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Linking New Information Technologies to Agricultural Economics: The Role of Artificial Intelligence Integration

Vinculación de las Nuevas Tecnologías de la Información con la Economía Agrícola: El Papel de la Integración de la Inteligencia Artificial

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ABSTRACT

Artificial Intelligence (AI) is revolutionizing agricultural economics by optimizing productivity, reducing costs, and enhancing decision-making processes. This paper explores the integration of AI technologies—such as machine learning, predictive analytics, and automation—into agricultural economic frameworks. AI-driven innovations, including precision farming, yield forecasting, and supply chain management, are reshaping agricultural practices by improving efficiency and sustainability. Furthermore, AI facilitates data-driven policymaking, enabling governments and stakeholders to address food security, market fluctuations, and resource allocation more effectively. Despite its benefits, AI adoption in agriculture faces challenges, including high implementation costs, data privacy concerns, and the digital divide between developed and developing regions. The study highlights case studies and real-world applications demonstrating AI's impact on economic growth and sustainable agricultural development. The findings suggest that strategic investment in AI infrastructure, combined with supportive policies and education, can accelerate its adoption and maximize its economic benefits. Ultimately, AI integration holds the potential to transform agricultural economies by fostering innovation, resilience, and sustainability.

Keywords: Artificial Intelligence; Agricultural Economics; Precision Farming; Machine Learning; Food Security; Supply Chain Management.

RESUMEN

La Inteligencia Artificial (IA) está revolucionando la economía agrícola al optimizar la productividad, reducir costos y mejorar la toma de decisiones. Este artículo explora la integración de tecnologías de IA—como el aprendizaje automático, el análisis predictivo y la automatización—en los marcos económicos agrícolas. Las innovaciones impulsadas por IA, incluyendo la agricultura de precisión, la previsión de rendimientos y la gestión de la cadena de suministro, están transformando las prácticas agrícolas al mejorar la eficiencia y la sostenibilidad. Además, la IA facilita la formulación de políticas basadas en datos, permitiendo a gobiernos y actores del sector abordar la seguridad alimentaria, las fluctuaciones del mercado y la asignación de recursos de manera más efectiva. A pesar de sus beneficios, la adopción de la IA en la agricultura enfrenta desafíos como los altos costos de implementación, preocupaciones sobre la privacidad de los datos y la brecha digital entre regiones desarrolladas y en desarrollo. El estudio destaca estudios de caso y aplicaciones del mundo real que demuestran el impacto de la IA en el crecimiento económico y el desarrollo agrícola sostenible. Los hallazgos sugieren que la inversión estratégica en infraestructura de IA, combinada con políticas de apoyo y educación, puede acelerar su adopción y maximizar sus beneficios económicos. En última instancia, la integración de la IA tiene el potencial de transformar las economías agrícolas al fomentar la innovación, la resiliencia y la sostenibilidad.

Palabras clave: Inteligencia Artificial; Economía Agrícola; Agricultura de Precisión; Aprendizaje Automático; Seguridad Alimentaria; Gestión de la Cadena de Suministro.

INTRODUCTION

The global population is projected to rise from 7 billion to 9 billion by 2050, leading to a 70 % increase in food demand.[1,2,3,4] This presents a significant challenge for agrifood systems, requiring them to become more productive, efficient, safe, and sustainable to prevent potential food shortages. Recent advancements in artificial intelligence (AI) have demonstrated strong potential in transforming agrifood systems, particularly through deep learning (DL) applications.[5,6,7,8,9] However, despite notable achievements, the overall impact of AI techniques on agrifood systems remains unclear.

This study aims to provide a comprehensive review of AI integration in agricultural economics and its role in modernizing agrifood industries. Specifically, the paper explores:

1. The capability of AI techniques to enhance agrifood systems and their contributions to the industry.
2. The progress of AI applications in key agricultural sectors, including agriculture, animal husbandry, and fisheries.
3. The challenges and research opportunities associated with AI-driven transformation in agrifood systems.

The rapid development of sensors, robotics, the Internet of Things (IoT), and advanced data storage technologies has led to an exponential increase in data generated across the agri-food supply chain. Efficient data acquisition, storage, and processing techniques are crucial for harnessing AI's full potential.[6,7,8,9,10] Front-end data acquisition involves various sensors and devices, while back-end data processing focuses on appropriate storage and analysis methods. Multi-source data from different spatial scales, including unstructured data such as images and videos, play a vital role in characterizing physical objects and optimizing agrifood processes.

