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ORCID: 0000-0002-3618-664X**DEVELOPMENT OF E-COMMERCE
IN INDUSTRIAL AGRICULTURE**

The introduction of e-commerce in the Ukraine's agricultural sector is a transformative opportunity due to the sector's significant contribution to the country's GDP and employment. The purpose of the study is to identify the impact of e-commerce on the Ukraine's agricultural industry, focusing on adoption, market accessibility, transparency, challenges, and the role of government support. The methodology combines qualitative and quantitative research, including literature review, surveys, interviews, and data analysis. The agricultural sector, which includes grains, oilseeds and livestock, faces challenges such as outdated infrastructure and market inefficiencies. E-commerce provides a solution to market access limitations, price transparency issues, and supply chain inefficiencies. Agri-platforms play a crucial role, providing a digital ecosystem for farmers, agribusiness and stakeholders, enhancing collaboration, digital transformation, data exchange, and market access. The research results show a notable increase in the e-commerce adoption, with agri-platforms such as AgroMarket and AgroExpert playing a key role. Advantages include increased market access, improved efficiency, transparency, streamlined procurement, and market diversification. Among the challenges there are digital literacy, resistance to change, logistical difficulties, and the need for secure digital payments. The study emphasizes the role of blockchain and the Internet of Things (IoT) in enhancing transparency, traceability, and efficiency in agribusiness. The proposed model points to supply chain integration, mobile access, digital payments, electronic markets, training, data analytics, standardization, and environmental sustainability as key factors for effective e-commerce implementation.

**РОЗВИТОК ЕЛЕКТРОННОЇ
КОМЕРЦІЇ В АПК**

Впровадження електронної комерції в аграрний сектор України є трансформаційною можливістю, що зумовлена значним внеском сектору у ВВП та зайнятість країни. Метою дослідження є ідентифікація впливу електронної комерції на аграрну промисловість України з акцентом на питаннях прийняття, доступності ринку, прозорості, викликів і ролі підтримки уряду. Методологія поєднує якісні та кількісні дослідження, включно з оглядом наукової літератури, опитуванням, інтерв'ю й аналізом даних. Сільськогосподарський сектор, що містить в собі зернові, олійниці та тваринництво, стикається з такими викликами, як застаріла інфраструктура і неефективності на ринку. Електронна комерція виступає рішенням для обмежень доступу до ринку, проблем прозорості цін і неефективностей ланцюга постачання. Агроплатформи відіграють важливу роль, забезпечуючи цифрове середовище для фермерів, агробізнесу та зацікавлених сторін, підвищуючи співпрацю, цифрову трансформацію, обмін даними і доступ до ринку. Результати дослідження показують помітне зростання прийняття електронної комерції, з ключовою участю агроплатформ, як-от AgroMarket і AgroExpert. Переваги включають підвищений доступ до ринку, покращену ефективність, прозорість, оптимізацію закупівель і диверсифікацію ринку. Серед викликів – цифрова грамотність, опір змінам, логістичні труднощі та потреба в безпечних цифрових платежах. У дослідженні наголошується на ролі блокчейну та Інтернету речей (IoT) у підвищенні прозорості, відстежуваності й ефективності в агробізнесі. Запропонована модель вказує на інтеграцію ланцюга постачання, мобільний доступ, цифрові платежі, електронні ринки,



Agriplatforms, supported by blockchain and IoT technologies, contribute to the sector's competitiveness. Government support and international initiatives are crucial for creating an enabling regulatory environment, increasing digital literacy, and ensuring financial assistance. The future promises improved stability and resilience of the Ukraine's agricultural sector thanks to optimized supply chains and improved market access through e-commerce.

Keywords: e-commerce, agricultural sector, digital adaptation, blockchain, Internet of Things (IoT), data analytics.

