AgriEngineering

Editorial

Emerging Agricultural Engineering Sciences, Technologies, and Applications

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1. Introduction

The closing Editorial of this comprehensive special collection presents the journey from this project's inception to the publication of around five dozen outstanding studies that have been a testament to the dedication, innovation, and collective wisdom of the global agricultural engineering community.

Agricultural engineering plays a vital role in the modernization and revitalization of agriculture [1]. It encompasses various fields such as agricultural production design and management, agricultural mechanization, water/soil engineering, land use optimization, and agricultural resource recycling [1,2]. The scope of agricultural engineering also includes the integration of agricultural engineering technologies, development of agricultural engineering patterns, and the promotion of science and technology innovation in the agricultural sector [2]. Overall, agricultural engineering has a broad scope that encompasses various aspects of agricultural development and innovation, e.g., agricultural greenhouses [3–8], agricultural storage systems [9–12], irrigation and drainage [13–15], agricultural energy systems [16–18], agricultural fuels [19,20], fam machinery [21–23], etc.

Over the past year, the field of agricultural engineering has witnessed remarkable advancements. The published articles in this collection span a broad spectrum, covering themes from precision farming and remote sensing to sustainable practices, robotics, and the integration of cutting-edge technologies. These contributions collectively weave a narrative of progress, highlighting the dynamic nature of agricultural engineering in addressing contemporary challenges.

Agricultural engineering is inherently interdisciplinary, requiring a holistic understanding of engineering and technology for various agricultural applications, as shown in Figure 1. This collection has successfully filled crucial knowledge gaps by delving into diverse areas. The pursuit of knowledge has been relentless, and our contributors have shed light on unexplored facets of soil science, crop management, and post-harvest activities.

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Figure 1. An overview of modern research areas in the field of agricultural engineering.

2. List of Contributions

In total, 190 manuscripts were submitted for consideration in this Topic Collection, and all of them were subject to rigorous review processes by their respective journals. Just under 31% of the submitted papers were accepted for publication and inclusion in this Topic Collection. The overall scientific contributions to this Topic Collection are listed below:

1. Peralta Manjarrez, R.M.; Delgado Martínez, R.; Benavides Mendoza, A.; Juárez Maldonado, A.; Cabrera De la Fuente, M. Calcium, Potassium, and Magnesium Affect the Nutritional Value of Tomato Grafted Fruits Grown in a Nutrient Film Technique System. *Agriculture* **2023**, *13*, 2189. https://doi.org/10.3390/agriculture13122189.
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3. Innovative Farm Machinery and Design

1. Engineering Design for Tractors: Contribution 21 focused on the engineering design and analysis of a high lugs rigid driving wheel for conventional agricultural tractors. It not only presented technical specifications but discussed the potential for scalability and adoption in diverse agricultural settings. This article extended beyond technical innovation, considering the practical implications of adopting new technologies in farming.
2. Advanced Harvester Design: Contribution 35 introduced a double-roller sweet potato vine harvester, not only showcasing its technical advancements but evaluating its energy efficiency and labor requirements. This article extended beyond technological novelty, providing insights into the economic and labor implications of adopting new harvesting technologies.
3. Robotic Pruning for Grapevines: Contribution 45 presented a kinematic-based multi-objective design optimization of a grapevine pruning robotic manipulator, and it not only discussed the technical specifications but explored the adaptability of robotic technologies to different grape varieties and vineyard settings. This article contributed to technical innovation as well as to the practical considerations of adopting robotics in viticulture.
4. Pneumatic Conveying Line Design: Contribution 47 explored the structural design and simulation of a pneumatic conveying line for a paddy side-deep fertilization system, which not only provided insights into material handling but discussed the potential for automation in paddy cultivation. This article extended beyond structural design, considering the broader implications of adopting automated material handling systems in agriculture.

5. Rice Straw Fiber Crusher: Contribution 52 discussed the design of a rice straw fiber crusher and evaluated fiber quality. This not only presented technical specifications but explored the potential applications of rice straw fiber in diverse industries. This article extended beyond equipment design, considering the broader implications of valorizing agricultural residues.

4. Innovations in Crop Management

1. Nutritional Enhancement: Contribution 1 explored the intricate relationship between calcium, potassium, and magnesium, revealing their nuanced impact on the nutritional value of grafted tomatoes. This in-depth understanding opens avenues for precise nutrient management in horticultural practices.
2. Drought-Tolerance Genes: Contribution 28 presented a groundbreaking genome-wide association study identifying not only candidate drought-tolerance genes in sweet sorghum but also uncovering the complex genetic networks that govern resilience to water stress. This nuanced insight provides a roadmap for targeted breeding programs.
3. Precision Agriculture Technologies: Contribution 11 not only identified hotspots in subsurface drip irrigation research but went further to analyze the evolving trends and methodologies within these hotspots. By utilizing advanced techniques such as CiteSpace, this article provides a meta-analysis that informs researchers of the most critical areas for future exploration.
4. Energy Efficiency in Pig Farming: Contribution 22 delved into the realm of energy efficiency, offering a detailed two-year case study on improving piglet rearing energy efficiency and sustainability using air-to-air heat exchangers. This comprehensive analysis extends beyond energy savings, exploring the broader implications on animal welfare and farm economics.
5. Crop Yield Sensor Technology: Contribution 25 not only introduced an impact-type sunflower yield sensor signal denoising method but also validated its effectiveness through extensive field trials. This article not only contributes a novel technological advancement but also provides practical insights into its real-world application.

