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Research Article

Comparative Analysis of Fruits and Vegetables Quality Using AI Assisted Technologies: A Review

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Abstract:

Food quality is a major issue for society since it is a crucial guarantee not only for human health but also for society's progress and stability. Planting, harvesting, and storage through preparation and consumption, all aspects of food processing should be considered. One of the most important methods for managing fruit and vegetable quality is by using AI food quality evaluation techniques. Upcoming automation technologies like Artificial intelligence (AI) and Computer vision (CV) are thought to profit from the availability of massive data for active training and the generation of intelligent and operational equipment in real time and predictably. This paper review provides an overview of leading-edge Computer vision (CV) and Artificial Intelligence automation technologies can help farmers in food processing and Agriculture Sector. In addition, thereview presents some implications for the recommendations and provocations regarding the addition of automations in actual time agriculture, policies, and universal substantial investments. Furthermore, it addresses the 4th industrial revolution automation technologies of Computer Vision and Deep Learning, as well as robots, which are the key sustainability for production of food is also addressed in it.

Keywords: Computer vision; Advanced process control; Artificial neuronal networking; Fuzzy logic; Autonomous navigation; Artificial intelligence; Image processing; Food processing

1. Introduction

In today's top competitive trade quality is a critical aspect in the present food sector because top-quality products are the foundation for success. Manual inspection is still widely utilized in the food industry, but it is time-consuming, difficult, and expensive, and it is easily impacted by physiological conditions, resulting in irrational and inconsistent assessment outcomes. It is vital to enhance quality evaluation of food items to meet the rising awareness, sophistication, and expectations of customers (Brosnan & Sun, 2004). Production speed and efficiency may be enhanced by production values and sustainable techniques if quality evaluation is done automatically. With the world's population expanding, the United Nations Food and Agricultural Organization (FAO) estimate that population of world in 2050 will be over 9.1 billion (Godfray et al., 2010) . This estimate substantially eliminates the need to account for a rise of seventy percent in global food supply and an almost twofold rise in developing economies (*Population and Food in the Early Twenty-First Century: Meeting Future Food ... - Google Books*, n.d.). The undernourishment word still points out to the inefficiency to get sufficient food and the quantity of inadequate edibles absorption required to join the requirements of dietary energy.

The latest revolutions in the food industry have opened the door to new methods of food production and technological transformation. Over the last decades many types of food were in demand, which contains few of the specific types such as functional foods that have demonstrated to be a key component of a healthy and good lifestyle. (Health and Illness - Michael Bury, Mike Bury - Google Books, n.d.) To join market demand and produce quickly, the industry of food produced a finite number of food processing methods. Latest agricultural and food processing technology was used, and they may be called innovative forerunners in the modernization of sector of food before being supplanted by smart machines and production lines (Edible Food Packaging: Applications, Innovations and Sustainability - Google Books, n.d.). Will these developments be able to feed the world's rapidly rising population, while avoiding the inevitable? Corresponding to the rise in technological breakthroughs and with the growth in need, it appears to be doable. With the increase of 4IR techniques Like AI, C.V robots during the last ten years, there has been a significant model change in investments and business models. In meeting future demand for a secure food supply, this cutting-edge technology might considered be a appropriate tool.

According to the FAO, Under the pandemic of COVID-19 most people impacted by worldwide hunger grew in 2020 and after maintaining nearly stable from 2014 to 2019, the prevalence of undernourishment (PoU) risen to nearly 9.9% in 2020, up from 8.4% in the past year. In terms of population, it is predicted that between 720 and 811 million people in the globe in 2020 will be hungry, considering additional statistical uncertainty. According to the midpoint of the estimated range (768 million), In 2020, 118 million more people will be hungry than in 2019 – or as many as 161 million if the upper end of the spectrum is considered. Food insecurity affects 793 million people, or one out of every nine people on the earth. The data from the FAO, as shown in Fig. 1B, shows that only a few Asian nations are still undernourished. The two largest nations, India, and China, are tied for top and second place, owing to their rapidly rising populations and economic achievements (*The Impact of Economic Shocks on Global Undernourishment - Sailesh Tiwari, Hassan Zaman - Google Books*, n.d.) .