навчання, аналітику даних, стандартизацію й екологічну сталість як ключові фактори для ефективної реалізації електронної комерції. Агроплатформи, підтримані технологіями блокчейн та IoT, сприяють конкурентоспроможності сектору. Підтримка уряду і міжнародні ініціативи мають вирішальне значення для створення сприятливого регуляторного середовища, підвищення цифрової грамотності та забезпечення фінансової допомоги. Майбутнє обіцяє поліпшену стійкість і витривалість українського сільськогосподарського сектору завдяки оптимізованим ланцюгам постачання та поліпшеному доступу до ринку за допомогою електронної комерції.

Ключові слова: електронна комерція, сільськогосподарський сектор, цифрова адаптація, блокчейн, Інтернет речей (IoT), аналітика даних.

JEL Classification: L81, O33, O13, L11.

Introduction

The agricultural sector in Ukraine, known for its vast expanses of fertile land, plays a crucial role in the country's economy. However, despite its significance, the sector faces numerous challenges that impact its efficiency and sustainability. This study aims to delve into the integration of e-commerce into Ukraine's agricultural landscape, addressing the pressing issues of outdated infrastructure, market inefficiencies, and the need for modernization.

Ukraine's agricultural sector, contributing substantially to the GDP and employment, is at a crossroads. Outdated infrastructure and insufficient investments hinder operational efficiency, leading to suboptimal productivity. The study's relevance lies in the potential of e-commerce to address these challenges, providing a platform for market accessibility, transparency, and overall improvement in agricultural practices.

A comprehensive review of recent research globally forms the foundation of this study. We would particularly like to highlight the scholarly works of the following authors: Melnyk (2023), Zhosan (2020), Gorobets et al. (2021), Grubar (2019), Kublitska (2023), Berezovska and Kyrychenko (2022), Ilchenko et al. (2023). The analysis encompasses various facets of e-commerce integration in agriculture, emphasizing the global perspective rather than limiting insights to local publications. Noteworthy contributions by scholars in the field are highlighted, addressing the unresolved aspects that pave the way for the current study. The literature review serves as a valuable guide, acknowledging the existing knowledge base and identifying gaps for further exploration.

The primary objective of this study is to assess the impact and potential of e-commerce in Ukraine's agricultural sector. With the hypothesis that e-commerce can address inefficiencies, enhance market

access, and foster sustainable agricultural practices, the research aims to substantiate these claims through empirical analysis.

The research methodology employs a combination of qualitative and quantitative methods. A thorough literature review establishes the theoretical framework, while data collection involves surveys and interviews with stakeholders in the Ukrainian agricultural sector. Rigorous data analysis, including both quantitative and qualitative approaches, ensures a robust examination of the adoption and effects of e-commerce.

The structure of the main body of the article is designed to present a coherent flow of results and insights. The study unfolds with an in-depth analysis of the current state of electronic trade practices in Ukraine's agricultural sector. Subsequent sections delve into the role of agri-platforms, exploring their impact on market accessibility, transparency, and overall entrepreneurial development. The integration of digital technologies such as blockchain and IoT is examined for its contributions to traceability, efficiency, and transparency in agribusiness.

In conclusion, this article aims to contribute to the evolving discourse on the intersection of e-commerce and agriculture in Ukraine. By addressing key challenges and leveraging digital solutions, the study seeks to provide valuable insights for policymakers, practitioners, and researchers invested in the sustainable development of Ukraine's agricultural sector.

1. Market Overview and Research Context

The Ukrainian e-commerce market is rapidly growing and gaining popularity among consumers and businesses. It encompasses various sectors, such as food products, electronics, fashion, furniture, and many others. Thanks to the increasing availability of the internet and the convenience of electronic payments, e-commerce becomes a significant aspect of the Ukrainian market, facilitating convenient shopping and business development.

In *Figure 1*, we can observe five primary sectors of e-commerce market in Ukraine. The quantitative research was conducted during 2022–2023.

