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Using Artificial Intelligence (AI) in Financial Decision-Making in the Agricultural and Rural Economy

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ABSTRACT

Using the artificial intelligence (AI) in financial decision-making in the agricultural and rural economy represents a significant innovation that can transform the way financial resources and strategies are managed in this sector. Agriculture and the rural economy usually face a variety of financial challenges, such as price volatility, unpredictable weather conditions, market risks and limited access to capital. In this context, AI can address many of these challenges and improve their economic efficiency and sustainability. The article explores a comparative analysis of the use of AI as an alternative to traditional methods considering important activities in the Agrico field as well as the interdependence between the optimization of the decision-making process in agriculture and the rural economy and regional development.

1. Introduction

In the context of accelerated digital transformations, artificial intelligence (AI) is playing an increasingly key role in optimizing decision-making in various economic areas, including agriculture and the rural economy. These sectors, essential for food security and regional development, are often marked by financial instability caused by factors such as price volatility, climate change and limited access to finance (World Bank, 2021) (FAO, 2022). The use of AI in financial decision-making offers a valuable opportunity to respond to these challenges through predictive analysis, automation and efficient resource allocation (Basso, B., & Antle, J. , 2020). By integrating advanced technologies into agricultural and rural processes, it can contribute to increasing economic sustainability and strengthening financial resilience in the face of systemic uncertainties (Zhang, 2023).

2. Literature review

The role of advanced technologies in agriculture and the rural economy. Agriculture and the rural economy are fundamental sectors for national economies, but they face multiple challenges, such as market volatility, climate risks, lack of access to finance and poor infrastructure. In this context, the use of advanced technologies, in particular artificial intelligence (AI), has been proposed as a viable solution to optimize financial processes and increase efficiency in these sectors. According to research by Basso and Antle (2020), AI has the potential to significantly improve the sustainability and competitiveness of agriculture through more accurate forecasts, process automation and decision-making based on

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predictive analytics. This technology can thus address the traditional shortcomings of the agricultural sector and support a more balanced regional development.

Artificial intelligence and improving decision-making in agriculture. Artificial intelligence is currently being used to improve decision-making in several areas of agriculture, from natural resource management to market forecasting and crop health monitoring. According to a study by Zhang et al. (2023), AI can analyse big data from various sources to provide precise recommendations on sowing time, fertilizer use or plant protection, so that resources are used more efficiently and sustainably. These optimized decision-making processes can reduce financial risks and increase productivity in the agricultural sector, with a direct impact on economic stability in rural regions.

Financial challenges in agriculture and the use of AI for risk management. Agriculture faces considerable volatility, especially in terms of agricultural product prices, unpredictable weather conditions and limited access to capital. In this context, the use of AI for financial risk analysis and management has been explored by numerous authors. For example, the World Bank (2021) has highlighted the importance of implementing innovative financial technologies to support farmers in rural areas in the face of economic instability. Machine learning algorithms can help model economic risks, forecast market fluctuations and optimize financial decisions. AI can thus help minimize financial risks and reduce the uncertainties faced by farmers, especially in the face of climate change and global market fluctuations.

Artificial Intelligence and Economic Sustainability in Rural Regions. A key aspect of the use of AI in agriculture and the rural economy is its impact on economic sustainability. Studies have shown that advanced technologies can increase the efficiency of natural resource use and contribute to environmental conservation, which are fundamental elements for the long-term economic development of rural regions. For example, using AI to optimize water, soil and nutrient management can reduce negative environmental impacts while improving agricultural yields (Basso, B., & Antle, J. , 2020). This approach not only helps protect the environment, but also strengthens the economic resilience of rural regions, which depend heavily on natural resources to support economic activities.

AI and access to capital for rural regions. Limited access to capital poses a significant challenge for farmers and entrepreneurs in rural regions. A study by FAO (2022) highlighted that AI can facilitate access to finance by developing digital financial solutions and microfinance platforms tailored to the specific needs of farmers in rural areas. For example, AI-based systems can assess financial risks and provide recommendations for safer loans, and scoring algorithms can help financial institutions better assess farmers' creditworthiness and the risks associated with loans. This can significantly improve access to capital and support economic development in rural areas.