Demographic estimations have a high degree of statistical accuracy, confirming the credibility of the food and agriculture organizations assertion based on population increase, as shown in Figure 1 worldwide heat map. Figure 3 shows greenhouse gas emissions on a global scale, saying that increased restoration linearizes the growth in environmental risks, and Figure 4 characterizes the value-added portion of GDP in terms of different portfolios on a global scale. Eventually, the records of uncertainty assessed based on a variety of aspects like high rising incomes in emerging nations and rising levels of economic inequity, among others, might lead to impartial worldwide estimations (*Rural Wage Employment in Developing Countries: Theory, Evidence, and Policy - Google Books*, n.d.) .

Finally, food supply remains a point of contention in the demand of supply chain, and the technique of selecting an acceptable technique from among continual latest practices that provide more desirable outcomes in terms of maintaining productivity while meeting demand. In comparison to other commercial sectors, the food industry is Conceptually developed and sluggish expanding, with advancement and essential research spending, in comparison to other business areas (*Agricultural Development and Economic Transformation: Promoting Growth with ... - John W. Mellor - Google Books*, n.d.) .

In Figure 1, the credibility of food and agriculture organization description positioned on increase population displayed as a worldwide heat map is supported by statistical demographic projections with a high degree of assurance. In a recent survey of food and agriculture organization 793 million people, or one out of every nine people on the planet, are insecure of food. The data from the food and agriculture organization, as shown in Figure 2, shows that only a few Asian countries are still undernourished. Intuitively, the two largest countries, India, and China, stand on first and second place, owing to their rapidly rising populations and economic achievements.

In Figure 3, Authors T. Reardon, J. E. Taylor, K. Stamoulis, P. Lanjouw and A. Balisacan represents greenhouse gas emissions on a continental basis, stating that increased modernization linearizes increased environmental dangers. Figure 4 represents the value-added division of Gross domestic product in terms of various collections on a continental size. Record unreliability, on the other hand, is computed using a range of criteria such as growing high incomes in emerging nations and expanding economic disparity, among others. It's possible that this will lead to impartial global estimations.

In several ways AI techniques can be used to manage fruit and vegetable quality. AI techniques can play a

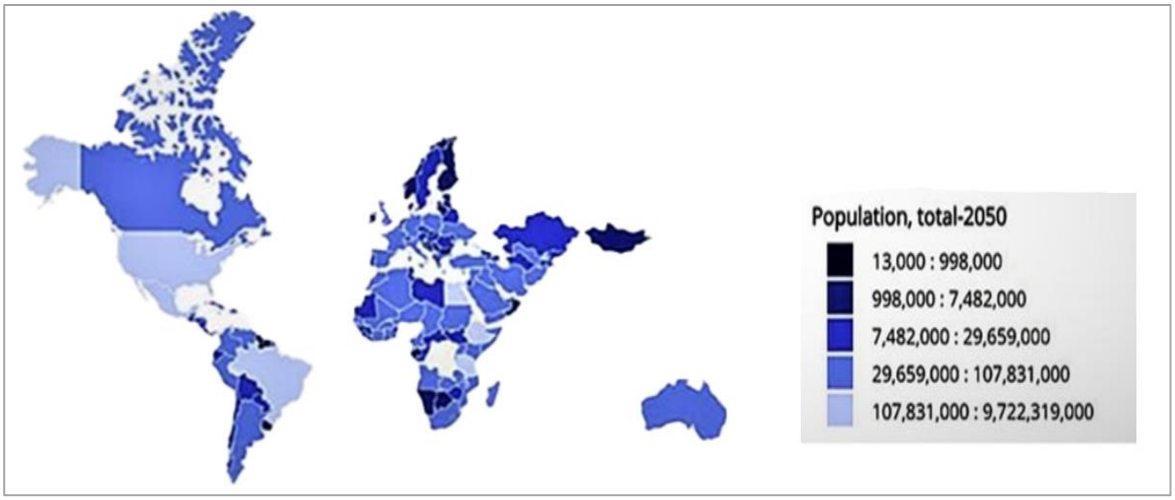

Figure 1: Various statistics illustrating food-based crisis global population growth heat map