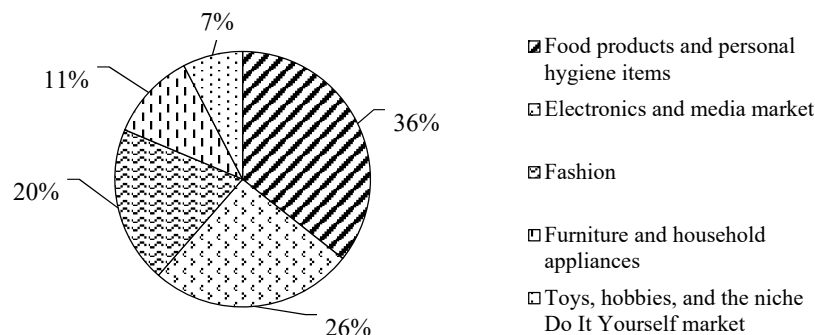


Figure 1. The domestic e-commerce market in Ukraine is based on five primary sectors

Source: (Melnik, 2023).

The agricultural sector's importance to Ukraine's economy is underscored by its significant contribution to the GDP and employment. Prior to the full-scale Russian invasion in 2022, the sector accounted for 11% of the country's GDP and nearly 20% of its labor force, emphasizing its critical role in both domestic and international markets. Ukraine is a major global exporter of key commodities like wheat, corn, and rapeseed, which is vital for global food security (Kublitska, 2023).

The Ukrainian agricultural sector has demonstrated resilience despite the war, managing to increase the production volume of key crops like grains and oil crops. Approximately 80 million tons of these crops were harvested in 2023, marking a 10% increase from the previous year. The sector has adapted by increasing the areas for oil crop production while decreasing grain crop areas. Export remains a critical component of Ukraine's agriculture, with about 70% of agricultural products being exported, contributing significantly to global food security. An increasing trend in the export of value-added agricultural products has been noted due to the high cost of exporting raw materials (Yatsenko et al., 2019).

Ukrainian agriculture faces several challenges, including land demining, funding shortages, and logistical difficulties. Farmers have adapted by shifting to more profitable crops, using direct export sales strategies, and benefiting from government programs like affordable lending at reduced interest rates.

Ukraine plays a critical role in the global agricultural market, especially in supplying oilseeds and grains. More than 55% of the country is arable land, and agriculture provides employment for a significant portion of the population. In 2021, agricultural products constituted the most important exports of Ukraine, totaling USD 27.8 billion and accounting for 41% of the country's overall exports (Lone & Weltevreden, 2022).

In order to obtain more information about the e-commerce market in Ukrainian agricultural enterprises, the results of a qualitative analysis method, such as surveys and interviews, were utilized.

According to official data from the Ministry of Digital Transformation, the dynamics of the share of the adult population with above-average digital skills increased by 12.6% in 2023 compared to 2021. In other words, officially, 40.4% of the population in Ukraine are confident internet users and consumers of e-commerce services (Cherkasy RSA, 2023).

According to our previous research, since the beginning of 2023, all niches in the Ukrainian e-Commerce sector are showing positive recovery. Ukrainian businesses are demonstrating remarkable adaptability and actively adjusting to the new reality. However, in dollar equivalent, the revenue of online retailers has not yet reached the levels of 2021. On average, we observe a decline of 43% across all categories (Ukrainian e-Commerce, 2023).

There is a sustained high level of organic user reach for agricultural products.

Since May 2023, there has been a trend towards optimizing the advertising budget. However, this optimization has had minimal impact on

the category's profits, specifically in terms of improving the efficiency of advertising campaigns.

The average transaction value remains at the 2021 level. The cost of acquiring one customer has decreased by 40% since May 2023.

The majority of revenue comes from users in the Lviv, Dnipropetrovsk, and Odesa regions.

Today in Ukraine and globally, there are certain challenges in the entrepreneurship of the agricultural sector that can be addressed through the implementation of e-commerce, namely:

Market Access Challenges: traditional agricultural businesses in Ukraine and globally often face limited market access. The implementation of e-commerce can open up new avenues for farmers and agribusinesses to reach a wider customer base.

Limited Price Transparency: lack of transparency in pricing can be a hurdle in the agricultural sector. E-commerce platforms can introduce more transparency by providing real-time market prices, enabling farmers to make informed decisions about pricing their products.

