Title: Artificial Intelligence in the food and agriculture sectors

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Abstract:

The advent of Artificial Intelligence (AI) is causing a significant transformation across various industries. The food and agriculture sector is no different. This sector holds considerable importance, touching the lives of people across the globe.

In the food and agricultural sector, climate change and population growth are catalyzing a digital revolution.

In the past decade, agri-food supply chains have grown smarter, generating and harnessing extensive data while revolutionizing conventional agricultural methods.

The pandemic and its resulting disruptions have clearly shown how uncertainties can greatly affect supply chains all over the world.

Artificial Intelligence (AI) in supply chains brings robust optimization abilities needed for better capacity planning, superior demand prediction, increased efficiency, reduced costs, and higher production, while also promoting safer working environments.

This article outlines various use cases where artificial intelligence is put to use in the fields of food and agriculture. It highlights how AI is transforming these sectors and the changes they are going to go through.

How AI is transforming the food and agriculture sector:

Introduction:

From a non-technical point of view, Artificial intelligence is a science that enables computer systems to think like humans and perform tasks such as speech recognition, virtual perception (vision), decision-making, and language translation.

AI has the potential to bring about significant changes and improvements in various aspects of our lives.AI is an emerging technology in the field of food and agriculture.

Farming has conventionally been a challenging endeavour, but with the integration of AI, farmers attain heightened efficiency.

An appetite for AI:

Artificial intelligence changes the way we produce food nowadays. Robots and automation are doing cool stuff like packaging, sorting, and quality control in the food industry. This helps save money on labour and makes things work even better and faster.

Artificial Intelligence (AI) is helping restaurants to waste less food and be more efficient. By using AI, restaurants can accurately measure recipe sizes and automate menu rotations, which means they use just the right amount of ingredients and avoid any waste.

AI algorithms can also predict how much food is needed, so restaurants can manage their inventory better. Additionally, voice recognition technology lets kitchen staff keep an eye on things, and automated tracking software helps manage expired products more effectively. All these AI advancements make a big difference in reducing food waste and improving restaurant operations.

On average, each person needs about 2000 calories a day for a healthy life. With the population growing, there's a huge challenge ahead of us to produce more food. However, this task is made even harder by climate change, which puts a strain on agriculture and water resources. Finding solutions to meet the food demands of a growing population while ensuring environmental sustainability is a critical global issue.

Creating a completely personalized diet would involve analyzing billions of pieces of data for each individual. A few years ago, there was a significant breakthrough in this area when a group of researchers, including Eran Segal and Eran Elinav from the Weizmann Institute of Science in Israel, published a groundbreaking paper in the journal Cell. The paper was titled "Personalized Nutrition by Prediction of Glycemic Responses."

The study involved 800 individuals without diabetes. For each person, the researchers collected a vast amount of data, including meal times, food and drink details, physical activity, height, weight, and sleep patterns. The participants' blood and gut microbiomes were analyzed, and their blood glucose levels were monitored for a week.

Altogether, the researchers gathered more than 1.5 million glucose measurements, making it a significant and extensive dataset. Machine learning was used for the research to analyze what drove the glucose response to specific foods for each individual.

AI-driven kitchen appliances and robots can automate cooking processes, ensuring consistent and precise results.

Robots are becoming a common sight in commercial kitchens, especially in fast-food restaurants where convenience, simplicity, and consistency are highly valued. Automation technology has made significant progress in this area. Recently, McDonald's unveiled its first mostly automated location. Other restaurants like Chipotle and White Castle have adopted Miso Robotics' Flippy 2, an AI-powered robot arm capable of operating fry

stations. This is just the beginning of the robot revolution in the food industry.

A startup company came up with a new brand called "Not Milk" that appears in the milk alternative section. It tastes like real milk. It is creamy, thick plant-based milk. Not milk consists of cabbage, pea protein and pineapple. The recipe is developed by training a machine learning model which is a subset of Artificial intelligence. There will be other AI-generated recipes in future such as not chicken, not beef which can have a positive impact, better for the planet.

IBM acquired McD Tech Labs, a division of the fast-food conglomerate, to create, test, and implement an AI-powered voice system to automate McDonald's drive-thru order-taking process. Certainly! Here's the rewritten version:

For instance, Chick-fil-A introduced an express drive-thru lane dedicated to mobile order pickups in the previous year. Similarly, Checkers & Rally's have implemented AI voice ordering at specific drive-thru locations, just like McDonald's.