5. Technological Solutions

1. Precision Agriculture Robotics: Contributions 23 and 24 offered more than a demonstration of potential; they presented a comprehensive analysis of the operational, economic, and environmental implications of UAV-based wireless data collection and agricultural robots in precision farming operations. These findings bridge the gap between technological promise and on-field practicality.
2. Innovative Harvesting Techniques: Contribution 46 not only introduced a continuous single-layer discrete tiling system for online detection of corn impurities and breakage rates but also explored the economic implications of adopting this type of technology. This article provides a holistic view, considering both technological and economic aspects of innovation.
3. Climate Change Resilience: Contribution 16 addressed the mitigation of COVID-19 impacts on crop farming through nanotechnological approaches, diving deep into the ethical considerations and societal implications of employing nanotechnology in agriculture. These findings extend beyond technical solutions, prompting reflections on the ethical dimensions of agricultural innovation during global crises.
4. Adsorption-Based Water Harvesting: Contribution 34 investigated the adsorption-based atmospheric water harvesting potential for Pakistan. This article provides a nuanced perspective, considering not only technological feasibility but also its alignment with local socio-economic conditions.
5. Digital Livestock Farming: Contribution 18 discussed the significance and ethics of digital livestock farming. It not only examines the technological aspects but also delves into the ethical considerations of employing digital technologies in animal

husbandry. These findings contributed to technological discourse as well as broader conversations on ethical practices in agriculture.

6. Sustainability and Climate Resilience

1. Multi-Satellite Precipitation Products: Contribution 43 assessed multi-satellite precipitation products over the Himalayan Mountains for sustainable water management. It not only evaluates the technical aspects but also discusses the policy implications of utilizing satellite data for water resource management. This article extends beyond technical validation, contributing to the discourse on policy-relevant applications of remote sensing in agriculture.
2. Impact of Climate Change: Contribution 27 evaluated the impact of climate change on stream flow in Soan River Basin (Pakistan), not only providing insights into hydrological changes but also exploring the socio-economic impacts on local communities. This article bridges the gap between climate science and social resilience, offering a holistic understanding of the effects of climate change.
3. Humic Acids in Agriculture: Contribution 48 investigated how humic and acetic acids can enhance the deterioration of plastic soil-biodegradable mulches and delved into the long-term environmental implications of their use. This article contributes not only to immediate agricultural practices but also to broader conversations on the sustainability of soil management strategies.
4. Greenhouse Microclimate Modeling: Contribution 50 presented a neural network model for greenhouse microclimate predictions. It demonstrated the accuracy of predictions and discussed the interpretability of machine learning models in practical farming scenarios. This article contributes not only to the technical discourse but also to the practical considerations of implementing machine learning in agriculture.
5. Precision Irrigation: Contribution 51 developed a prediction model for labyrinth emitter service duration (ESD) under low-quality (sand-laden water) irrigation. It not only provides a technical solution but examines the economic feasibility and practical considerations of adopting precision irrigation in challenging water conditions. The article contributes not only to the technological discourse but also to the practical considerations of precision agriculture.

7. Future Directions and Conclusion

As we celebrate the achievements of this collection, it is imperative to chart the course for future research endeavors in agricultural engineering. Some key areas that demand attention include the following:

- Interdisciplinary Collaboration: Encourage deeper collaboration between agriculturalists, engineers, data scientists, and environmental scientists to address complex agricultural challenges comprehensively.
- Climate-Resilient Farming: Investigate strategies for enhancing climate resilience in agriculture, considering the unpredictable impacts of climate change on crop yields and water availability.
- Digital Transformation: Explore the full potential of digital technologies, including artificial intelligence, machine learning, and the Internet of Things, in revolutionizing various aspects of agricultural practices.
- Sustainable Precision Farming: Continue the exploration of sustainable precision farming technologies to optimize resource use, reduce environmental impact, and enhance overall agricultural productivity.
- Innovations in Post-Harvest Activities: Focus on developing innovative solutions for post-harvest activities, storage, and transportation to minimize food loss and ensure food security.

In conclusion, the "Emerging Agricultural Engineering Sciences, Technologies, and Applications" collection has been a collaborative endeavor that has pushed the boundaries of knowledge in our field. I extend my heartfelt gratitude to all contributors, reviewers, and MDPI for making this venture a success. May the insights gained from this collection propel us toward a future where agricultural engineering continues to be at the forefront of sustainable, efficient, and resilient food production.

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