Sustainable development of the agricultural sector of the economy

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Abstract. Our paper analyses the current trends, recent changes, and pathways for further sustainable development of the agricultural sector of the economy. Moreover, it examines the challenges faced by the agricultural sector and highlights the need for sustainable practices to ensure its long-term environmental, social, as well as economic viability. The paper discusses emerging trends such as precision agriculture, agroecology, and digital technologies, along with policy measures and collaborative approaches that can pave the way for a more sustainable agricultural sector. It stresses the importance of the advanced information and communication technologies (ICT) that can help the agricultural sector of the economy to further enhance its productivity, automatization, and resilience. Our results and findings might be relevant and helpful for the stakeholders and policymakers seeking the efficient solutions facilitation the effective and rapid transition towards sustainable economy based on the Sustainable Development Goals (SDGs) and capable of withholding the threats geopolitical and economic instability.

1 Introduction

The agricultural sector constitutes one of the main pillars of the world’s economy as the Earth’s population is constantly growing causing the increasing demand for food and stable agricultural production [1-2]. Its importance is further reinforced by the recent global climate changes, health emergencies such as the recent COVID-19 pandemic as well as the geopolitical disasters that create additional risks for the agricultural production [3-4].

In the recent decades, the traditional practices associated with agriculture have often resulted in negative environmental and social impacts. As the world population continues to grow and natural resources become increasingly scarce, there is an urgent need to shift towards sustainable development in the agricultural sector [5]. Within this context, sustainable development refers to a holistic approach that seeks to meet present needs without compromising future generations’ ability to meet their own needs. In the context of *Corresponding author: ENKorneeva@fa.ru*
2 Key challenges faced by the agricultural sector

One of the primary challenges is surely the ubiquitous climate change. Rising temperatures, unpredictable weather patterns, and extreme events such as droughts and floods significantly impact crop yields and livestock productivity. Farmers are forced to adapt to these changes by implementing new techniques and investing in resilient infrastructure.

Another major challenge is the depletion of natural resources. Overuse of water for irrigation purposes has led to water scarcity in many regions, threatening agricultural activities which might lead to massive migrations. Moreover, excess use of chemical fertilizers and pesticides has degraded soil quality over time, causing nutrient exhaustion.

Fig. 1. Challenges faced by the agricultural sector of the economy in the 21st century
3 Sustainable practices in agriculture

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Description</th>
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<tbody>
<tr>
<td>Precision agriculture</td>
<td>Technology-driven approach optimizing resource use, enhancing productivity and reducing environmental impacts</td>
</tr>
<tr>
<td>Agroecology</td>
<td>Integrating ecological principles, promoting biodiversity, soil health, and minimizing chemical inputs</td>
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<tr>
<td>Digital technologies</td>
<td>Internet of Things (IoT) and Blockchain technology enabling real-time monitoring, data analysis, and traceability</td>
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<tr>
<td>Sustainable agriculture</td>
<td>Government policies incentivizing sustainable practices, regulatory frameworks, and research support</td>
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<tr>
<td>Public-Private Partnerships (PPP)</td>
<td>Collaboration among stakeholders to promote knowledge sharing, technology transfer, and capacity building</td>
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As outlined in Table 1 above, sustainable agricultural practices include several important aspects. The first one is the precision agriculture that has emerged as a promising approach to optimize resource use and enhance productivity. By integrating technologies...
such as remote sensing, geographic information systems (GIS), and global positioning systems (GPS), precision agriculture enables farmers to make informed decisions regarding irrigation, fertilization, and pest management. This technology-driven approach promotes resource efficiency, reduces environmental impacts, and enhances yield potential.

The second aspect is agroecology. Agroecology emphasizes the integration of ecological principles into agricultural practices. It focuses on enhancing biodiversity, promoting soil health, and minimizing chemical inputs. By adopting agroecological approaches such as organic farming, conservation agriculture, and diversified cropping systems, farmers can improve soil fertility, enhance resilience to climate change, and reduce negative environmental externalities.

Furthermore, other important aspects include digital technologies in agriculture. The most well-known is the Internet of Things (IoT). It has revolutionized the agricultural sector by enabling real-time monitoring and data-driven decision-making. IoT devices such as sensors, drones, and automated machinery collect and analyse data on soil moisture, weather conditions, and crop health. This information helps farmers optimize resource allocation, predict pest outbreaks, and manage irrigation more efficiently.

Another relevant aspect that might be used for enhancing the sustainable practices in agriculture is the Blockchain technology which offers potential solutions to various challenges in the agricultural sector, such as traceability, supply chain transparency, and fair trade. By creating immutable and transparent records, Blockchain can enhance trust among stakeholders, ensure fair prices for farmers, and enable consumers to make informed choices about the origin and quality of agricultural products.