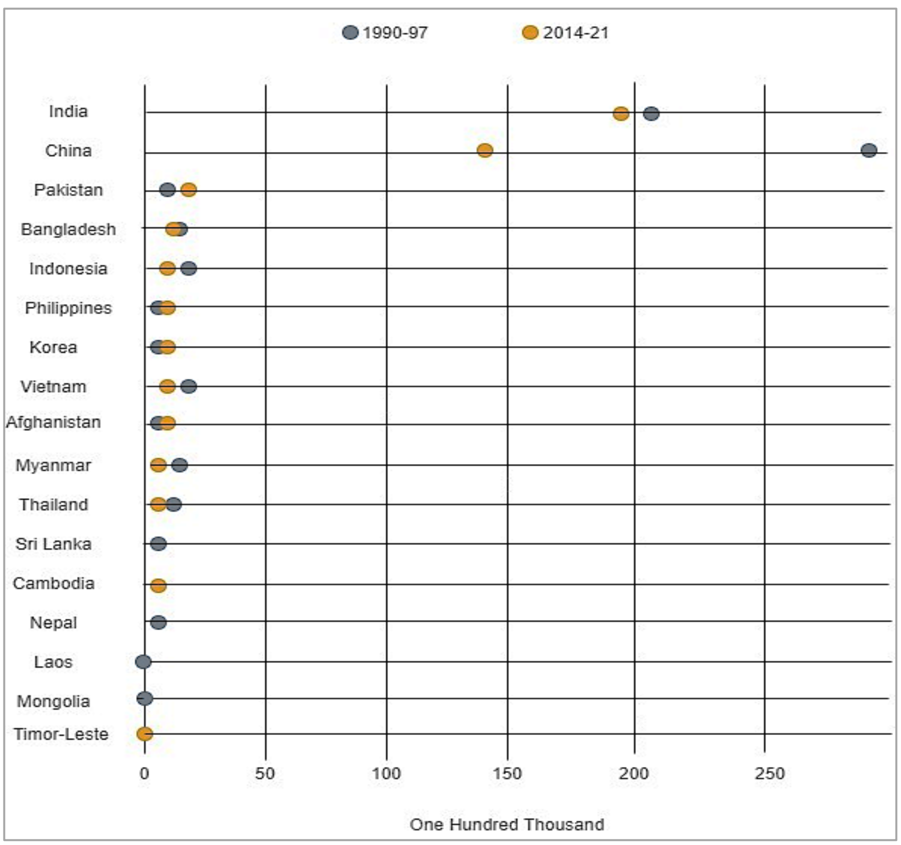

Figure 2: Undernourishment of food in Asian countries

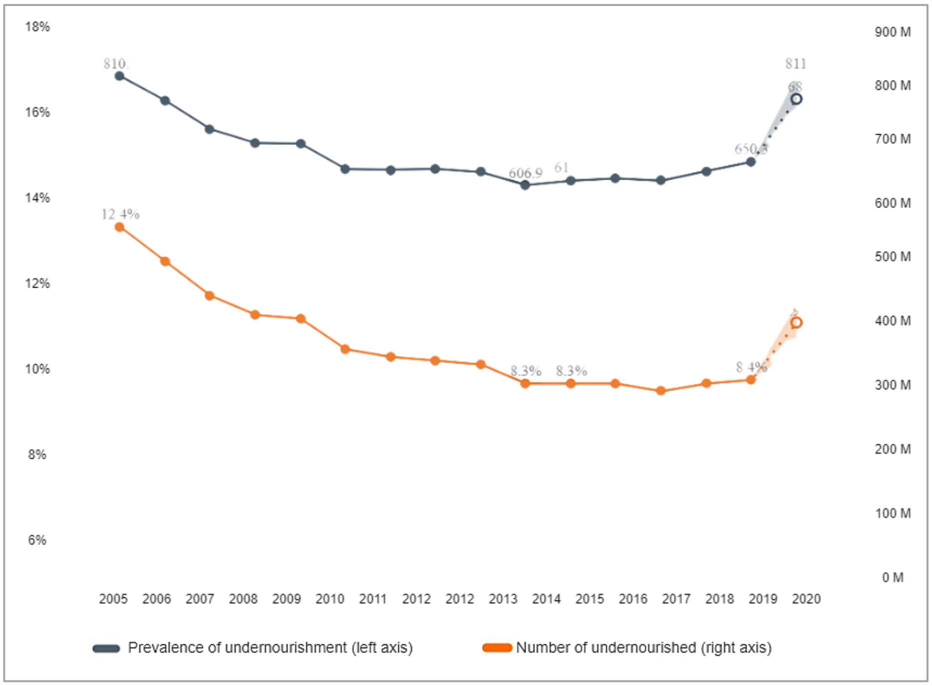

Figure 3: Gas emissions of greenhouse in agriculture

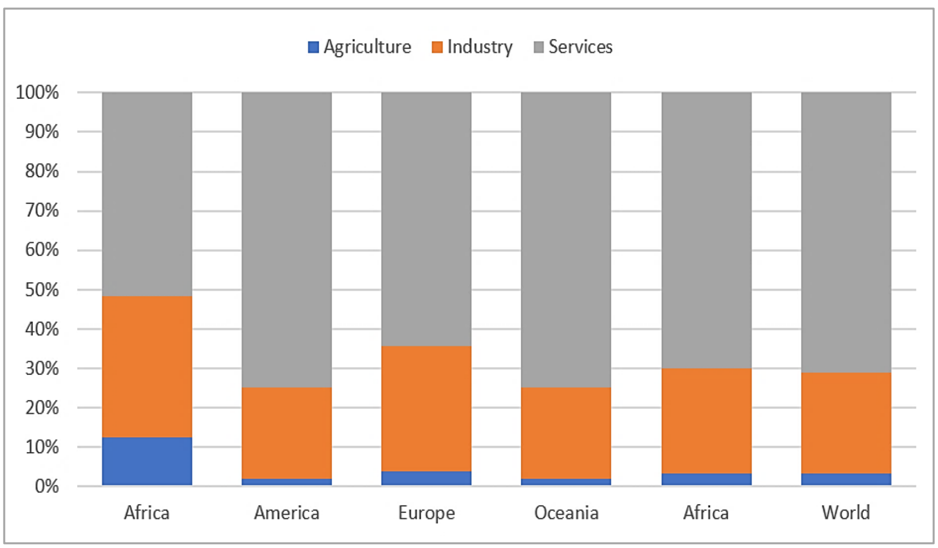

Figure 4: Value added share of GDP (2013)

crucial role in managing fruit and vegetable quality. Image recognition algorithms can be trained to identify different types of produce and evaluate their quality based on appearance, helping with sorting and grading. Predictive analytics can analyze data from various sources like weather forecasts, soil sensors, and crop yields to predict produce quality before harvesting, aiding in data-driven decision making on when to harvest, how much to harvest, and storage/transportation. Smart packaging with AI-powered sensors can monitor environmental factors like temperature and humidity during transportation and storage, adjusting storage conditions or alerting handlers when necessary. AI can also be used to monitor produce quality during processing and packaging, detecting defects or bruises that affect quality, reducing waste and ensuring only high-quality produce reaches consumers. Overall, AI techniques can improve product quality and consistency while reducing waste and ensuring high-quality produce is delivered to consumers.

Other than food management and processing in the food industry, the major sector that may affect a significant change in the food economy is the food business. According to data, several aspects like control quality, kind of food, present direction, customer psychology, and human well-being impact the food processing business (*Food Geographies: Social, Political, and Ecological Connections - Pascale Joassart-Marcelli - Google Books*, n.d.) (*Food Safety and International Competitiveness: The Case of Beef - John Spriggs, Grant Isaac - Google Books*, n.d.) .