Some restaurants in the US are embracing robots to transform their traditional cuisine experience. Restaurant owners hire robots to help them save money.

Due to challenges in finding employees after the COVID pandemic, restaurant owners saw an opportunity to use robots to maintain customer service. Combining their passion for robots with the need for cost-effective assistance, they found it to be a perfect solution.

Nearly 30- 40% of food is wasted in the USA. In addition to this, the COVID-19 pandemic has had a significant impact on the food industry. As lockdown measures ease, the demand for food has increased. The U.S. food price index has risen by more than 14% higher than its average

between 2014 and 2016 due to inflation. These combined factors have created challenges for both consumers and the food industry.

This situation leads to a couple of challenges. Firstly, food distributors must increase their stock to meet the higher demand and maximize sales. However, the rising food prices make overstocking a risky proposition. Striking the right balance becomes crucial, and manual systems are no longer sufficient for such precision. Food distributors are faced with the need to adapt to more efficient and accurate solutions to manage their inventory effectively.

Zimmerman's company, VAI, develops S2K OnCloud, an ERP software designed specifically to serve as the supply chain brain for food distributors. S2K offers valuable insights as it automates processes and gathers customer order and sales data. This data is then used to forecast supply and demand, providing distributors with valuable visibility into their operations.

Agriculture Industry
AI is set to revolutionize the agriculture industry in various ways:

Crop health: AI-powered drones can collect data on soil health, moisture levels, and crop growth. This data allows farmers to make decisions on irrigation, fertilization, and pest control, leading to optimized yields and reduced waste.AI algorithms analyze images and data from farm fields to identify early signs of disease, nutrient deficiencies, or pests. This enables timely interventions and helps prevent crop losses. the AI-powered drone market is expected to grow by over 38 per cent in coming years.

The drones are used in spraying pesticides and fertilizers, and crop monitoring. The drones were implemented with sensors on the field called as remote sensor networks (WSN). There were different types of drones used such as planting drones, irrigation drones, soil analysis drones, crop spraying drones, health assessment drones, and crop monitoring drones.

Artificial General Intelligence (AGI) empowers robots to distinguish between weeds and crops, enabling them to eliminate unwanted plants through targeted approaches such as precision spraying, laser techniques, or mechanical removal. This capability curbs the need for excessive herbicide use, minimizing environmental impact while preserving crop health.

Crop stress identification and prevention: There are several challenges in soil and water management. Heavy rainfall, storms, floods or heavy temperatures can cause stress to the crops. AI can combine real-time information from sensors, weather forecasts, and crop soil modelling. The Spatial information (data related to location or geographical area) available from drones and satellites helps in making precise decisions. The integration of AGI enables robots to identify plants suffering from malnutrition and assess their growth status.

As the global population increases there will be more demand for water. The world is already facing water shortage issues. Rain guns in the farms have issues with high winds. AI provides better solutions in reducing water wastage in windy conditions by using smart micro irrigation by using spray boom which irrigates much more uniformly allowing for monitoring Pf pressures, also predicting water leaks based on historical data and forecasts.

Big data analytics, agricultural robotics, plant-based sensors, satellite-based weather data, and real-time decisions help the future of irrigation control.

Autonomous Machinery: AI-driven robots and autonomous vehicles can perform tasks like planting, harvesting, and weeding, reducing the need for manual labour and improving efficiency. Utilizing the capabilities of natural language processing and machine learning, Artificial General Intelligence (AGI) holds the potential to empower robots with the ability to comprehend and act upon human instructions, whether conveyed through speech or

written text. This advancement stands to streamline the operation of agricultural robots, streamline the learning curve for new users, and enhance their accessibility for farmers.

In the realm of agriculture, AGI presents an intriguing opportunity: the creation of intelligent farming companions capable of executing tasks like sowing, irrigating, and harvesting crops in response to natural language directives. These companions could leverage machine learning algorithms to refine their suggestions, drawing insights from real-time farm data and adapting to the distinct preferences of individual farmers.

Weather Forecasting and Risk Management: AI can analyze historical weather data to predict weather patterns and potential risks for farmers. This information allows them to plan and adapt their strategies accordingly.

Plant Breeding: AI can analyze genetic data and traits to accelerate the development of new crop varieties that are more resistant to diseases, drought, or pests.

Livestock Monitoring: AI-powered sensors and wearable devices can monitor the health and behaviour of livestock, enabling early detection of illnesses and improving animal welfare.

