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Organic Farming: A Sustainable Approach to Agriculture

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***Abstract*—Organic farming is a sustainable agricultural practice that prioritizes environmental health by eliminating synthetic fertilizers, pesticides, and genetically modified organisms (GMOs). It emphasizes natural processes to enhance soil fertility, promote biodiversity, and maintain ecological balance. This paper explores the significance of organic farming, its current status in India, and the various phases involved in the organic farming process. Key aspects discussed include soil health management, crop production and growth, weed control, pest and disease management, harvesting and post-harvest handling, supply chain management, and future research directions to advance organic farming practices. Additionally, the paper examines the integration of emerging technologies such as Artificial Intelligence (AI) and Machine Learning (ML) in organic agriculture. AI-driven innovations, including predictive analytics, automated monitoring, and AI-powered supply chain solutions, have the potential to enhance productivity, optimize resource use, and improve economic viability for farmers. The study also highlights key challenges in organic farming, such as lower yields, market accessibility, and the need for technological advancements, while presenting policy recommendations and research opportunities to strengthen organic agriculture's role in sustainable food production.**

***IndexTerms*— Organic farming, Soil health management, AI-powered platforms, Supply chain management, Precision agriculture, Sustainable food systems.**

I. INTRODUCTION

Organic agriculture emphasizes minimal use of synthetic inputs and focuses on ecological sustainability through practices like soil cultivation, pest management, and eco-friendly marketing. Though traditional, organic farming is evolving with advanced technologies like Artificial Intelligence (AI) and Machine Learning (ML), which enhance efficiency, increase productivity, and support sustainable practices. This paper presents the full cycle of organic agriculture—from soil preparation to market access—highlighting how AI and ML can address key challenges. In India, organic farming improves soil health, reduces pollution, promotes healthy food, and supports better farmer income [12].

A. Research Problem

Despite the growing adoption of organic farming in India and worldwide, several challenges persist, including lower yields compared to conventional farming, pest and weed management without synthetic chemicals, and market accessibility for organic products.

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Additionally, while AI and ML have shown promise in optimizing various agricultural processes, their integration into organic farming remains underexplored, particularly for small-scale farmers. There is a need to investigate how emerging technologies can enhance productivity, sustainability, and economic viability in organic farming while maintaining ecological integrity.

B. Research Objectives

To analyze the current status, benefits, and challenges of organic farming, with a particular focus on India. To explore the role of AI and ML in enhancing soil health, pest management, weed control, and overall crop production in organic farming. To identify research opportunities for integrating AI, ML, and blockchain technology in organic farming processes. To evaluate the economic and environmental impact of transitioning from conventional to organic farming. To propose policy recommendations and technological solutions for improving the adoption and efficiency of organic farming practices.

II. The Benefits of Organic Farming Include

A. Environmental Benefits

Reduces soil degradation and promotes biodiversityPractices like agroforestry, cover cropping, and reduced tillage help reduce soil degradation by improving soil health and preventing erosion. These methods also promote biodiversity by creating habitats and supporting a wide range of plant, animal, and microbial species. [1,2,3]. Decreases pollution by avoiding synthetic pesticides and fertilizersAvoiding synthetic pesticides and fertilizers reduces pollution by preventing harmful chemicals from contaminating soil, water, and air. This approach promotes healthier ecosystems and supports Regenerative agriculturepractices that protect both the environment and human health. [2,4,5]

Enhances soil fertility through natural composting methodsNatural composting methods enhance soil fertility by recycling organic matter into nutrient-rich humus. This process improves soil structure, promotes beneficial microorganisms, and reduces the need for synthetic fertilizers.[1,2]

Supports water conservation by reducing chemical runoffReducing chemical runoff supports water conservation by preventing harmful substances from contaminating water sources. This practice helps maintain clean water for ecosystems and human use, promoting sustainable agricultural practices.[6,2]

B. Health Benefits

Delivers naturally grown, toxin-free, and GMO-free food, fostering healthier crops and lowering agriculture's environmental impact. This approach supports sustainable agriculture and provides consumers with safer, more natural food options. [7,8,9]

Organically cultivated food tends to be richer in essential nutrients, offering higher levels of vitamins, minerals, and antioxidants than conventionally grown produce.

This is due to healthier soil practices and the absence of synthetic chemicals, which enhance the overall quality of the produce[7,8,10].