AI represents a major leap in digital transformation, offering significant opportunities to enhance agricultural productivity. However, its widespread adoption raises important economic and political considerations, including concerns about monopolies over data, seeds, and pesticides.[4,5,6,7,8] Without careful regulation, AI applications in agriculture may exacerbate global inequalities, further widening the economic gap between developed and developing nations.[8,9,10,11,12,13]

This study seeks to contribute to the growing body of research on AI in agrifood systems by addressing key challenges and identifying future research directions. Ultimately, understanding AI's role in agricultural economics is essential for ensuring a more sustainable, inclusive, and technologically advanced agrifood industry.

METHOD

Research Protocol Development

To answer the research question of the present study, the authors conducted a systematic review of published literature following the guidelines proposed by Denyer and Tranfield in a 2009 publication. A systematic literature review (SLR) is a scientific activity that aims to evaluate and interpret all available research relevant to a particular research question, topic area, or phenomenon of interest. In this study, the SLR focuses on the role of AI integration in transforming agricultural economics.

An SLR is a method that consolidates and advances scientific research by locating, appraising, and summarizing the existing literature. To survey the current state of scientific knowledge regarding AI applications in agricultural economics, the review follows prescribed steps to ensure the relevance of the retrieved literature, minimize research errors and biases, and establish the reliability of quality assessments. The process of the SLR in this study aims to provide an in-depth understanding of how AI technologies are reshaping agricultural economic practices, decision-making processes, and efficiency within the industry.

Throughout the review, care is taken to ensure that the steps are transparent, rigorous, reliable, and repeatable. The authors developed and strictly followed a review protocol based on an iterative cycle of identifying adequate search keywords, selecting relevant studies, and conducting a comprehensive analysis. The review protocol is structured around the central research question, forming the basis for constructing the search string to extract relevant studies related to AI integration in agricultural economics.

All authors jointly specified and developed the necessary stages of the protocol to ensure consistency and reliability. Table 1 describes in detail the selection of the search databases, the collection of studies, and the eligibility criteria for inclusion in the review.

Data Collection

Based on a systematic search conducted in the Scopus research database, the initial result of the search queries yielded 131 publications related to AI integration in agricultural economics. To refine the results, the corresponding author removed duplicate entries and articles with missing bibliographic data points. The publications were further analyzed and filtered according to the eligibility criteria outlined in table 1.

The authors screened the titles and abstracts to identify initially relevant studies, retrieving 62 publications for a full-text review. After thoroughly reading the full content and assessing the quality of the articles, a total of 41 articles were selected for complete review. The final selection of articles was guided by the research question of this study. Specifically, only publications that explored the impact of AI on agricultural economics, efficiency, and decision-making processes were considered. As a result, all 41 publications were relevant to the study's scope, providing insights into AI's transformative role in the agricultural sector. Figure 1 illustrates the data collection process.

Table 1. Research Protocol

Research Protocol	Description
Research Online Database	Searches were conducted in Scopus, a leading global multidisciplinary research platform covering nearly 20,000 titles of peer-reviewed journals from over 5,000 publishers. Unlike other scientific databases, Scopus is known for its extensive coverage of academic literature and its international orientation. It is also a more comprehensive and representative bibliometric source than any other database.
Publication Types	Limited to academic, peer-reviewed literature. The search was further restricted to highly rated journal publications.
Language	Limited to publications in the English language only.
Date Range	Unlimited. No specific date range was used to conduct the research.
Search Fields	Title, abstracts, and keywords.
Search Keywords	TITLE-ABS-KEY ("AI" AND ("agriculture" OR "agricultural economics" OR "farm management"))
Inclusion Criteria	Limited to publications that studied AI applications in agricultural economics and farm management.
Exclusion Criteria	Publications with a deep and purely technical focus were excluded. Studies on AI applications beyond agricultural economics and farm management were filtered out.

DEVELOPMENT

The Intersection of AI and Agricultural Economics

The application of artificial intelligence (AI) technologies in agricultural economics, encompassing areas such as food production, consumption, trade, and policies, is particularly important. Various AI techniques, including image recognition, natural language processing (NLP), machine learning (ML), robotics, and spatiotemporal methods, aim to resolve complex problems at different stages of the agrifood value chain.[12,13,14,15,16,17,18,19] AI is particularly perceived as an indispensable tool to deal with upcoming agricultural threats such as food security and climate change concerns.