The impact of AI on regional economic and social cohesion. Another important aspect of the use of AI in agriculture and the rural economy is its effect on economic and social cohesion in rural areas. According to a World Bank report (2021), AI technologies can help reduce economic gaps between urban and rural areas by improving access to information, education and business opportunities. By providing more accurate data and decision-making tools, AI can help rural SMEs become more competitive, attract investment and create jobs, thereby increasing social and economic cohesion.

As a methodology for conducting the research, it was used a literature review, descriptive approach through a comparative analysis using of AI in agriculture compared to traditional working methods.

The literature clearly highlights the important role of artificial intelligence in optimizing decision-making in agriculture and the rural economy, with a significant impact on regional economic and social development. From improving resource efficiency and managing financial risks, to increasing access to capital and promoting sustainability, AI offers innovative solutions that can help solve the problems facing rural regions. In the future, the full integration of AI in these sectors will be essential for building a resilient and sustainable rural economy.

The research employs a qualitative approach grounded in a systematic literature review and comparative analysis to explore the application of Artificial Intelligence (AI) in financial decision-making within the agricultural and rural economies, particularly focusing on Romania and the European Union.

Literature Review: A comprehensive collection of scholarly articles, reports, and case studies was gathered from academic databases (e.g., Scopus, Web of Science), EU project repositories, and governmental publications. The review aimed to identify existing AI applications, their impact on financial decision-making processes in agriculture, and challenges or benefits experienced in both Romania and broader EU contexts. Key themes such as AI-driven risk assessment, credit scoring, insurance, and financial planning tools were synthesized to establish a theoretical and practical framework.

Comparative Analysis: The collected literature was systematically compared to discern similarities and differences in AI implementation between Romania and other EU member states. The analysis focused on variations in technology adoption, financial outcomes, regulatory support, and rural economic impacts. This approach enabled a nuanced understanding of how regional factors influence AI's effectiveness in agricultural financial decision-making.

By combining these methods, the research offers an evidence-based and contextually relevant assessment of AI's role, highlighting lessons learned and potential future directions for enhancing financial sustainability in rural economies.

3. Use of AI in Agriculture Compared to Traditional Working Methods

3.1. Comparative Analysis of the Use of AI as an Alternative to Traditional Methods

Artificial Intelligence (AI) has a significant impact on the transformation of agricultural activities, revolutionizing traditional working methods through automation, optimization and forecasting. Compared to classical approaches, the use of AI offers more efficient, more accurate and scalable alternatives for various processes in agriculture, from land monitoring to production and distribution optimization. In this context, the comparative analysis between the use of AI and traditional procedures is essential for understanding the impact of these technologies.

Below are some examples of AI use:

Crop Monitoring and Plant Health

Traditional (Manual) Methods: Crop monitoring is usually done through direct physical inspections by farmers, who visually check the condition of the plants, signs of diseases, pests or environmental

stresses. This can include field or greenhouse inspections and recording observations in logs or spreadsheets.

Use of AI: Field sensors, drones, and AI-powered thermal/spectral cameras can collect visual and environmental data about crops, and AI algorithms can analyse this data to identify signs of disease, pests, or other anomalies. The analysis can be done much faster and on a larger scale than with manual methods.

Comparison:

- Efficiency: AI allows for continuous, large-scale monitoring of fields without the need for farmers to be constantly present in the field.
- Accuracy: AI can detect subtle changes in plant health that may escape human observation, improving the accuracy of identifying problems.
- Cost: Initially, deploying sensors and drones can be expensive, but in the long run, the time savings and lower labour costs can make up for the investment.
- Scalability: AI allows for expansion to large areas of land or multiple locations, while manual monitoring becomes much more difficult as the area expands.

Irrigation and Water Resources Management

Traditional Methods: Manual irrigation or fixed irrigation systems, with manual control of the amount of water used. These methods can often lead to wastage of water resources due to inefficient control.

Use of AI: Smart irrigation systems equipped with AI sensors and algorithms monitor soil moisture in real time and automatically adjust water flow to optimize resource use. These systems can consider weather forecasts and soil variables to adjust irrigation, reducing water waste.