Inefficient Supply Chain: the agricultural supply chain can be inefficient and prone to wastage. E-commerce can streamline the supply chain, from procurement to distribution, reducing inefficiencies and minimizing losses.

Access to Agricultural Inputs: farmers may face challenges in accessing quality seeds, fertilizers, and other agricultural inputs. E-commerce platforms can facilitate the easy procurement of these inputs, ensuring farmers have access to the necessary resources.

Technology Adoption Gap: the agriculture sector may lag in adopting modern technologies. E-commerce implementation can act as a catalyst for the adoption of technology, encouraging precision farming methods, IoT (Internet of Things) applications, and data-driven decision-making.

The implementation of e-commerce in the agricultural sector addresses various challenges faced by traditional agricultural businesses in Ukraine and globally. It opens up new market avenues, enhances price transparency, streamlines supply chains, facilitates access to agricultural inputs, and acts as a catalyst for technology adoption, ultimately contributing to the overall efficiency and sustainability of the sector.

2. E-commerce Integration in the Ukrainian Agricultural Sector

E-commerce in the agricultural market of Ukraine is gradually gaining traction, marking a shift towards digital solutions in the sector. This analysis aims to examine the current state of electronic trade practices and their impact on the agricultural industry (Berezovska & Kyrychenko, 2022).

In Ukraine, e-commerce in the agricultural sector and agri-platforms have played a significant role in improving the entrepreneurial environment. These electronic solutions create opportunities for farmers to utilize

resources more efficiently, providing convenient access to markets and facilitating the optimization of agricultural processes.

It is essential to note that agri-platforms expand the capabilities of e-commerce, considering the specific needs of agriculture. They contribute to efficient trade by providing farmers access to innovative solutions, improving the supply chain, and enhancing the competitiveness of Ukrainian agricultural producers (Grubar & Gygalkovich, 2019).

Agri-platforms in Ukraine are digital resources that bring together participants in the agricultural sector – from farmers and suppliers to investors and experts. These platforms provide various services and tools to optimize agricultural activities, exchange data, develop businesses, and facilitate interaction among all participants in the supply chain (Hevko & Yaskal, 2020).

However, according to the authors, a suitable definition would be: an agri-platform can be uniquely defined as a digital ecosystem specifically designed for the agricultural sector, seamlessly integrating e-commerce, data analytics, and collaborative tools. It serves as a comprehensive online hub that facilitates the exchange of goods, services, and information among farmers, agribusinesses, and stakeholders, fostering efficiency, innovation, and sustainable practices within the agricultural supply chain.

The essence of agri-platforms can be further elucidated through the definition of their roles (*Table 1*).

Table 1

Role of Agri-Platforms in Ukraine

Name	Description	Role
Industry Unification	Platforms unite farmers, agribusinesses, suppliers, experts, and investors into a single digital ecosystem	Creating a community and knowledge exchange that promotes industry development
Digital Transformation	Agri-platforms facilitate the adoption of digital technologies such as IoT, artificial intelligence, and blockchain in the agricultural sector	Ensuring digital transformation to enhance production efficiency and resource management
Data Exchange and Analytics	Platforms enable farmers to exchange data, analyze market information, and make informed decisions	Supporting data-driven decision-making and improving productivity
Marketplace for Goods and Services	Some platforms act as online marketplaces where farmers can buy/sell agricultural products and services	Creating a digital space for trade and resource exchange
Training and Consultation	Platforms offer opportunities for training, knowledge exchange, and expert consultations	Supporting skill development and enhancing expertise among participants in the agricultural sector

Source: completed by the author according to (Kublitska, 2023; Yatsenko et al., 2019).

There is a notable increase in the adoption of e-commerce platforms within the agricultural sector. Farmers and agribusinesses are leveraging online platforms for buying and selling agricultural products, streamlining transactions, and expanding market reach.

Considering the above, it is relevant to examine the advantages and challenges of consumers, agricultural producers, and intermediaries in the agricultural products market using agri-platforms (*Table 2*).