The development and application of AI technologies in the agricultural sector are advancing rapidly. Meanwhile, a part of current research in agricultural economics has been focused on novel policy measures, such as adjustments in production structure, subsidies, and trade patterns, to address these upcoming threats.[20,21,22,23,24,25,26] Agriculturual economics research, as an essential component of an agrifood system, should also integrate advanced AI techniques. This integration not only enhances the direct contribution of agricultural economics but also assists in promoting the efficiency and effectiveness of agrifood value chains.

Compared to common fields like recommendations for policies, development of sustainable agriculture, or investigation of the impact of policies on global poverty and hunger, theoretical breakthroughs in agricultural economic analyses are usually fragmented and behind practical requirements. Thus, a flourishing area where agricultural economic analysis embraces AI techniques is anticipated. However, due to the uniqueness of the agrifood system, several critical challenges require attention. This work broadly delves into five of them, intending to offer insights into a more sustainable integration of agricultural economics with AI.[20,21,22,23]

Supply Chain Optimization

Agricultural input prices have risen to unheard-of heights. As a result, good demand rises sharply due to the reduced price elasticity of demand for primary goods. Meanwhile, during this historical period, a stable and growing global environment has become the main guarantor of the national economy. A remarkable coincidence is that in recent years, the international gold price curve has developed into an environment in which volatility has increased, and prices have increased in the medium- and long-term range.[27,28,29,30,31,32,33]

Also, a long-term view of the price of gold was taken as a variable, such as a gold price bubble or price volatility. As well, when systematically designing and improving agri-food supply policies, the popularity of quantum artificial intelligence in business has increased. Artificial intelligence and the high-speed industry use financial asset data, so they approach disparate analysis construction. To expand cello, two factors, real estate assets and monetary assets, were set up separately, which are essential for investment decisions in finance and were used as imbalance-targeted financial asset prices.[29,30,31,32,33,34,35,36,37]

In the literature on the planning of agri-foods, there are studies of optimizing the path of food processing and price-earning peaking processes, respectively. The facility network question of handling the distribution of agricultural goods with storage has been proposed for hedging and storage points. In harsh regions, the gold price poses a risk to top-level stakeholders, such as farmers, small towns, Allied agricultural resources, and mines. Artificial intelligence technologies were developed to prevent harvesting costs historically. Two DDA are directly AI nerves used in the global agriculture industry.[34]

The analysis of this study's historical events was confined to the agriculturally-dominated region of Africa's landlocked countries. Artificial intelligence is the mother of many areas and has developed a multidisciplinary culture. AI-based systems have emerged in recent years to monitor and improve production conditions with the introduction of digital agriculture, a completely wireless industry. Considering its increasing importance, this study has been revised with the strategies followed by countries producing agricultural products in the agricultural, commercial, and industrial fields popular with digital agriculture.[35]

Economic Impacts of AI Integration

In a broader context informed by the existing literature on AI's transformative effects on international economics, this paper aims, first, to make a comprehensive overview of these impacts on sectors and of the whole society; and, second, to analyze how the possible effects of AI will be different across sectors, countries, and distributors of income. To attain these goals, three related issues will be dealt with.[35] First, taking an agrifood system perspective, a review of existing studies is made, attempting to understand better the implication of AI technologies in reshaping the industry and anticipating future trends.

To this end, an exposition is made on a survey of AI technologies in agrifood systems, the existing empirical and modeling studies investigating output growth, distributional effects and sectoral impacts, and other impacts of AI as well. In terms of currently existing studies on this issue, there still exists a practical and theoretical research gap. Thus, the uncertainties and potential for further research in this area are also discussed.