Due to the limits imposed on the food processing business, solutions to increase values of production, havoc control, and market demand satisfaction is required (*Remaking the North American Food System: Strategies for Sustainability - Google Books*, n.d.-a). Market trends, as previously said, drive food processing technology, which in turn influences the food sector. Systematically, market trends are determined by client attitudes about the food or product, which may be influenced using certain tactics or marketing strategies (*Remaking the North American Food System: Strategies for Sustainability - Google Books*, n.d.-b).

According to Global Meals Technology, time restrictions, social events, stress alleviation, and indulgence have raised the merchandise need for the modular of food (*Food Authentication: Management, Analysis and Regulation - Google Books*, n.d.). Equivalently, factors like as increased need for awareness of health and wellbeing have resulted in a significant growth in adoption of useful foods. Saying like "Eat Worldwide Local," "Natural = Healthier," and "Gluten-free in more markets of Asian" highlight the significant impact of health and wellbeing knowledge of market trends. (Annunziata & Pascale, 2009).

With the advancement of machineries, the construction sector and contemporary corporation have reached new heights of productivity in a matter of decades. (AI) is a collection of several methodologies and developments, the most important of which are two main ideas known as Deep Learning and Neural Networks which are responsible for AI's tremendous progress (Rajakumari & Pradhan, 2023). This innovation was formerly unthinkable, but because of today's tremendous computer capacity of Graphics Processing Units, it is now conceivable (GPU). Because of this compute capacity, neural networks were able to simulate the components of the brain of human, allowing the Artificial intelligence to study complicated tasks using huge amounts of Training data (Macedonia, 2003).