Table 2

Advantages and challenges of using Agri-platforms

Advantages	Challenges
<i>Increased Market Accessibility:</i> e-commerce provides rural producers with broader access to markets, breaking geographical constraints and facilitating national and international trade	<i>Limited Digital Literacy:</i> some farmers face challenges in adopting e-commerce due to limited digital literacy. Comprehensive training programs are essential for widespread adoption
<i>Improved Market Efficiency:</i> the online environment facilitates quicker and more efficient transactions, reducing the time it takes to bring products from the farm to the consumer	<i>Resistance to Change:</i> some farmers may resist adopting e-commerce due to traditional practices, highlighting the need for awareness campaigns to showcase the benefits
<i>Enhanced Transparency:</i> digital platforms improve transparency in pricing, ensuring fair deals and reducing the impact of intermediaries on farmers' revenue	<i>Logistical Challenges:</i> efficient last-mile delivery and transportation logistics pose challenges, especially in remote rural areas
<i>Streamlined Procurement:</i> farmers benefit from streamlined processes in procuring agricultural inputs, leading to cost savings and operational efficiency	<i>Quality Assurance:</i> ensuring the quality of products during transportation and delivery remains a concern, requiring robust packaging and handling solutions
<i>Market Diversification:</i> e-commerce allows farmers to diversify their markets, reaching a broader consumer base and reducing dependency on local markets	<i>Secure Payment Solutions:</i> developing and implementing secure and reliable digital payment solutions tailored to agricultural transactions remains a critical challenge
<i>Data-Driven Decision-Making:</i> digital platforms enable farmers to make informed decisions based on real-time market data, optimizing production strategies and resource allocation	<i>Uneven Internet Access:</i> unequal internet access in rural areas hampers the full utilization of e-commerce platforms, limiting their effectiveness

Source: completed by the author according to: (Lone & Weltevreden, 2022; Berezovska & Kyrychenko, 2022).

Here is a list of the main Agri-platforms operating in Ukraine (*Table 3*).

The main agri-platforms in Ukraine, including *AgroMarket*, *AgroExpert*, *AgroVesna*, and *AgroPro*, play a crucial role in facilitating agricultural activities by providing farmers and agribusinesses with essential tools and resources. These platforms contribute to the modernization and efficiency of the agricultural sector in Ukraine through digital solutions and improved market access.

Table 3

The main agri-platforms in Ukraine

Factor	<i>AgroMarket</i>	<i>AgroExpert</i>	<i>AgroVesna</i>	<i>AgroPro</i>
Description	An agricultural e-commerce platform, focusing on connecting farmers with suppliers and buyers for agricultural products and equipment	A platform that provides services for accounting and analysis of agricultural activities. It assists farmers in managing their farms and making informed decisions	A platform for exchanging experience and knowledge in the agricultural sphere. It provides opportunities for consultations, discussions, and training for farmers	An online platform for bringing together experts in the field of agriculture. It offers opportunities for knowledge exchange and recommendations
Features	Specialized categories for seeds, fertilizers, machinery, and an integrated communication system	Agricultural activity analysis, farm management services, decision support	Facilitates knowledge exchange, consultations, and discussions in the agricultural community	Provides a platform for knowledge sharing and recommendations among agricultural professionals
Website	https://agro-market.net/ua	https://agroexpert.top	https://agrovesna.com.ua	https://agropro.org.ua
Type of website	Marketplace			
Website Audience	Retail Trade, Wholesale Trade	Retail Trade	Wholesale Trade	Retail Trade, Wholesale Trade
Year of establishment	2011	2016	2011	2009
Types of products	Seeds, plants, fertilizers, garden and yard products, etc	Agricultural products on the Ukrainian market	Specializes in the production, purchase and sale, storage, sorting, shock freezing of fresh berries	Plant protection agents, fertilizers, sowing materials, fumigants, reagents, rodenticides

Source: completed by the author according to (Lone & Weltevreden, 2022; Grubar & Gygalkevych, 2019).

3. Technological Integration: Blockchain, IoT, and Data Analytics

To simplify the usage of agri-platforms in e-commerce, Internet of Things (IoT) and blockchain technology are employed.