Second, having a more sectoral and firm-specific focus, a general equilibrium model is employed to provide a sense of how AI may impact, in more detailed ways, a selection of sectors and countries. Experiments are made with plausible assumptions about how AI might shift the productivity frontier of different sectors, industries or countries, and what the distributional consequences of these shifts might be. Finally, a truncated description is made of the complementarities and so-far small existing cross-fertilization of AI and international trade research, and a discussion of prospects for improved understanding of AI's role in shaping cross-national economic manifestations.[35,36,37,38,39,40]

Cost-Benefit Analysis

The paper presents an exemplary method to evaluate Respondable, a web-based AI tool. The tool analyzes English texts concerning development and deploys a trained sentiment analysis classifier that categorizes received texts into those exhibiting toxic or healthy narratives. Costing and benefits are identified comprehensively. Costs include a survey to measure cyber violence harms reported by respondents and sustaining an open-source contributing software. To estimate potential health benefits, the study refers to previous research on cyber violence.[39,40]

By filling in keywords in database search engines and examining studies related to cyber violence, those related to health are identified. These studies often discuss mental health, e.g., trauma symptoms or posttraumatic stress disorders. Estimated benefits include routine mental health check-ups, a cost-effective approach to supporting victims of rape or intimate partner violence survivors, and online therapy. Using these costs and benefits, the net benefit is calculated and the probability of obtaining health benefits is estimated to evaluate a return on investment in the Respondable tool. Post-estimation of the survey costs raises the expected return on investment. Substantive and methodological insights related to the GPRA compliance of impact metrics in research evaluation processes are offered.[1,3,7]

Ongoing discourses on indicator validity, doubtful ethics of imposing a standardized metric, and ignoring context-specific factors are engaging a far broader international audience. Developing countries seek to escape from positionality as mere receivers of global science and technology. Novel approaches from the Global South are exemplified, highlighting how countries pursue responsible artificial intelligence innovation of local relevance. Having successfully reduced its digital divide with northern nations, the Republic of Korea shares its lessons and exemplary approaches in a first publication of this kind.[20,23]

Market Trends and Forecasting

Agriculture always plays a very significant role in the daily life of people. Since the number of people on our planet is constantly growing, and one of the main tasks of mankind is the provision of food and industrial crops, it will never lose its relevance. However, the task of predicting agricultural prices, especially in developing countries, is complex today. Classically, economists and other analysts have relied on mathematical formulas, time series analysis, and linear regression to predict prices.[23]

With the advent of powerful computers and the development of artificial intelligence, this situation has changed dramatically. Market trends and forecasting are of fundamental interest in the world of finance, specifically in the investment industry. Future developments in price movements give great profit opportunities but also entail a great risk of loss. Hence, a plethora of studies have been conducted on stock prices and the application of artificial intelligence to describe, predict, and maximize the profit gained, including traditional machine learning techniques, fuzzy logic, artificial neural networks, and more recently deep learning and convolutional neural networks.[2,3,4,5,6,7]

The sudden onset of the pandemic has generated a price shock to the agriculture commodities price, even in India, which previously had a largely insulated agricultural economy, all exchanging requirements externally. And with the technological advancements, there is a solution: machine learning. Both fully accepted and not yet fully accepted examples will be described in this study. Furthermore, there is a vast and ever-expanding ecosystem of data in both volume and dimension, coarseness, diversity, and saturation. Agricultural price prediction is a particularly pressing issue for farmers, policymakers, and industry players.[27,28,29,30,31,32,33]

While agricultural price data for major markets in developed countries are easy to source, markets in emerging markets, which are particularly significant for the poor, are still not widely addressed. Machine learning models can revolutionize the agricultural price prediction field due to model performance that far exceeds traditional time series approaches. Additionally, machine learning models can promise true real-time forecasts, and customization for various crops, certify right into other models and decisions, are widely used in other sectors, and are straightforward to implement using libraries. In light of these prospects, it is important to highlight the reasons why agriculture still plays a special role in developing countries.[20,21,22,23,24,25,26,27,28,29,30]

Barriers to AI Adoption in Agriculture

Artificial intelligence (AI) technologies have revolutionized almost all fields of science and technology. A review is dedicated to describing and addressing a range of problems and research challenges in the context of the integration of AI in agriculture. Indeed, the comparative analysis of business sectors transformed by AI suggests that agriculture has a considerable, if not larger, potential to benefit from AI transformation relative to its critical role in society. However, many challenges and open issues need to be solved. Despite the significant development and achievements of AI models in recent years, numerous hurdles remain for general and broad commercialization across different business sectors.