This technique, which was revealed in 2014, demonstrated to the world how quickly robots can learn complicated jobs that humans took decades to perfect. Within a few years, DeepMind technology has advanced from simple jobs such as document review and spam email categorization to more complex ones like as object identification, context creation, and scene interpretation. (Moritz et al., 2015) (Mnih et al., 2015) . Even difficult sectors like remedies and pharmaceutics have encountered this type of AI through challenging tasks like anticipating problems of eye based only on retinal scans (Gulshan et al., 2016) .

The combination of NVIDIA and Google ushered in the age of self- driving automobiles Esther Francis. NVIDIA, a prominent GPU manufacturer, provided computing basics for self-driving AI training using Google's enormous data set of views of street and automotive glossaries. (Chen & Lin, 2014).

Figure 5 depicts use cases of AI application scenarios in a variety of disciplines like in agriculture, finance, pharmaceuticals, Automotive, Healthcare, Public/Social, Consumer, Manufacturing, Telecom, Energy, Media, Travel Transport etc.

a) Farmers may utilize artificial intelligence (AI) to gain real-time insights on their crops, allowing them to identify areas that require irrigation, fertilizer, or pesticide treatment. Furthermore, innovative agricultural techniques such as vertical agriculture may help to increase food output while decreasing resource usage.

b) Agriculture: AI can be used to optimize crop yields by analyzing soil and weather data to determine

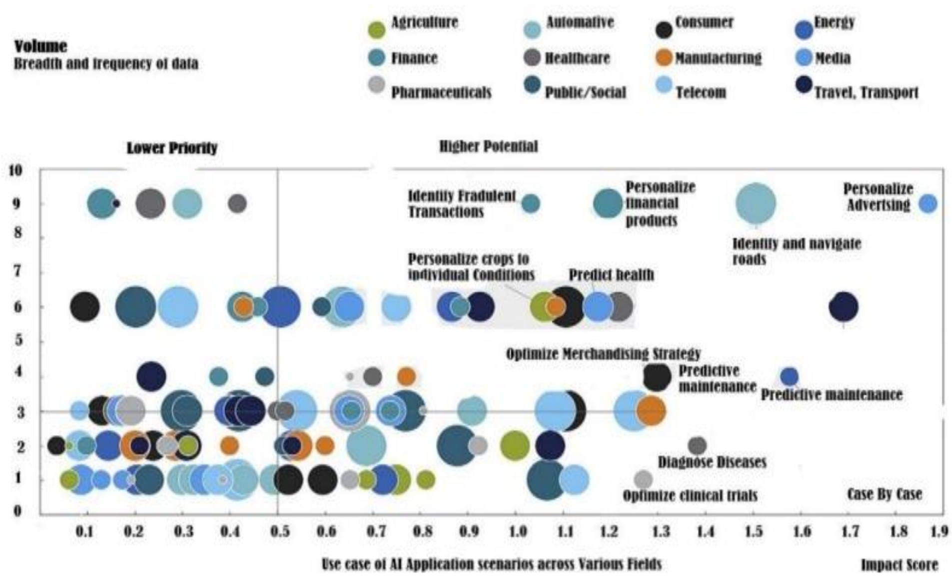

Figure 5: Use-cases of AI application

the best irrigation and fertilization strategies. AI can also be used to monitor plant health and detect diseases early, allowing for timely intervention and reduced crop loss. In addition, AI can be used to automate farm machinery, reducing labor costs and improving efficiency.

c) Finance: AI can be used for fraud detection by analyzing large amounts of financial data to identify patterns of fraudulent behavior. AI can also be used for credit scoring by analyzing credit history, income, and other relevant factors to determine the creditworthiness of individuals or businesses. In addition, AI can be used for trading algorithms to identify profitable investment opportunities.

d) Pharmaceuticals: AI can be used for drug discovery by analyzing large datasets to identify potential drug targets and design more effective treatments. AI can also be used to predict drug interactions by analyzing patient data to determine the most effective drug combinations. In addition, AI can be used for personalized medicine by analyzing genetic data to determine the best treatment options for individual patients.

e) Automotive: AI can be used for self-driving cars by analyzing sensor data to navigate roads and avoid obstacles. AI can also be used for predictive maintenance by analyzing vehicle data to identify potential issues before they occur. In addition, AI can be used for driver assistance systems to help drivers avoid accidents and improve overall safety. In Automation, artificial intelligence applications make it possible for machines to complete real human tasks.

f) Healthcare: AI can be used for medical image analysis by analyzing medical images to detect abnormalities and assist with diagnosis. AI can also be used for patient monitoring by analyzing patient data to detect changes in health and provide early warning of potential issues. In addition, AI can be used for drug discovery by analyzing large datasets to identify potential treatments for various diseases.