The integration of these technologies can enhance production quality, reduce resource losses, and increase the efficiency of farm management. However, considerations for data security, confidentiality, and farmer education are crucial for successful implementation.

Blockchain is a distributed database stored on multiple computers simultaneously and constantly updated through blocks of information. Each block contains a set of transactions, information about their timestamp, and a reference to the previous block.

The integration of digital technologies, such as the Internet of Things (IoT), in Ukraine has significant potential for the development of various sectors, including agriculture, industry, and urban planning. Implementing IoT allows for real-time data collection and analysis, improving efficiency, and positively impacting the country's economy. We can provide a few more examples of the use of IoT in agriculture: Field Monitoring; Livestock Monitoring; Automated Irrigation.

Let's now consider the significance of each method (*Table 4*).

Table 4

Use of Blockchain and IoT on Electronic Platforms in Agribusiness

Function of agri-platforms	<i>Blockchain</i>	<i>IoT</i>
Product Traceability	Electronic platforms employ blockchain to establish a product traceability system. Each stage of the production process, from planting in the field to sales, is recorded in the blockchain, providing resilience and reliability to the information	IoT sensors are used to gather data on cultivation conditions, such as humidity, temperature, and weather conditions. These data are integrated into the blockchain, offering detailed information about the quality of the products
Inventory Management	The use of smart contracts on the blockchain allows for the automation of inventory management. Real-time inventory tracking and automatic resource replenishment simplify supply chain management	IoT systems are utilized to monitor resource levels, automatically reflecting in the blockchain, ensuring accuracy and reliability of data
Community Finance	Microfinance systems based on blockchain efficiently and securely provide financial support to rural communities	Community initiatives can use IoT for data collection on production and distribution of financial resources, reflected in the blockchain

Source: completed by author.

Electronic platforms successfully combine blockchain and IoT to enhance transparency, traceability, and efficiency in agribusiness. For a broader and more effective implementation of electronic commerce in agriculture, we propose using a model that utilizes blockchain technology that has been improved by the authors (*Figure 2*).