First, the agrifood industry possesses unique characteristics and constraints that are difficult for conventional AI applications in other fields. Agrifood is produced and consumed universally across diverse regions, cultural contexts, and economic levels. These differentiate the agrifood sector, with unique features not found in other industries, such as products, climates, and crop types. These characteristics thereof demand AI models that are robust in performance across the immense variability of input data, which may change in quality, representation, spatio-temporal properties, and more.

Second, the adoption of AI in agriculture and the food industry is still limited, by comparison with fields such as transportation, logistics, healthcare, or financial services. There is a range of challenges that must be overcome if the potential of AI in agriculture is to be realized. Third, improved yields are particularly important in addressing the rising demand for food, constrained by the availability of suitable agricultural land.

In addressing some of the barriers to entry in AI solution development, to transform the present agrifood ecosystem to one in which AI models play a growing role, it is hoped to encourage greater use of AI model development in the agriculture and food sectors. Regarding the problem of protecting AI technologies, it suggests an alternative to keeping algorithms secret; blockchain-based evidence of model ownership.[20,21]

Financial Constraints

Smallholders generally have limited access to formal savings facilities because rarely are there any financial institutions providing savings and credit services in such areas. Insurance and price hedging instruments are almost non-existent since markets for these instruments are missing or severely underdeveloped.[2,7,30,31,32,33] This paper reviews financial constraints and innovative models of agricultural finance for smallholders in rural areas. A focus is made on sustainable models that are embedded in enduring transaction-based relations in agricultural value chains, and on farmers within emerging urban-penetrated agricultural dynamic markets in highland areas.

Broadly speaking, the rural poor, like their urban counterparts, require and use a variety of financial services.

These comprise savings, credit, leasing, insurance, money transfers, international remittances, safekeeping, and so forth. However, in most cases, these services are inappropriate and provided on usury terms. Historically, many donors, as well as governments (national and local) have heavily invested in the likes of agricultural development banks, pro-smallholder extension and input supply systems, agricultural credit etc. initiated by political initiatives. In most cases, these efforts, though well intended, did not produce the expected results. Similarly, financial institutions have, in general, demonstrated a lack of interest in agriculture finance.(27,33)

This is because, since the 1980s, financial liberalization and structural adjustment programmes have directed the financial sector to focus on short-term, collateral-based, high-return sectors and shut down concessional, subsidized credit windows managed by state and parastatal banks. Situated in the middle of the supply of financial services and the demand for such services, agricultural finance markets are wrought with high transaction costs and high risks that significantly hinder the development of financial services.(33,40)

Technical Challenges

Based on a comprehensive review of 517 recent publications, the potential applications of AI technologies in addressing the pressing food security challenges of the future are discussed. They are capable of detecting fungal infestations, pathogens, nitrate levels, weeds, senescence, heat, water loss, vigour, and nutrient shortage that is deemed impossible by human eyes and other existing technologies. Enabled farming automation has supportive systems for planting, water management, temperature regulation, animal feeding, and field maintenance.(21,22,23,24,25,26,27,28,29,30,31,32,33,34,35)

AI algorithms and information retrieval procedures enable researchers to rapidly identify and classify relevant academic literature relating to their programmes. Arabic-speaking smallholders about the potential benefits of machine learning technologies have led to an ongoing project to provide technical and theoretical training in AI and machine learning. The adoption and improvement of machine learning projects are being evaluated and all relevant training materials and protocols will be openly published. It is anticipated that other universities and research institutions engaged in agri-related programmes in AI and machine learning in developing countries may benefit from this evaluation and the materials distributed by the partnership.(35)

Data Privacy Concerns

We live in an increasingly connected world where agricultural operations are empowered by advanced technologies. The application of advanced technologies to Big Data generated in agriculture creates new opportunities for improved analysis. There is significant potential for associated benefits to address global challenges related to natural resource scarcity, population growth, and food security.(20,21,22,23) Big Data empowers the farming community with the just-in-time information needed to optimize resource usage, increase productivity and adaptability, and enhance the environmental soundness and sustainability of agricultural practices.

There are widespread policy efforts on the part of governments and other stakeholders to enhance the availability and sharing of Big Data to encourage more efficient and transparent use in agriculture. To this end, calls have been made to strengthen the innovation power of agriculture-related companies, promote the flow of information and the exchange of good practices, ensure fair competition, and adopt common principles. The aforementioned developments will drive transformative changes in agricultural economics and the functioning of agricultural markets.

