the costs and revenues of implementing grape-quality zoning and selective harvesting in small vineyards (up to 1 ha) was also performed, together with the calculations of potential revenue increases after selective harvesting and the production of different wine types from the same grapevine variety and vineyard. Results show that NDVI and NDRE proved to be very useful when used to delineate vigour zones and grape quality zoning of vineyards; however, OSAVI proved to be the least predictive index. In terms of investment, both scenarios of using grape-quality zoning resulted in higher profits, despite the higher costs required to implement grape-quality zoning and selective harvesting.

The eighth article [9] aimed to evaluate the relationships between satellite-derived spectral indices (NDVI and NDWI) and soil electrical conductivity (EC) with the content of soil nutrients, such as potassium, phosphorus, magnesium, and soil pH. The purpose was to determine whether spectral indices or EC are more appropriate to be used for soil sampling and to predict soil nutrients. The study was conducted at three crop fields with maize, where 47 management zones for soil sampling were delineated based on the soil EC. The authors found significant correlations between NDVI for bare soil and nutrient content in soil and pH. A very strong positive correlation was also observed between the soil EC and the potassium content, and a moderate correlation was noted between the soil EC and the magnesium content. Based on those results, the authors suggested the use of these two variables for the delineation of management zones in agronomic practice for optimized soil sampling and variable-rate fertilization.

In the ninth study [10], the authors evaluated the connotation and extension of agricultural technology progress and divided agricultural environmentally-friendly technology into resource-saving technology and emission-reduction technology progress from the perspective of function goals. Based on the panel data of 30 provinces of China from 2000 to 2010, the authors adopted slack-based models to measure the progress of environment-based technology, in order to discuss its dynamic evolution across time. Authors found that China's agricultural environmentally-friendly technology progress showed an overall upward trend, leading to labour level, per capita agricultural gross product, and agricultural internal structure being positively and significantly related to agricultural environmentally-friendly technology progress and its different types.

In the final published article [11], the authors aimed to understand the social drivers of automated technology acceptance and adoption in Australian cotton farms, employing a different methods approach to identify the rate of adoption of an automated technology. For that, a survey was conducted interviewing 176 growers that responded to several questions about adoption and use of technology, perceived usefulness, and workforce attitudes, among others. The authors concluded that both social factors and workforce considerations influence growers' motivation to adopt automated technology on farms. On the other hand, perceived usefulness and ease of use barriers are challenges for those trying to adopt automated technology.

In Conclusion, the articles published in this Special Issue cover a wide range of Precision Agriculture adoption strategies. I look forward to further research conducted in this domain.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. ISPA. ISPA Precision Agriculture Definition. 2019. Available online: https://ispag.org/ (accessed on 16 August 2022).
2. Anselmi, A.A.; Molin, J.P.; Bazame, H.C.; Corrêdo, L.d.P. Definition of Optimal Maize Seeding Rates Based on the Potential Yield of Management Zones. *Agriculture* **2021**, *11*, 911. [CrossRef]
3. Rupnik, R.; Vavpotič, D.; Jaklič, J.; Kuhar, A.; Plavšić, M.; Žvanut, B. A Reference Standard Process Model for Agriculture to Facilitate Efficient Implementation and Adoption of Precision Agriculture. *Agriculture* **2021**, *11*, 1257. [CrossRef]
4. Wang, D.; Xu, S.; Li, Z.; Cao, W. Analysis of the Influence of Parameters of a Spraying System Designed for UAV Application on the Spraying Quality Based on Box–Behnken Response Surface Method. *Agriculture* **2022**, *12*, 131. [CrossRef]
5. Jo, H.; Asekova, S.; Bayat, M.A.; Ali, L.; Song, J.T.; Ha, Y.-S.; Hong, D.-H.; Lee, J.-D. Comparison of Yield and Yield Components of Several Crops Grown under Agro-Photovoltaic System in Korea. *Agriculture* **2022**, *12*, 619. [CrossRef]
6. Hrynevych, O.; Blanco Canto, M.; Jiménez García, M. Tendencies of Precision Agriculture in Ukraine: Disruptive Smart Farming Tools as Cooperation Drivers. *Agriculture* **2022**, *12*, 698. [CrossRef]
7. Manning, J.K.; Cosby, A.; Power, D.; Fogarty, E.S.; Harreveld, B. A Systematic Review of the Emergence and Utilisation of Agricultural Technologies into the Classroom. *Agriculture* **2022**, *12*, 818. [CrossRef]

8. Rendulić Jelušić, I.; Šakić Bobić, B.; Grgić, Z.; Žiković, S.; Osrečak, M.; Puhelek, I.; Anić, M.; Karoglan, M. Grape Quality Zoning and Selective Harvesting in Small Vineyards—To Adopt or Not to Adopt. *Agriculture* **2022**, *12*, 852. [CrossRef]
9. Mazur, P.; Gozdowski, D.; Wójcik-Gront, E. Soil Electrical Conductivity and Satellite-Derived Vegetation Indices for Evaluation of Phosphorus, Potassium and Magnesium Content, pH, and Delineation of Within-Field Management Zones. *Agriculture* **2022**, *12*, 883. [CrossRef]
10. Chen, G.; Deng, Y.; Sarkar, A.; Wang, Z. An Integrated Assessment of Different Types of Environment-Friendly Technological Progress and Their Spatial Spillover Effects in the Chinese Agriculture Sector. *Agriculture* **2022**, *12*, 1043. [CrossRef]
11. McDonald, N.; Fogarty, E.S.; Cosby, A.; McIlveen, P. Technology Acceptance, Adoption and Workforce on Australian Cotton Farms. *Agriculture* **2022**, *12*, 1180. [CrossRef]