g) Public/Social: AI can be used for predicting and preventing crime by analyzing crime data to identify patterns and potential hotspots. AI can also be used for monitoring social media for potential threats by analyzing social media data to detect potential threats to public safety. In addition, AI can be used for analyzing public sentiment by analyzing social media and other data to determine public opinion on various issues. In Public Sector AI might aid citizens by answering their commonly asked questions through chatbots or virtual assistants, or AI could assist public employees by making welfare payments and immigration decisions, identifying fraud, and designing new infrastructure projects

h) Consumer: AI can be used for personalized marketing by analyzing customer data to provide personalized recommendations and marketing messages. AI can also be used for chatbots to provide customer service and support. In addition, AI can be used for recommendation engines to suggest products and services to customers based on their past behavior and preferences.

i) Manufacturing: AI can be used for predictive maintenance by analyzing machine data to detect potential issues before they occur. AI can also be used for quality control by analyzing product data to detect defects and improve overall product quality. In addition, AI can be used for supply chain optimization by analyzing data to determine the most efficient and cost-effective supply chain strategies.

j) Telecom: AI can be used for network optimization by analyzing network data to improve performance and reduce downtime. AI can also be used for customer service chatbots to provide support and assistance to customers. In addition, AI can be used for fraud detection by analyzing call data to detect potential fraudulent behavior. In Telecom or telecommunications (SONs), Building self-optimizing networks isanother popular application of AI algorithms that detect and accurately forecast network anomalies automatically monitor such networks. 63.5 percent of telecom businesses are actively integrating AI to improve their network infrastructure, according to IDC.

k) Energy: AI can be used for energy demand forecasting by analyzing historical data and weather patterns to predict future demand. AI can also be used for optimizing energy usage by analyzing energy data to identify areas where energy usage can be reduced. In addition, AI can be used for predicting equipment failure by analyzing equipment data to detect potential issues before they occur. In Energy, Artificial intelligence has the potential to reduce energy waste, minimize energy costs, and expedite the implementation of clean renewable energy sources in power systems around the world. Power system planning, operation, and control can all benefit from AI.

l) Media: AI can be used for content recommendation by analyzing user data to provide personalized content recommendations. AI can also be used for automated news writing by analyzing news data to generate news articles automatically. In addition, AI can be used for video analytics by analyzing video data to identify potential issues and improve overall video quality. In Media creation workflows journalists can now include AI. In what is becoming known as 'automated journalism,' they can gather content and comprehend data pools, as well as generate and distribute media at the touch of a button. Algorithms are beingutilized to generate large-scale tales.

With the annual rise in AI startups, developments in industries across the public and commercial sectors will accelerate in the future decade, as seen in Fig. 2, which depicts a conceptual study conducted by McKinsey & Company Global Institute about the importance and possible opportunity of incorporating AI into various areas (Jones, 2017) (Jones, 2017). Since the most recent wave of AI advancements has skyrocketed, Analysts and advisors predict that by 2020 AI will be a major technology sustaining many corporations (Müller & Bostrom, 2016) . The fundamental logic for this is the rapid expansion of digital data, with the annuary rate of data production predicted to reach forty-four trillion gigabytes by 2020 (Batista & Marques, 1 C.E.) . With this big amount of data intact and smart AI companies, the fourth Industrial Revolution is on its way through novel approaches to current challenges in a variety of industries. Late developments in AI, CV, and Big Data, the symptoms of the Fourth Industrial Revolution might be seen in every industry. The food industry is one such industry that has recently seen a significant impact from AI on its procedures, equipment, and machines. With the introduction of AI-powered processes and machines in agriculture and the sector of food, growing of crop, cultivation, production, and methods of processing have changed.

This paper focuses specifically on food quality evaluation techniques using different AI-based algorithms and computer vision techniques. An AI algorithm is a subset of machine learning that advises the computer on how to learn to function on its own. As a result, the device is always learning how to enhance processes and do jobs more effectively. Artificial intelligence (AI) refers to machine intelligence as opposed to natural intelligence displayed by animals such as humans. Algorithms for artificial intelligence are commonly classified into three types. There are three types of learning: supervised learning, unsupervised learning, andreinforcement learning. In the case of unsupervised learning, the goal output is not provided, and the model is intended to generate a template from the inputs provided. Reinforcement learning is a subset of supervised learning. In this learning example, you are given a rating that indicates how accurate the model's output is. The model is fed diverse data in the supervised learning approach, and the model's findings are compared to the real goal outputs. The model attempts to minimize the mistakes.