The prospect of a Digital Single Market poses unique challenges for the Common Agricultural Policy (CAP) and rural economies. This poses new challenges to rural jobs and viability, and the wider rural economy supported by the CAP. The CAP design and governance will need to properly account for these new challenges and adverse effects. Evidence-based work supporting the development and implementation of interconnected rural-urban policies within the framework of the broader discourse on territorial development and interconnectivity is required, focusing on place-based policies in rural, urban, and peri-urban areas.

Furthermore, there is a need to identify and promote the creation of sustainable circular agri-food business models, showcasing the digitization uptake in agriculture and smart cities concept in tandem with sustainable food production and resource efficiency goals. Industrial and innovation policies will also need to be developed specifically to account for the forthcoming transformations in the operation of the agri-food sector, and ensure that digital and platform-based solutions do not proliferate further leading to market failures. Data access and interoperability of market platforms, as well as creating a sounder and more transparent competitive environment for those operating in it, are particularly essential.

Case Studies of Successful AI Implementation

The current survey examines the status and challenges of integrating AI into agriculture. An exhaustive review of AI applications in associated disciplines is provided. Based on the investigation, some directions for future research and development in the field are suggested. A comprehensive survey on the applications of

AI in agrifood systems is conducted. AI technologies include machine learning, deep learning, evolutionary algorithms, expert systems, and natural language processing. Major agriculture-focused AI applications cover pest prediction, agricultural robots, yield estimation, and artificial pollination.[27,28,29,30,31,32,33] To improve agriculture-specific technology, the emerging opportunities of AI in agriculture are analyzed.

The application of AI technology to improve agricultural efficiency and reduce labour reliance is discussed. Established AI technologies are classified into three categories: smart farming, agriculture-management systems, and decision support systems. The role of AI in pest prediction, disease detection, cropping patterns, crop monitoring, planting decisions, and irrigation is explored. Case studies of successful AI implementation in agriculture are provided. Environmental monitoring sensors represent an effective tool to acquire relevant data about agricultural farmlands. This paper presents a methodology for predicting leaf area index in vineyards by integrating AI models with geoprocessing. The AI framework has been compared with previous common techniques. Another design of the AI-based system is reported to address agrifood analysis tasks. The setups to withstand environmental stressors are particularly detailed, achieving a user reliability test on the overall system performance.

Case Study 1: AI in Crop Yield Prediction

Artificial Intelligence plays a vital role in transforming Agricultural Economics, its functioning, and other perspectives. AI is a major technology of the 21st century, used in several sectors to produce effectual results and to make precise decisions based on underlying conditions. It provides computational intelligence that allows machines to learn and respond to variable situations in real-time without human interference. The application of AI takes place in various sectors of human life. Precise decision-maker activities associated with conditional aspects are the focusing point in many countries, for example, precision farming, a component of Agriculture, gives notice to act on time for farmers. Precision farming or precision agriculture is regarded as an optimized method of doing agriculture more effectively and profitably. [2,7,33,34,35,36,37,38,39,40]

IoT sensors and Unmanned Aerial Vehicles (UAVs) are types of machinery that are widely used in the field of novelty agricultural methodology that creates millions of data points every day. Advanced farmers who wish to act in a way that technology makes full use of this data; play the big data piece of data usage in AI which is asked to the meaning of that data is inferred. The COVID-19 pandemic has expanded different fields of technology-enabled services. The fields such as food, health, natural weather conditions, natural disasters, means of transportation and the use of energy, electricity, etc., wanton industrial sectors have undergone civil life application in their companies and commercial activities were initiated.

The global shutdowns closed millions of small and medium-sized businesses around the world. With digital transformation, technologies behind many applications can continue basic functions in the environment of an epidemic and a post-epidemic situation. The phenomenon of viral transmission rapidly accelerating, multidimensional lockdowns, and immobilized industrial and transportation measures failed to provide the expected results. Priority shifts in all streams of human activities lead to different technologies - plant and animal breeding, green technology, food safety – and meanwhile, continued activities that caused pollution and further spread of the infection.