Compared:

- Efficiency: AI allows for much more efficient use of water, optimizing the exact amount needed for each area of the field.
- Accuracy: AI-based systems can adjust irrigation for specific soil and crop conditions, while traditional methods can over- or under-irrigate.
- Costs: The initial cost of installing automated systems can be high, but the savings from optimal water use and reduced resource consumption in the long term can offset these expenses.
- Scalability: AI allows irrigation systems to be expanded quickly to large areas, while manual irrigation management becomes more complex as the land area increases.

Crop prediction and risk management

Traditional methods: Farmers typically rely on their own experience and field observations to estimate yields and assess risks (such as drought or pest attacks). This can lead to inaccurate estimates based on subjective observations.

Use of AI: AI models analyse a large amount of data, including historical data, weather conditions, soil types, and current crop data, to predict yields and assess risks. AI can create accurate scenarios based on different environmental conditions and help farmers adjust their financial and production plans.

Compared:

- Efficiency: AI can make forecasts much more accurately and quickly than traditional methods, reducing uncertainty in crop management.
- Accuracy: AI models can combine a variety of factors and analyse complex data that is impossible to process manually. This makes crop forecasting much more accurate.
- Costs: The initial investment in the technology required for AI is higher, but it can reduce financial losses through better risk management.
- Scalability: AI models can be scaled up to large farms and can provide forecasts for entire agricultural regions, while manual estimates are limited to individual farms.

Pest Control and Disease Management

Traditional Methods: Pest control is done through chemical methods, pesticide application, or manual inspections to identify signs of infestation. This can lead to excessive use of chemicals and negative impacts on the environment.

Use of AI: Using drones, video cameras, and sensors, AI can accurately identify pests and diseases based on images and data collected. AI models can suggest accurate and streamlined treatments, reducing the need for excessive pesticide application.

Compared:

- Efficiency: AI reduces the time needed to identify and treat pest problems, being much faster than manual inspections.
- Accuracy: AI can identify pests and diseases much faster and more accurately, and treatment applications are more specific, reducing the risks of incorrect treatment.
- Costs: Although the initial costs of equipment and technologies are higher, reducing the use of pesticides and manual labour can lead to long-term savings.
- Scalability: AI can be applied to large areas and can manage various areas simultaneously, while manual application is more difficult to scale.

Product distribution and sales management

Traditional methods: Agricultural products are distributed through physical channels, such as local markets or intermediaries, and farmers rely on personal relationships and direct negotiation.

Use of AI: AI can optimize supply chains by choosing the best transport routes and forecasting demand for various products. It can also help farmers access online markets, promoting their products through personalized digital marketing.

Compared:

Efficiency: AI enables faster and more efficient distribution of products by predicting demand and managing the supply chain.

- Accuracy: AI models can more accurately predict demand for agricultural products and optimize inventories, reducing losses.

- Costs: Distribution costs can be reduced by optimizing transportation and eliminating intermediaries. In the long run, farmers can earn more by selling directly to online marketplaces.
- Scalability: AI allows for the scaling of sales globally, while traditional distribution is limited to local markets.

The use of AI in agriculture offers several significant advantages compared to traditional methods. While initial implementation may be more expensive and requires a certain level of investment in technology, the long-term benefits in terms of efficiency, accuracy and scalability are considerable. AI allows for the optimization of resources, reduction of operating costs and maximization of yield, transforming agriculture into a more sustainable and profitable industry.

3.2. Using AI in Agricultural Financial Management

Forecasting and Financial Risk Management. AI can help predict financial and economic risks by using machine learning algorithms to analyse historical data and current conditions. For example, AI models can analyse market trends, fluctuations in agricultural product prices, and other economic variables to provide accurate forecasts of future prices. This allows farmers and rural entrepreneurs to adjust their production plans and sales strategies. AI can also analyse weather data and climate models to help farmers predict weather conditions and take action to minimize the impact of extreme events, such as droughts or floods. This information can be used to adjust financial plans and prevent major financial losses. By using AI, farmers can identify financial risks earlier and develop strategies to mitigate them, such as diversifying production or taking out customized insurance for weather events or market fluctuations.