Reduces health risks pertaining to synthetic chemicals Reducing usage of synthetic chemicals lowers the risk of exposure to harmful pesticides and fertilizers. This leads to healthier food, safer environments, and fewer long-term health concerns for consumers and farmworkers.[7,11]

C. Economic Benefits

Organic products often fetch higher market pricesOrganic products typically command higher market prices due to their perceived health benefits and environmentally friendly production methods. This premium reflects consumer demand for sustainable and chemical-free goods.[13,14,15,16]

Reduces dependency on expensive synthetic fertilizers and pesticidesOrganic farming reduces dependency on costly synthetic fertilizers and pesticides by relying on natural methods for soil fertility and pest control. This lowers production costs for farmers and promotes more sustainable agricultural practices.[17,18,19]

Boosts earnings for small and local farmers by enabling them to sell their products at premium prices, fostering economic sustainability.It also opens up access to niche markets that prioritize sustainability and health-conscious choices.[16,20]

D. Sustainability

Maintains long-term soil fertility and productivityOrganic farming practices maintain long-term soil fertility by using natural methods like crop rotation and composting. These practices improve soil health, ensuring continued productivity without depleting the land's resources. [21,22]

Encourages crop rotation and sustainable farming techniquesEncouraging crop rotation helps prevent soil depletion by varying plant types and promoting biodiversity. Sustainable farming techniques, like this, reduce the need for synthetic inputs and support long-term agricultural health.[23,21,22]
Reduces reliance on non-renewable resourcesOrganic farming reduces reliance on non-renewable resources by using renewable inputs like compost and natural pest control. This shift promotes sustainability and reduces the environmental impact of agricultural practices.[22,24,25]

E. Climate Change Mitigation

Enhances carbon sequestration in soil Organic farming enhances carbon sequestration in soil by increasing organic matter and promoting soil health. This process sequesters carbon, lowers greenhouse gas emissions, and plays a vital role in combating climate change.
Reduces greenhouse gas emissions by avoiding synthetic inputs such as pesticides andfertilizers, organic farming reduces greenhouse gas emissions associated with their production and use. This contributes to lower carbon footprints and supports a more sustainable agricultural system.
Promotes sustainable land management and reduces deforestation. Promoting environmentallyconscious methods for land utilizationhelps to maintain soil health and prevents overexploitation of natural resources. This approach reduces the need for deforestation by improving land productivity and encouraging responsible use of existing forests.
Organic farming is growing in India, with more land being used for organic cultivation and more farmers adopting organic practices. India has the highest number of organic farmers in the world.[26]

F. Organic farming in India

LandAs of March 2023, 101.72 lakh hectares of land was under organic certification.This reflects the growing shift towards organic farming, with more land being dedicated to sustainable agricultural practices. [26]
StatesChhattisgarh has the largest area under organic farming, followed by Madhya Pradesh, Maharashtra, Rajasthan, and GujaratChhattisgarh has the largest area under organic farming, followed by Madhya Pradesh, Maharashtra, Rajasthan, and Gujarat. These states are leading the adoption of organic agriculture, contributing to sustainable farming practices across India..[27]
CropsIn 2019-20, India produced organic food products like oilseeds, sugarcane, cereals, millets, cotton, pulses, and moreIn 2019-20, India produced a wide range of organic food products, including oilseeds, sugarcane, cereals, millets, cotton, and pulses. This diverse production showcases India's growing commitment to organic farming and its potential to meet the increasing demand for sustainable, chemical-free crops. [28]
ExportsSoya meal, oilseeds, tea, coffee, cereals, spices, and medicinal plants are among the top exports of organic products from IndiaIndia's top exports of organic products include soya meal,oilseeds, tea, coffee, cereals, spices, and medicinal plants. These products reflect the country's growing role in the global organic market, catering to the increasing international demand for sustainably producedgoods. [27]
Organic districtsSikkim is the first and only state in India to be fully organic. "The Nilgiris in Tamil Nadu is aiming to become the first organic district in the south by 2030.Sikkim is the first and only state in India to be fully organic, setting a benchmark for sustainable farming. The Nilgiris in Tamil Nadu is working towards becoming the first organic district in the southern region by 2030, further promoting organic agriculture in India".[26,30]

III. RESEARCH OPPORTUNITIES IN ORGANIC FARMING LIFE CYCLE

Fig. 1 shows the Block Diagram of Organic Farming Life Cycle. It describes different phasesduring Organic Farming.