The Food and Agriculture Organization of the United Nations has developed a strategic policy-oriented using the Best Available Techniques associated to milk and meat production during the global prevention epidemic situation. Now global agriculture requires a 70 % increase in food production to meet the demands of agriculture due to the expanding global population. There are biotic and abiotic factors that hurt agricultural production capacity, and effective impact on participation, and inefficiency is often weakened by doing the same thing as statistical crop modelling, the temperature rises and it shows future disasters that can still be prevented or mitigated. A better quality of service concept was developed there.[33]

In precise farming, data acquisition is performed from IoT sensors and accordingly, it processes and predicts Crop yield. On the other hand, it predicts upcoming and long-term natural weather conditions, and if natural disasters such as hail and universal disasters are predicted, it gives notice to farmers in advance. All these applications in Agriculture become a necessity to meet agriculture food production demands. To date, the question is, however, a minimum knowledge of ML Engage Methodology, and how it is involved in the precise farming mechanism. This paper's focus was on this point to inform them, how Machine Learning (ML) is involved in this Precision farming proceeding mechanism. In precision agriculture, machine learning results, especially related to the development of a cloud-powered platform, is mainly aimed at farmers which will be able to act as a crop recommendation platform. Machine Learning is a branch of AI and it allows the ability to learn without explicit programming.

This can specify smart machines that which are mimicking the ability of human problem-solving. This is a decision-making tool in precision agriculture. The ability of ML also is distributed throughout the growing and harvesting cycle which starts from futurity to cultivation prediction to soil cultivation prediction, to the estimate of water requirement to crop estimate service. At the final stage, before harvesting the Plan and Crops to be taken yield as an input and the expected yield is predicted. When connecting to the ground the GPSbased collective objects Sprayer, and Planter are associated with the mentioned system and implementation is started the respective task by the implementation is accomplished only by auto-planning action on the GPS-map registered carp. For that, easy access will be available to the farmer through the mobile App and get advice.

Case Study 2: AI in Pest Management

Artificial intelligence (AI) has long been a part of agriculture. However, the current approach is mostly additive; that is, AI is added to existing systems to provide information, which is stored on the cloud, and then used to make decisions about how to respond. While the potential is already vast, how AI could truly transform agricultural economics is currently sparse. It lays out a vision for the future in which AI is fully integrated with production, observation, shaping inputs in real-time, acting on processes autonomously, and where observations, pests, and restructuring supply chains to utilize data efficiently.

It explores ways to bring this future into the present, along with the profound implications for society in general in a world where food is produced quite differently than today. To make all this economically feasible from a producer's perspective, the AI expansion needs to happen at the enterprise level, some in public goods provided by governments, most in the private sector, with many multibillion-dollar companies and uncountable smaller ones providing equipment, software, support, financial services and taking central roles in the operation of many farms.(39) Probably, the machinery is likely to be leased on a per-acre basis, akin to cloud server usage.

It is often said that data is the new oil.(40) If this is true, then agriculture currently operates in an analogous state to the early 20th century when individual farmers were able to drill and refine some oil for personal use, but the real business of energy was conducted by gigantic concerns controlling the chain from extraction to final delivery in homes and factories. If data indeed becomes a fundamental building block of the entire economy, it will have to be harvested and utilized by agriculture, as the industry with (literally) the broadest physical footprint on Earth. This will inevitably make agriculture the largest, most powerful, most profitable, and most influential sector of the global economy. And by extension, any food chain analysis will default to the food sector first—a peculiarity on a civilizational scale.

CONCLUSION

For large-scale food production in the future, it is essential to incorporate AI models in the current agricultural management system. AI integration identifies efficient recommendations in the early stages of a growing season using readily available data such as historical data and weather information.

AI can fuel sustainable and equitable growth in the agricultural sector by providing a solution for mitigating the anticipated negative effects of climate change on agricultural productivity. AI-powered agricultural systems strategically improve crop production through the real-time monitoring of soil health, crop health, and water management. Integration with satellite and weather data makes AI agronomical models more optimal and can water crops timely with variable rate irrirrgation, as well as provide warning alerts about diseases and pests.

AI can facilitate decision-making and help formulate an optimized plan for each field to maximize yield and profitability while reducing costs and resources. Some major retailers have also ventured into the agricultural industry by providing consultation services that utilize AI models to instruct agriculture production.

Another perspective involves the optimization problem in the food supply chain. AI models are proposed to determine the strategy of a single supplier who faces either a monopoly retailer or a retailer competition in a two-stage game. The findings also highlight the implications of the supplier's setting decision on the retailer and offer some managerial suggestions.

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