In addition, policy measures and collaborative approaches are also key to the promotion of the sustainable practices in the agricultural sector of the economy. The first measure is the sustainable agriculture policies. Governments worldwide are increasingly implementing policies that promote sustainable agriculture. These policies may include financial incentives for adopting sustainable practices, regulatory frameworks to reduce environmental pollution, and support for research and development in sustainable farming techniques. Well-designed policies can provide a conducive environment for farmers to transition towards sustainable practices.

The second measure is public-private partnerships (PPP). Collaborative initiatives involving governments, non-governmental organizations, research institutions, and the private sector can play a crucial role in driving sustainable development in agriculture. Public-private partnerships can facilitate knowledge sharing, technology transfer, and capacity building. By pooling resources and expertise, stakeholders can address common challenges and promote sustainable agricultural practices on a broader scale.

4 Technology and innovation in sustainable agriculture

The role of technology and innovation in sustainable agriculture is paramount in ensuring the long-term viability and productivity of the agricultural sector. Technology has revolutionized every aspect of agriculture, from crop production to livestock management, and has become an indispensable tool for achieving the SDGs. One crucial aspect where technology plays a pivotal role is in precision farming. Advanced technologies such as remote sensing, geographic information systems (GIS), and global positioning systems (GPS) enable farmers to precisely monitor their fields' conditions and optimize resource allocation. This allows for efficient use of water, fertilizers, and pesticides, reducing waste while maximizing yields.

Moreover, innovative technologies have enabled the development of genetically modified crops that are resistant to pests, diseases, or environmental stresses. These crops not only increase productivity but also reduce the need for harmful chemicals used in conventional farming practices.
Technology also facilitates data-driven decision-making through smart farming systems. By collecting real-time data on weather patterns, soil moisture levels, or pest infestations using sensors and IoT devices, farmers can make informed choices regarding irrigation schedules or pest control measures. This helps minimize resource wastage while maintaining optimal crop health. Furthermore, technology has facilitated the adoption of alternative energy sources such as solar power or biogas in agricultural operations. By reducing reliance on fossil fuels for irrigation pumps or machinery, these innovations contribute to mitigating greenhouse gas emissions and promoting a more sustainable energy mix. In order to achieve sustainable development of the agricultural sector, it is crucial to implement sustainable farming techniques and methods. These practices aim to minimize the negative impacts on the environment, preserve natural resources, and ensure long-term food security. One key aspect of sustainable farming is soil conservation. Farmers can adopt practices such as crop rotation, cover cropping, and reduced tillage to improve soil health and fertility. Crop rotation helps break pest cycles while enhancing soil nutrients through alternating different crops in a particular field over time. Cover cropping involves planting specific crops during fallow periods to prevent erosion and maintain soil structure. Reduced tillage techniques minimize soil disturbance, preserving its organic matter content and reducing carbon emissions. Efficient water management is another critical component of sustainable farming. Implementing irrigation systems that use water efficiently can help conserve this valuable resource while optimizing crop growth. Precision agriculture technologies like drip irrigation or sensor-based systems enable farmers to apply water precisely where needed, reducing wastage. Furthermore, integrated pest management (IPM) practices are essential for sustainable farming. IPM focuses on using a combination of biological control methods, crop rotation, resistant varieties, and targeted chemical applications to manage pests effectively while minimizing environmental impact. By adopting these sustainable farming techniques and methods, the agricultural sector can ensure both environmental stewardship and economic viability for future generations.

5 Role of government policies in promoting sustainable agriculture

The role of government policies in promoting sustainable agriculture is crucial for achieving long-term development and addressing the challenges faced by the agricultural sector. Governments play a pivotal role in creating an enabling environment that fosters sustainable practices and supports farmers, while also ensuring food security for their population. One key aspect of government policies is the provision of financial incentives and subsidies to encourage farmers to adopt sustainable agricultural practices. These can include grants for implementing environmentally friendly technologies, promoting organic farming methods, or investing in renewable energy sources on farms. Such incentives help reduce the financial burden on farmers and make sustainable practices more accessible. Additionally, governments can regulate and enforce environmental standards and regulations within the agricultural sector. By setting clear guidelines for water usage, pesticide use, waste management, and land conservation, governments can ensure that farming activities are carried out sustainably without harming natural resources or ecosystems. Furthermore, governments have a responsibility to invest in research and development programs aimed at improving agricultural productivity while minimizing environmental impacts. By supporting innovative technologies such as precision agriculture or agroecology, governments can contribute to increasing yields while reducing inputs like water and chemicals. Government policies also play a critical role in promoting education and awareness about sustainable agriculture among farmers.
providing training programs on efficient resource management techniques or offering extension services that deliver knowledge directly to rural communities, governments can empower farmers with the necessary skills to adopt sustainable practices successfully.