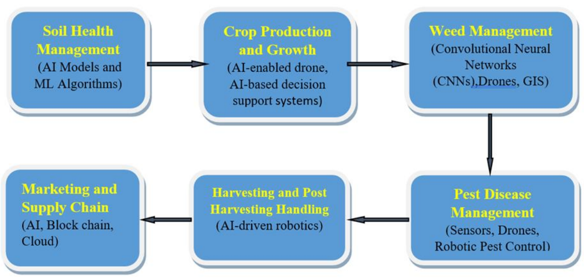

Fig 1. Organic Farming Life Cycle

A. Soil Health Management

Soil health is the foundation of any organic farming system. Organic farmers focus on building soil fertility through the use of compost, cover crops, and crop rotations. The quality of the soil determines the crop's resistance to pests, diseases, and its ability to retain water, which ultimately affects the farm's productivity.

Soil preparation is essential in organic farming to create a fertile, balanced, and sustainable growing environment. It ensures optimal plant growth, improves soil structure, and enhances nutrient availability.

Research Opportunities in Soil Health Management

- Soil Monitoring: AI technologies, including sensor networks and satellite imagery, are increasingly being used to monitor soil conditions in real-time. AI models can predict soil nutrient needs, moisture levels, and microbial activity, thereby allowing farmers to make informed decisions about the right amendments for soil health.
- Predictive Analysis for Fertilization: ML algorithms can process historical data on soil health and crop performance to predict the best time to add organic fertilizers or compost, ensuring optimal crop growth while maintaining soil sustainability.

In the field of soil monitoring, AI technologies, including sensor networks and satellite imagery, are increasingly being used to monitor soil conditions in real-time (Fan et al., 2022)[30]. AI models can predict soil nutrient needs (Rutkowski&Łysiak, 2023)[31], moisture levels (Nonato et al., 2022)[32], and microbial activity (Han et al., 2023)[33], thereby allowing farmers to make informed decisions about the right amendments for soil health (Bello et al., 2021)[34].

B. Crop Production and Growth

In organic farming, crop production is based on principles such as crop rotation, intercropping, and the use of natural fertilizers. Organic farming avoids the use of synthetic pesticides and fertilizers, relying on biological methods to control pests and diseases.

Research Opportunities in Crop Production and Growth

- Crop Monitoring: AI-enabled drone technology and satellite imagery help in monitoring crop health and identifying signs of stress, disease, or nutrient deficiency. Through image recognition algorithms, AI can detect early indicators of pest attacks or diseases, allowing farmers to intervene before issues escalate.
- Precision Agriculture: AI-based decision support systems allow farmers to use precise amounts of water, fertilizers, and other inputs. By analysing soil data and environmental conditions, AI can optimize irrigation schedules, reducing water consumption while enhancing crop growth.
- Machine Learning in Crop Disease Detection: ML algorithms can be trained on large datasets containing images of healthy and diseased crops, enabling them to detect crop diseases with high accuracy. AI models like convolutional neural networks (CNNs) are particularly adept at visual recognition tasks, which can aid in identifying diseases in organic crops without the use of chemical treatments.

In the context of crop monitoring, AI-enabled drone technology and satellite imagery play a crucial role in identifying signs of stress, disease, or nutrient deficiency in crops (Rashid et al., 2023)[35]. Through image recognition algorithms, AI can detect early indicators of pest attacks or diseases, allowing farmers to intervene before issues escalate (Meilin et al., 2021) [36].

C. Weed management

Weed management in organic farming is essential to prevent crop competition, maintain soil health, and ensure high yields without relying on synthetic herbicides. Weeds compete with crops for nutrients, water, and sunlight, leading to reduced productivity and increased labour costs for manual removal. Traditional organic methods such as mulching, crop rotation, hand weeding, and mechanical tillage can be time-consuming and less effective for large-scale farming. Effective weed management in organic farming enhances soil fertility, reduces pest infestations, and promotes sustainable agriculture. Developing innovative, eco-friendly solutions is crucial to improving efficiency while maintaining environmental and organic farming principles.