Computer vision technologies are processes for capturing, processing, analyzing, and comprehending digital pictures, as well as the extraction of high-dimensional data from the actual world to create numerical or symbolic information, such as judgments,are examples of computer vision tasks. To allow self-driving automobiles, computer vision is required. Volvo, Audi Tesla, and BMW, handle various cameras, radar, lidar, and ultrasonic sensors to capture images from the surroundings for their self-driving vehicles to distinguish, traffic signals, lane markings, signs and objects and drive safely.

Deep learning and computer vision robotics are being increasingly used in food production to enhance various aspects of the production process. For example, deep learning algorithms can be applied to analyze images of food products to detect defects such as discoloration, bruises, and other imperfections, allowing manufacturers to remove defective products before they reach consumers. In addition, computer vision systems can sort, and grade food products based on size, shape, color, and texture, which can be particularly useful in fruit and vegetable processing. Another application of deep learning and computer vision robotics is in packaging. By leveraging these technologies, manufacturers can ensure that products are packaged correctly, with the appropriate amount of food in each package. This can reduce waste and improve efficiency in the packaging process.

Incorporating AI technologies in real-time agriculture has the potential to revolutionize the industry by enhancing productivity, reducing costs, and improving sustainability. However, there are several challenges that need to be addressed to realize these benefits. Here are some challenges and recommendations for incorporating AI technologies in real-time agriculture and policies:

a) Data management: The use of AI in agriculture requires large amounts of data, including weather patterns, soil conditions, and crop information. One of the main challenges is the lack of standardization and interoperability of data from different sources. Policymakers can address this by encouraging the development of common data standards and protocols and supporting the development of data-sharing platforms.
b) Infrastructure: AI technologies in agriculture require high-speed internet access, which is not always available in rural areas. Policymakers should invest in broadband infrastructure to ensure that farmers can access AI technologies.
c) Adoption: Many farmers may be hesitant to adopt AI technologies due to the perceived complexity and cost. Policymakers can encourage adoption by providing financial incentives such as tax credits or subsidies to farmers who adopt AI technologies. Additionally, policymakers can invest in

training programs to help farmers understand the benefits and use of AI technologies.

d) Ethical considerations: AI technologies in agriculture raise ethical concerns such as privacy, ownership of data, and bias in decision-making. Policymakers should develop guidelines and regulations to address these concerns and ensure that AI technologies are developed and used in an ethical and responsible manner.

e) Standards and certification: AI technologies in agriculture require standards and certification to ensure that they are safe, effective, and reliable. Policymakers should develop and enforce standards and certification processes to ensure that AI technologies meet these requirements.

Overall, the adoption of AI technologies in real-time agriculture has the potential to enhance productivity, reduce costs, and improve sustainability. Policymakers should address challenges such as data management, infrastructure, adoption, ethical considerations, and standards and certification, and provide incentives and support to encourage the use of AI technologies in agriculture. Furthermore, computer vision systems can be used to monitor inventory levels and track the movement of products through the production process, which can help manufacturers optimize their production processes and reduce waste. Additionally, deep learning algorithms can identify potential food safety hazards, such as foreign objects or contaminants, in food products to ensure their safety for consumption.

In conclusion, the application of deep learning and computer vision robotics in food production has the potential to significantly enhance the efficiency, accuracy, and safety of the production process. The Fourth Industrial Revolution (4IR) refers to the current period of rapid technological progress, characterized by the integration of physical, digital, and biological systems. It has significant implications for a wide range of industries, including agriculture and food production, where it has the potential to improve sustainability.

In the context of food production, the 4IR can help improve sustainability in several ways. For instance, farmers can leverage technologies such as IoT, drones, and satellite imaging to collect and analyze real-time data on soil moisture, nutrient levels, and crop health, allowing for more targeted application of fertilizers and pesticides. This can reduce waste and increase crop yields.

Additionally, the use of blockchain technology, sensors, and other tracking systems can enhance transparency and traceability in the food supply chain. This can help reduce food waste, improve food safety, and ensure that products are sustainably sourced. Furthermore, vertical farming, which utilizes artificial lighting and controlled environments to grow crops, can help address the challenges of land scarcity and water use in traditional agriculture. This technology can also reduce the need for pesticides and fertilizers while reducing transport-related emissions. Finally, predictive analytics and machine learning algorithms can help food manufacturers and retailers optimize their production processes and reduce waste, which is a significant contributor to greenhouse gas emissions. Overall, the 4IR offers an opportunity to revolutionize the way food is produced, distributed, and consumed while increasing sustainability and reducing environmental impact.