In addition, the sustainable management of natural resources in agriculture constitutes an essential component of promoting the long-term development and viability of the agricultural sector. It involves adopting practices that ensure the efficient use of resources while minimizing negative environmental impacts. One key aspect of sustainable resource management is soil conservation, already mentioned above. Soil erosion and degradation pose significant threats to agricultural productivity. Implementing measures such as contour ploughing, terracing, and agroforestry can help prevent erosion, maintain soil fertility, and enhance water infiltration capacity. Additionally, integrating agroecological approaches that promote crop diversity and reduce reliance on chemical inputs can foster a more resilient agricultural system.

Lastly, energy consumption in agriculture should be addressed sustainably by transitioning towards renewable energy sources like solar or wind power for irrigation systems or farm machinery operations.

6 Conclusions

Overall, it becomes quite clear that today’s agricultural sector of the economy is at a critical juncture, facing numerous challenges that require urgent attention. This paper has highlighted some of the current trends, changes, and pathways for further sustainable development within the agricultural sector. The sustainable development of the agricultural sector requires a holistic approach that acknowledges the importance of biodiversity and conservation. By promoting biodiversity in agricultural practices, our society and economy can create resilient ecosystems that support long-term food production while preserving natural resources in the face of the global climate change and the geopolitical issues in accordance with the SDGs. Sustainable management of natural resources in agriculture need to balance economic viability with environmental stewardship.

Achieving sustainable development in the agricultural sector requires a focus on economic viability and social equity. This paper has explored the strategies and measures needed to ensure that sustainable agriculture practices are economically profitable while promoting fairness and social inclusivity. It can conclude that the crucial aspect of economic viability is via promoting efficient resource management. Thence, sustainable agricultural practices should aim to optimize the use of natural resources such as water, soil, as well as energy. By adopting innovative technologies, farmers can minimize waste, reduce input costs, and increase productivity. Additionally, diversifying income sources through value-added activities like organic certification or agrotourism can enhance financial stability for farmers.

Furthermore, social equity plays a pivotal role in sustainable agriculture as it aims to create an inclusive society where all participants have equal opportunities for growth. Ensuring access to land, credit facilities, and markets for small-scale farmers is vital for their economic empowerment. Implementing fair trade practices that provide fair prices to producers can also help bridge the income gap between smallholders and larger agribusinesses.

Moreover, incorporating gender equality into sustainable agriculture is essential. Women constitute a significant portion of the agricultural workforce but often face unequal access to resources and decision-making power. Promoting gender equity by providing training programs, access to credit facilities specifically designed for women farmers, and...
encouraging their participation in cooperatives can lead to more inclusive agricultural development. All in all, it is apparent that through the combination of precision agriculture, embracing agroecological approaches, leveraging digital information and communication technologies, implementing supportive governmental policies, and fostering PPP collaboration, the modern agricultural sector of the economy can enhance its environmental, social, and economic sustainability in the face of the modern-day risks and challenges. It is through such concerted efforts that our society and economy can build a resilient and sustainable future for agriculture and secure food systems for the generations to come.

References

2. J. Lowenberg-DeBoer, I. Huang, V. Grigoriadis, S. Blackmore, Economics of robots and automation in field crop production. Precision Agriculture, 21, 278-299 (2020)
3. C. Galanakis, The “vertigo” of the food sector within the triangle of climate change, the post-pandemic world, and the Russian-Ukrainian war. Foods, 12(4), 721 (2023)
7. E. Korneeva, N. Skornichenko, T. Oruch, Small business and its place in promoting sustainable development, E3S Web of Conferences, 250, 06007 (2021)


17. X. Yin, J. Chen, J. Li, Rural innovation system: Revitalize the countryside for a sustainable development, Journal of Rural Studies, 93, 471-478 (2022)


20. L. Hrustek, Sustainability driven by agriculture through digital transformation, Sustainability, 12(20), 8596 (2020)


29. U. Sengupta, H. Kim, Meeting changing customer requirements in food and agriculture through the application of blockchain technology. Frontiers in Blockchain, 4, 613346 (2021)


32. B. Kheyfets, V. Chernova, Sustainable agriculture in Russia: research on the dynamics of innovation activity and labor productivity. Entrepreneurship and Sustainability Issues, 7(2), 814-824 (2019)


40. B. Baker, T. Green, A. Loker, Biological control and integrated pest management in organic and conventional systems. Biological Control, 140, 104095 (2020)


42. A. Adenle, K. Wedig, H. Azadi, Sustainable agriculture and food security in Africa: The role of innovative technologies and international organizations, Technology in Society, 58, 101143 (2019)


46. M. Mazumder, M. Kabir, Farmers’ adaptations strategies towards soil salinity effects in agriculture: the interior coast of Bangladesh. Climate Policy, 22(4), 464-479 (2022)

47. A. Raihan, A. Tuspekova, Nexus between emission reduction factors and anthropogenic carbon emissions in India. Anthropocene Science, 1(2), 295-310 (2022)