Research Opportunities in Weed Management:

AI can enhance organic weed management by enabling precision, efficiency, and automation while following organic farming principles. Some key research opportunities include:

- AI-Based Weed Detection and Classification: Machine learning models, such as Convolutional Neural Networks (CNNs), can be utilized for precise weed detection by distinguishing weeds from crops through image recognition. Advanced imaging techniques, including multispectral and hyperspectral imaging, enable the identification of weed species at various growth stages, improving targeted weed management. Additionally, the development of open-source weed databases specifically designed for organic farming conditions can enhance AI model training, providing a valuable resource for researchers and farmers to improve weed detection accuracy and optimize non-chemical weed control strategies.

- Precision Mechanical Weeding: AI-powered robotic weeders equipped with cameras and sensors can efficiently identify and remove weeds while ensuring crop protection. Autonomous weed cutting and flaming systems, guided by AI-driven precision tools, offer an effective non-chemical approach to weed control in organic farming. Additionally, AI-controlled cultivation tools can optimize soil management by minimizing disturbance while precisely targeting weeds, enhancing sustainability and efficiency in organic weed management practices.
- AI-Powered Decision Support Systems: AI-driven predictive weed growth models, utilizing climate and environmental data, can help forecast weed emergence and enable timely interventions. Additionally, AI can optimize crop rotation and companion planting strategies to naturally suppress weeds by selecting the best plant combinations and sequences. Machine learning models can also enhance soil and mulch management by analyzing soil conditions and recommending the most effective organic mulching techniques to minimize weed germination, contributing to more sustainable and efficient weed control in organic farming.

AI-enhanced UAVs (drones) can be utilized for aerial weed mapping in organic farms, providing high-resolution imagery for precise weed identification. Real-time monitoring of weed infestations is made possible through AI-analyzed drone imagery, allowing farmers to detect problem areas quickly and take timely action. Additionally, automated weed suppression planning, integrated with Geographic Information Systems (GIS), can help design targeted weed management strategies based on spatial data, improving efficiency and sustainability in organic farming practices.

- AI in Biological Weed Control
- Machine learning models can be employed to analyze the effectiveness of natural weed predators, such as insects and fungi, in controlling weed populations. AI-based monitoring of all allopathic plants, which naturally inhibit weed growth through chemical interactions, can help optimize their use in organic farming. Additionally, AI can enhance the timing and application of organic weed suppression methods by analyzing environmental conditions and weed growth patterns, ensuring maximum effectiveness while maintaining sustainable farming practices.[37]

D. Pest Disease Management

In organic agriculture, pest management is typically done using natural predators, traps, and other non-chemical methods. However, these methods can be labour-intensive, and the risk of crop loss remains a concern.

Research Opportunities in Pest Disease Management

- Predictive Pest Management: AI can predict pest outbreaks by analyzing environmental factors such as temperature, humidity, and crop-specific vulnerabilities. Machine learning models cananalyze historical data of pest activity and map potential infestations, enabling farmers to take preventive actions.
- Automated Pest Detection: Advanced AI systems integrated with sensors or drones can monitor the presence of pests in crops. These systems can identify pests from images and videos and alert farmers about potential threats.
- Robotic Pest Control: In combination with robotics, AI algorithms can automate the application of natural pesticides or even perform mechanical pest control through precision robotics. This reduces the labour burden and the risk of overuse of pest control measures.

Predictive Pest Management: AI can predict pest outbreaks by analyzing environmental factors such as temperature, humidity, and crop-specific vulnerabilities (Rezaei-Moghaddam&Samiei, 2019). Machine learning models can analyze historical data of pest activity and map potential infestations, enabling farmers to take preventive actions.[38]

E. Harvesting and post Harvesting Handling

Organic farmers are committed to harvesting their crops at the peak of their ripeness, ensuring that the produce remains of high quality. Post-harvest handling includes cleaning, sorting, packaging, and sometimes even processing crops to extend shelf life.

Research Opportunities in Harvesting and post Harvesting Handling

- Harvest Optimization: AI-driven robotics are increasingly used for harvesting crops, especially in large-scale organic farms. These robots are equipped with AI-powered vision systems that assess the ripeness of fruit or vegetables, ensuring that harvesting occurs at the optimal time to maximize yield and minimize waste.

- Sorting and Quality Control: Post-harvest, AI systems can be used to sort crops based on size, color, and quality, which ensures that only the best produce reaches consumers. Machine learning algorithms can help determine the best packaging techniques to minimize damage during transport.