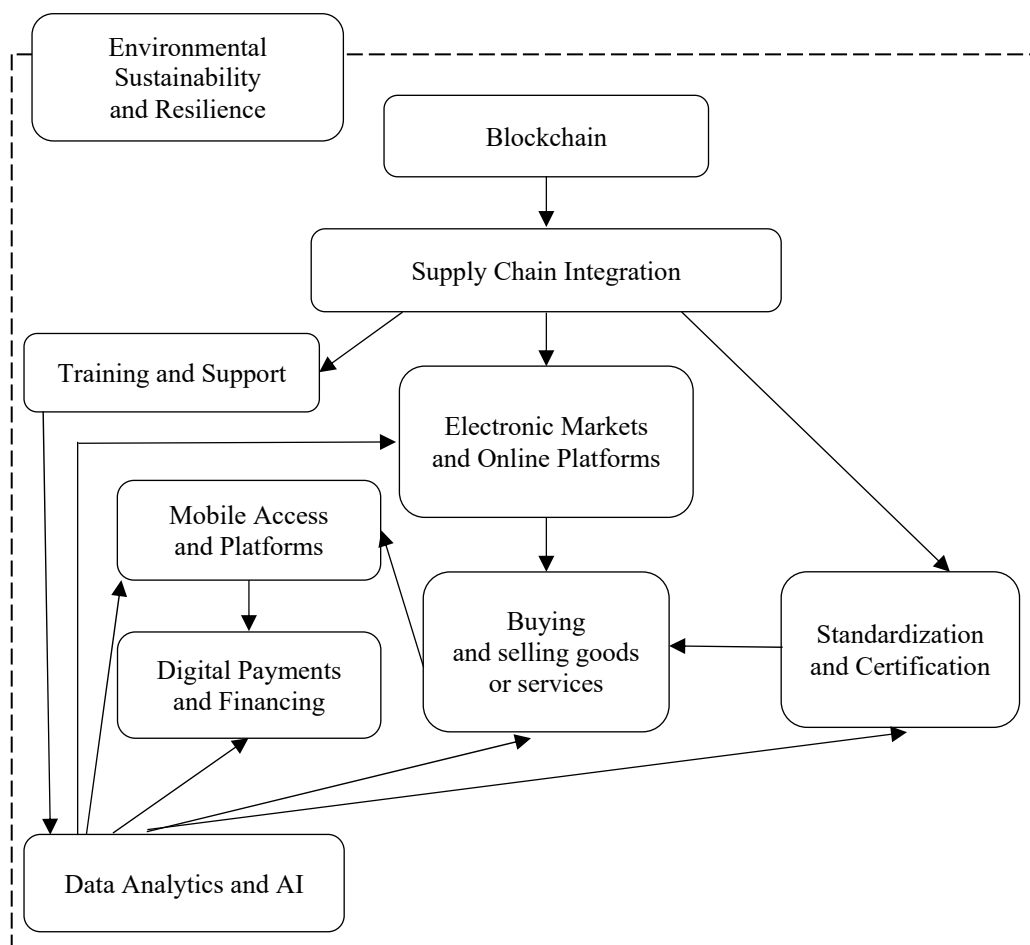


Figure 2. The model that utilizes blockchain technology

Source: completed by author.

Supply Chain Integration: efficient supply chain management, including the use of blockchain technology to ensure transparency and product traceability from the farm to the consumer.

Mobile Access and Platforms: developing mobile applications that facilitate access to markets and trade for farmers in remote or rural areas.

Digital Payments and Financing: implementation of secure digital payment systems and access to financing for small and medium-sized agricultural enterprises.

Electronic Markets and Online Platforms: creating electronic markets where farmers can sell their products directly to consumers or intermediaries.

Training and Support: organizing training programs for farmers to teach them how to use digital tools and platforms.

Data Analytics and AI: applying data analytics and artificial intelligence to analyze market trends and assist farmers in making informed decisions.

Standardization and Certification: establishing quality and safety standards for products and implementing certification systems.

Environmental Sustainability and Resilience: implementing sustainable development practices, reducing environmental impact, and promoting organic farming.

It is also crucial to create a supportive legislative and regulatory environment that fosters innovation and digital transformation in the agricultural sector.

Conclusions

The integration of e-commerce into Ukraine's agricultural sector presents a transformative opportunity for the industry. It is evident that e-commerce adoption is on the rise, with farmers and agribusinesses increasingly embracing digital platforms to enhance their operations.

The benefits of e-commerce in agriculture are clear, including improved market accessibility, enhanced market efficiency, transparency in pricing, streamlined procurement, market diversification, and data-driven decision-making. These advantages collectively contribute to the sector's overall efficiency and competitiveness.

However, several challenges need to be addressed for the successful implementation of e-commerce. These challenges include limited digital literacy among some stakeholders, resistance to change, logistical difficulties, and the need for secure digital payment solutions. Overcoming these obstacles will require targeted training programs, awareness campaigns, and infrastructure improvements.

Agri-platforms play a pivotal role in uniting various participants within the agricultural supply chain, fostering collaboration, and facilitating digital transformation. These platforms offer a range of services, including data exchange, marketplace solutions, training, and knowledge sharing.

The integration of blockchain and IoT technologies is crucial for ensuring product traceability, efficient inventory management, and community finance within the agricultural sector. These technologies enhance product quality and consumer trust.

Looking ahead, the future of e-commerce in Ukrainian agriculture appears promising. Ongoing challenges, such as logistical issues and funding shortages, are expected to drive increased adoption of digital solutions. The focus on value-added products and global market integration will further bolster the sector's competitiveness.

Government support and international initiatives will play a vital role in shaping the trajectory of e-commerce adoption in agriculture. Promoting digital literacy, providing financial assistance, and creating a supportive regulatory environment are essential components of this transformation.

Ultimately, the adoption of e-commerce has the potential to enhance the sustainability and resilience of Ukraine's agricultural sector. By optimizing supply chains, reducing waste, and improving market access, the industry can navigate challenges and thrive in an increasingly digital landscape.

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