Optimizing the allocation of financial resources. AI can support farmers and rural entrepreneurs in making decisions regarding the allocation of financial resources. By using machine learning models and optimization algorithms, the most efficient ways of using capital can be identified, reducing costs and maximizing profit. For example, AI can help automate accounting and financial processes, reducing errors and saving valuable time. These tools can manage the financial flows of agricultural enterprises and generate accurate financial reports in real time, facilitating faster and better-founded financial decision-making. In terms of investments, AI can analyse the profitability of various projects, including the purchase of agricultural equipment, the construction of rural infrastructure or the expansion of businesses. Financial models can calculate anticipated long-term costs and revenues, helping to make better-informed decisions.

Access to finance and credit. One of the biggest obstacles in agricultural and rural economies is limited access to finance. AI can help farmers and rural businesses improve their chances of obtaining credit and investment by analysing their financial risks and financial behavior. For example, for AI-based credit scoring, banks and financial institutions can use AI algorithms to assess farmers' risks and ability to pay, even in the absence of traditional financial histories. AI can analyse data such as payment history, resource utilization, and past business performance to provide a credit score tailored to the specifics of agriculture. AI can also help develop microfinance solutions by assessing repayment capacity and personalizing financial offers for small and medium-sized farmers in rural areas, who might otherwise be excluded from access to capital.

Sustainable and financial development strategies. Artificial intelligence can help promote a more financially sustainable agricultural and rural economy. By analysing data and identifying the most efficient farming practices, AI can support the development of growing strategies that are both profitable and environmentally sustainable. AI can help farmers implement precision farming techniques, which include optimal use of resources, minimizing losses, and maximizing yields, with minimal environmental impact. These techniques can include the use of sensors to monitor soil and plants, as well as drones to inspect and manage crops. AI models can help sustainably manage natural resources (water, soils, biodiversity) by monitoring and analysing data on their consumption and optimizing their use, thereby reducing costs and negative environmental impact.

Innovations in the distribution and sales process. AI can improve the distribution process of agricultural products, optimizing supply and sales chains, reducing losses and transportation costs. Thus, AI algorithms can calculate the most efficient transportation routes, saving time and costs for farmers and traders., and e-commerce platforms can use AI to provide more effective marketing solutions and help producers reach international or national markets, promoting their products in personalized and more effective ways.

4. The interdependence between decision-making optimization in agriculture and the rural economy and regional development

The optimization of decision-making in agriculture and the rural economy plays a crucial role in regional development, with profound implications for economic growth, sustainability and social balance. The integration of advanced technologies, such as artificial intelligence (AI), into the decision-making process can address multiple challenges faced by these economic sectors, such as market volatility, climate change and lack of capital, thus contributing to a positive impact on regional development.

Resource efficiency

One of the most important aspects of decision-making optimization is improving resource efficiency, which is essential for sustainable agriculture and economic prosperity in rural areas. Informed decisions based on predictive analytics made with the help of AI allow farmers and entrepreneurs in rural areas to maximize the use of available resources, reduce losses and minimize economic risks. For example, by using AI systems to forecast weather conditions and monitor financial markets, strategies can be adopted to optimize agricultural production and reduce price volatility (Basso, B., & Antle, J. , 2020). These approaches not only support agricultural sustainability, but also contribute to increasing incomes in rural regions.

Increasing regional economic competitiveness

Another important aspect is that AI can support agriculture and the rural economy in increasing regional economic competitiveness. By applying technologies to automate and optimize production processes, farmers and businesses in rural areas can become more competitive both domestically and internationally. The use of advanced technologies in agricultural processes can reduce production costs, thus improving farmers' profit margins and contributing to regional development by creating jobs and generating additional income (Zhang, 2023). Also, by investing in digital infrastructure and education,

rural areas can attract new business opportunities, improving their integration into regional and national economies.