In the context of AI-driven robotics being used for harvesting crops and AI-powered vision systems assessing the ripeness of fruit or vegetables, a relevant citation is "Deep Learning-Based Method for Classification and Ripeness Assessment of Fruits and Vegetables" by Tapia-Mendez, E., Cruz-Albarrán, I. A., Tovar-Arriaga, S., & Morales-Hernández, L. A. (2023). This article provides insights into the use of deep learning for ripeness assessment, aligning with the AI-powered vision systems used in harvesting.[39]

F. Marketing and Supply Chain

Organic products are often marketed based on their environmental sustainability and health benefits. However, accessing market opportunities and ensuring fair pricing for organic farmers can be challenging, especially for small-scale producers.

Research Opportunities in supply chain management system

- Supply Chain Optimization: AI can optimize supply chain logistics, ensuring that organic produce is delivered quickly and efficiently to markets, reducing spoilage and waste. ML models predict demand and optimize delivery schedules, helping farmers reach markets at the right time.
- Market Access through AI Platforms: AI-powered platforms can connect organic farmers with consumers, restaurants, and retailers, ensuring better access to markets. These platforms use AI to analyze purchasing patterns, enabling farmers to better understand market trends and improve their sales strategies.
- Traceability and Certification: Blockchain, powered by AI, is being used for traceability of organic products. Consumers can track the origin of their food, ensuring that it adheres to organic standards. This system also helps eliminate fraud and ensure that only certified organic products reach the market.

Supply Chain Optimization: AI can optimize supply chain logistics, ensuring that organic produce is delivered quickly and efficiently to markets, reducing spoilage and waste. ML models predict demand and optimize delivery schedules, helping farmers reach markets at the right time (Weinberg et al., 2022).[40]

IV. Conclusion and Challenges of Future Research Directions

A. Conclusion

Organic farming is a sustainable approach that provides key environmental, health, and economic benefits by reducing chemical use, enhancing soil fertility, and supporting biodiversity. The integration of technologies like AI and machine learning further boosts farming efficiency and sustainability. In India, the growth of organic farming presents significant potential for meeting global demand for healthier, eco-friendly food. While challenges like yield variability and market access remain, addressing these through innovation and policy support will be crucial in advancing the sector toward a sustainable future.While the integration of AI/ML in organic agriculture offers numerous benefits, it also presents challenges such as high initial costs, a need for technical expertise, and data privacy concerns.

B. Future Work

Future research is necessary to: Develop low-cost AI and sensor solutions for small-scale organic farmers. Improve the accuracy and interpretability of AI/ML models for crop health monitoring and pest prediction.

Developing AI-driven, scalable, and adaptive weed management systems that integrate real-time monitoring, precision mechanical weeding, and ecological strategies to enhance sustainability in organic farming.Explore the potential of AI for integrating diverse organic farming practices, such as agroforestry and perm culture, into automated systems.AI-driven automation in harvesting and post-harvest handling by developing more advanced vision systems, precision sorting techniques, and adaptive quality control to improve efficiency, reduce waste, and ensure superior produce quality. Enhance AI-driven platforms for global market access for organic farmers, particularly those in developing countries.

References

[1] Organic Farming Provides Reliable Environmental Benefits but Increases Variability in Crop Yields: A Global Meta-Analysis