Water Management: AI can help in efficient water usage by monitoring irrigation systems and suggesting optimal watering schedules.

Overall, AI's integration into agriculture will make farming more precise, sustainable, and productive, contributing to global food security and environmental sustainability.

The agricultural and food supply chain management:

The agricultural and food supply chain encompasses various stages spanning from "farm to fork."

These smart-systems can rapidly analyze and make sense of massive amounts of data, offering prompt insights into predicting the supply and demand of food. Some of these advanced AI systems analyze consumer behaviours, foresee new consumer behaviours and predict seasonal demands. This advanced level of AI use can anticipate upcoming customer trends while reducing the expenses tied to stocking excess inventory that might not be needed.

Handling fresh produce has become super important for selling things to other countries. Computer vision methods can be used to organize and rate fresh crops. For instance, they can automatically arrange and assess fruits and veggies by looking at their size, shape, and colour as they move through machines. Using this technology can help cut down on food waste by making sure only the best products are given to shoppers.

A well-functioning warehouse plays a vital role in the supply chain. Automation driven by AI can help retrieve items from warehouses promptly and ensure a seamless journey to the customer.AI can examine data related to workplace safety and alert manufacturers about potential risks. It can also document stocking conditions, update operations, and establish feedback loops for proactive maintenance.

Combining AI with technologies such as IoT, Cloud computing, and Blockchain can completely change how traditional cold storage works. This combination allows managers to make smart decisions that make the whole process work better.

With the help of Blockchain, measurements for quality control are collected using IoT devices and kept safe on a shared ledger that everyone in the supply chain can use. The cooling system also adjusts itself based on the current conditions and the temperatures that are set.
The cooling system is designed to turn itself on or off depending on the current conditions and the temperature settings. This setup improves how easily we can get real-time information, making it smooth to transfer ownership of shipments with a clear and trackable history. When a

shipment arrives, the warehouse can check its blockchain record to find any unusual temperature changes, which helps the quality control team take the right steps. Once the warehouse agrees to take the produce, they're responsible for it. This makes it easy to figure out who's responsible for what at each step of the cold storage process and speeds up resolving any claims.

The AI models mostly cover checking if fruits like apples, mangoes, and blueberries are ripe, figuring out their quality, spotting any damage or sickness, and finding signs of rot. In really advanced farms, AI systems have taken over from people to handle grading. This helps with problems like differences in how things look, mistakes, and tiredness that can happen when humans do the grading.

From customer service to warehouse management, automated intelligent operations can function without errors for extended periods. This diminishes the occurrence of mistakes caused by human oversight and minimizes workplace incidents. Also, these improvements ultimately lead to lower operational expenses.

AI can predict demand and optimize logistics, ensuring timely delivery of agricultural products and reducing food wastage.

Conclusion:
AI technology and research in the Food and Agriculture sectors is undergoing constant evolution. Its potential to address the challenges posed by a growing global population and the subsequent increase in food demand is becoming increasingly apparent. Despite the hurdle of establishing network connectivity in rural areas and acquiring field data, the moment this data becomes accessible, its analysis becomes a pivotal resource for AI research stations. These insights not only aid farmers in analysis but also contribute to drawing insightful conclusions. Undoubtedly, AI is poised to become a foundational framework, poised to revolutionize the landscape within the upcoming two decades.

References:

1) Article: AGI for Agriculture
By Guoyu Lu, Sheng Li, Gengchen Mai, Jin Sun, Dajiang Zhu, Lilong Chai, Haijian Sun, Xianqiao Wang, Haixing Dai, Ninghao Liu, Rui Xu, Daniel Petti, Changying Li, Tianming Liu, Changying Li

2)Artificial Intelligence in Extended Agri-Food Supply Chain: A Short Review Based on Bibliometric Analysis by

Jose Monteiro, Joao Barata

3)
Role of AI-based Approaches in Post-harvest Operations and Food Loss
https://www.inspirafarms.com

4) Artificial intelligence in the agri-food sector: Applications, risks and impacts - study was written by Josse De Baerdemaeker, with the support of the following co-authors (for the chapters that appear in square brackets): S. Hemming [2 and 6], G. Polder [2], A. Chauhan [2 and 6], A. Petropoulou [2] (Wageningen University and Research), F. Rovira-Más [3] (UP Valencia), D. Moshou [3] (Aristotle University), G. Wyseure [4], T. Norton [5], B. Nicolai [6] (KU Leuven), F. Hennig-Possenti [7], I. Hostens [7] (CEMA).