Adaptability to climate change

Sustainable regional development also depends on the capacity of agricultural and rural regions to adapt to climate change. Agriculture is highly sensitive to climate conditions, and AI technologies can help anticipate and manage these changes by analyzing weather data and adapting planting and harvesting strategies. In this context, optimizing financial decisions in agriculture contributes to strengthening regional economic resilience, providing more effective solutions for protecting resources and reducing financial risks (World Bank, 2021).

Impact on social and economic cohesion

The economic development of rural regions is not limited to increasing income and productivity, but also to improving social cohesion. AI can help reduce inequalities between urban and rural regions by improving access to information and resources, thus promoting more balanced economic development. Implementing more accessible and efficient financial solutions for farmers, through digital platforms and smart financial applications, can reduce economic barriers and encourage entrepreneurship in rural areas (Basso, B., & Antle, J. , 2020) .

Collaboration between the public and private sectors

In addition, optimizing the decision-making process in agriculture and the rural economy is closely linked to collaboration between the public and private sectors. Governments and international organizations can support the implementation of advanced technologies in these sectors through favourable policies, investments in digital infrastructure and continuous education for farmers. Public-private partnerships are essential to support a favourable business environment in rural regions and accelerate economic development (World Bank, 2021) (FAO, 2022).

5. Short case studies

Example 1 Case Study: AI for Crop Insurance and Credit Scoring in Romanian Agriculture

In Romania, several fintech startups and agricultural cooperatives have adopted AI-driven platforms to improve financial decision-making for farmers. One such initiative involves using AI to analyse satellite imagery, weather data, and farm management information to predict crop yields and risks more accurately. This enables insurers to tailor crop insurance products and helps banks assess creditworthiness for agricultural loans with greater precision, reducing financial risks for both parties.

- AI algorithms evaluate multiple data sources to forecast crop outcomes.
- Insurers set premiums dynamically based on predicted risk levels.
- Banks use AI to determine loan eligibility, offering better terms to low-risk farmers.

This system has been supported by EU rural development funds aimed at digital transformation in agriculture (Popescu, A., & Tănăsescu, M., 2021).

Example 2 Case Study: EU-Wide AI Initiatives in Smart Farming and Financial Services

The EU-funded project SmartAgriHubs integrates AI technologies to facilitate precision agriculture and connect farmers with financial services. AI models analyse soil data, weather forecasts, and market prices to advise farmers on crop planning and investments. The AI-driven decision-support tools also help financial institutions better understand farm performance, leading to customized loan products and risk assessments across rural Europe, including Romania.

- AI-driven decision support helps farmers optimize production and investment.
- Financial institutions use AI insights for better loan risk profiling.
- Enhances sustainability and profitability of rural economies (European Commission, 2020)

Example 3 Case Study: AI-Enabled Financial Planning for Smallholders in Eastern Europe

A collaboration between Romanian agricultural cooperatives and AI startups developed a mobile app that uses machine learning to offer personalized financial planning for smallholder farmers. By inputting farm data, the AI system suggests optimized budgeting, loan management, and investment timing to improve profitability. The tool incorporates real-time market trends and EU subsidy regulations, helping farmers navigate complex financial decisions in a volatile market (Ionescu, D., & Marinescu, L., 2022).

6. Conclusions

In conclusion, the integration of AI into financial decisions in the agricultural and rural economy has significant potential to transform this sector. Using advanced data analysis and optimization technologies, AI can support farmers and rural entrepreneurs to improve financial resource management, reduce risks and costs, and promote more sustainable and profitable development. However, to maximize the impact of AI in this sector, it is essential to invest in education and training to enable farmers and rural leaders to adopt and apply these technologies effectively.

The use of AI in agriculture offers several significant advantages compared to traditional methods. While the initial implementation may entail higher costs and require a certain level of investment in technology, the long-term benefits in terms of efficiency, accuracy, and scalability are considerable. AI enables resource optimization, reduced operating costs and maximized yields, transforming agriculture into a more sustainable and profitable industry.

The interdependence between optimizing decision-making in agriculture and the rural economy and regional development is complex and multidimensional. Implementing artificial intelligence in these sectors not only improves efficiency and competitiveness but also contributes to the sustainable and balanced development of rural regions. By adopting advanced technologies and through well-thought-out policies, rural areas can become engines of economic growth and social cohesion.

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