[2] Does organic farming reduce environmental impacts?--a meta-analysis of European research.
[3] Landscape context affects the sustainability of organic farming systems
[4] Landscape context affects the sustainability of organic farming systems
[5] Measuring the environmental effects of organic farming: A meta-analysis of structural variables in empirical research.
[6] Environmental impacts and production performances of organic agriculture in China: A monetary valuation.
[7] Human health implications of organic food and organic agriculture: a comprehensive reviewStudies on Benefits of Organic Food Products in Human Life during Covid-19
[8] Diet and food type affect urinary pesticide residue excretion profiles in healthy individuals: results of a randomized controlled dietary intervention trial.Are Organic Foods Safer or Healthier Than Conventional Alternatives?
[9] A Systematic Review of Organic Versus Conventional Food Consumption: Is There a Measurable Benefit on Human Health?
[10] https://krishibazaar.in/blog/organic-farming-in-india-principles-benefits-growth-potential-and-leading-companies#:~:text=Organic%20farming%20offers%20a%20wide,and%20free%20from%20harmful%20chemicals.
[11] Financial competitiveness of organic agriculture on a global scale Organic agriculture in the twenty-first century Comparative Economics of Conventional, Organic, and Alternative Agricultural Production Systems
[12] The Role of Organic Farming in Achieving Agricultural Sustainability: Environmental and Socio-economic Impacts
[13] Economic Impact of Organic Agriculture: Evidence from a Pan-India Survey
[14] Environmental impacts and production performances of organic agriculture in China: A monetary valuation.
[15] The economic implications of organic farming
[16] How organic agriculture contributes to sustainable developmentSoil Health and Sustainable Agriculture
[17] Is There a Need for a More Sustainable Agriculture?
[18] Sustainability in global agriculture driven by organic farming
[19] Assessing the sustainability of agriculture at the planning stage
[20] Green Horizons: Navigating the Future of Agriculture through Sustainable Practices
[21] https://officerspulse.com/2024/04/17/organic-farming-benefits-present-status-and-future-prospects/
[22] https://nconf.dac.gov.in/StatusOrganicFarming#:~:text=India%20is%20home%20to%2030,areas%20for%20livestock%20and%20beekeeping.
[23] https://www.ceew.in/publications/sustainable-agriculture-india/organic farming#:~:text=A%20recently%20published%20report%20by,net%20sown%20area%20under%20organic.&text=Which%20are%20the%20major%20crops,medicinal%20plants%20(3.84%20percent).
[24] https://www.youtube.com/watch?v=6Y5nacNBYkM#:~:text=this%20is%20gopala%20Krishnan%20who%20has%20returned,organic%20District%20in%20the%20South%20by%202030.
[25] Fan, Y., Wang, X., Funk, T., Rashid, I., Herman, B., Bompoti, N., ...& Li, B. (2022). A Critical Review for Real-Time Continuous Soil Monitoring: Advantages, Challenges, and Perspectives. Environmental Science and Technology.
[26] Rutkowski, K., &Łysiak, G. (2023).Effect of Nitrogen Fertilization on Tree Growth and Nutrient Content in Soil and Cherry Leaves (Prunuscerasus L.).Agriculture.
[27] Nonato, R. F., Moreira, P., Silva, D. O. D., Ferreira, M. W. C. D., Reis, A., Cardenas, A., ... &Siqueira, F. S. F. D. (2022). Long-term Evaluation of Bonding Performance of Universal Adhesives based on Different Dentinal Moisture Levels. The Journal of Adhesive Dentistry.
[28] Han, M., Chen, Y., Sun, L., Yu, M., Li, R., Li, S., ...& Zhu, B. (2023). Linking rhizosphere soil microbial activity and plant resource acquisition strategy.Journal of Ecology.
[29] Bello, S., Alayafi, A. H., Al-Solaimani, S. G., & Abo-Elyousr, K. (2021). Mitigating Soil Salinity Stress with Gypsum and Bio-Organic Amendments: A Review.Agronomy.
[30] Rashid, A., Schutte, B., Ulery, A., Deyholos, M., Sanogo, S., Lehnhoff, E., & Beck, L. (2023). Heavy Metal Contamination in Agricultural Soil: Environmental Pollutants Affecting Crop Health. Agronomy.
[31] Meilin, A., Rubiana, R., Jumakir, Suheiti, K., Murni, W. S., Rustam, &Bobihoe, J. (2021).Study of pest attacks on maize plantation in the oil palm replanting land of Jambi Province. IOP Conference Series: Earth and Environmental Science.
[32] Barker, A. L., Geva, Y., Simonovsky, E., Shemesh, N., Phillip, Y., Shub, I., & Dayan, F. E. (2023).Protoporphyrinogen oxidase inhibitors discovered by Artificial Intelligence platform.In Advances in Weed Science.
[33] Rezaei-Moghaddam, K., &Samiei, S. (2019). Adoption of Integrated Pest Management (IPM): The Case of Iranian Farmers. European Online Journal of Natural and Social Sciences, 8, 269-284.
[34] Tapia-Mendez, E., Cruz-Albarrán, I. A., Tovar-Arriaga, S., & Morales-Hernández, L. A. (2023).Deep Learning-Based Method for Classification and Ripeness Assessment of Fruits and Vegetables.Applied Sciences.
[35] Weinberg, S. J., Sanches, F., Ide, T., Kamiya, K., &Correll, R. (2022). Supply chain logistics with quantum and classical annealing algorithms. Scientific Reports, 13.