A brief introduction of techniques with their performance is also given in the ending sections. This paper is structured as follows: Section II will be containing a literature review; Section III will be comparative analysis that we have done from recent and up-to-date research articles. A brief introduction of datasets, models, and algorithms will also be given. Finally, section IV will discuss the findings of our comparative study of computer vision and intelligence methodologies as they apply to a variety of agricultural applications of agriculture like processing of food, smart irrigation, applications that are based on agriculture, farming, next generation farming, and data of plant analysis.

2. Literature Review

In a recent study by (Singh et al., 2022) presented multiple approaches for reducing post-harvest loss (PHL) and improving quality control using various machine learning algorithms. The authors also demonstrate the effectiveness of integrating Internet of Things (IoT) sensors into a traceability system for the perishable food supply chain to minimize PHL. The analysis is supported by substantial data to showcase the impact of Deep Learning and IoT in precision agriculture and food processing, specifically in reducing PHL losses in fruits. The study critically reviews and discusses the accuracy outcomes of various machine learning models, including their recall, precision, and F1 score. The models utilize RBG images, infrared images, and hyperspectral images to develop training and testing data sets followed by feature extraction and classification. The proposed model achieved a classification accuracy of 93.33 percent. However, the results of MFC InceptionV3 based on MNet were even better, achieving 99.92 percent accuracy and reducing misclassification by 5.98 percent compared to the original InceptionV3 and 4.17 percent compared to FC InceptionV3. These findings demonstrate the effectiveness of deep learning models in reducing PHL losses in fruits.

The authors Al-Sammarraie, Gierz, Przybył (Al-Sammarraie et al., 2022) their aim of this article was to investigate the feasibility of utilizing artificial intelligence technology to predict the sweetness of oranges. The study accomplishes this by analyzing the correlation between the RGB values of orange fruits and their sweetness levels, utilizing the orange data mining tool. The study uses a dataset of orange fruit images and applies various machine learning algorithms to compare and identify the algorithm with the highest prediction accuracy. The results demonstrate that the red color value has a more significant impact on predicting orange fruit sweetness compared to the green and blue color values, as there exists a direct relationship between the value of the red color and the level of sweetness. Additionally, the logistic regression model algorithm was found to provide the highest degree of accuracy in predicting orange fruit sweetness.

In a recent study by (Sharma et al., 2022) their aim was to evaluate the nitrogen status of wheat crops using predictive computational intelligence techniques. This evaluation is based on analyzing crop images taken under varying lighting conditions in the field. The study involves HSI color normalization of the wheat crop, followed by an optimization process that utilizes genetic algorithm (GA) and artificial neural network (ANN) based prediction and crop precision status classification. This optimized approach based on ANN significantly distinguishes between wheat crops and other unwanted plants and weeds, while categorizing crop yield age into classes. The experimentation results in a validation accuracy of 97.75%, with a minimized error rate of 0.22 and a 0.28 decrease in loss value. Compared to other contemporary counterparts, the proposed ANN+GA mechanism provides improved performance outcomes while minimizing error rates

The authors (Wieme et al., 2022) demonstrated that hyperspectral imaging can be an effective tool for evaluating the quality parameters of fruits, vegetables, and mushrooms and analyzed both laboratory-measurable variables and more complex properties like maturity, ripeness, detection of biotic defects, physiological disorders, mechanical damages, and sensory quality. The article starts with an overview of quality concepts, measuring principles, and theory and analysis of hyperspectral imaging systems. Then, it described emerging techniques for monitoring and assessing quality parameters, pre- and post-harvest, and reviews and discusses their applications. Additionally, this review illustrated how artificial intelligence, particularly machine learning and deep learning, can be used for hyperspectral imaging analysis in horticulture. Lastly, the article highlighted some challenges and considerations for future research, including improving data availability, finding solutions for better integrating artificial intelligence, and transferring knowledge from research parameters to those relevant for industrial stakeholders.

To evaluate the quality of fruits and vegetables, several parameters such as size, shape, and appearance are taken into consideration. Among these parameters, appearance plays a crucial role in determining the market value and consumer preference. To address this, authors (Tata et al., 2022) presented an application that has been developed to classify and grade fruits and vegetables based on their appearance. This proposed system utilizes image processing techniques to extract relevant features such as color, shape, and Histogram of Gradient (HOG) to classify the produce. Additionally, techniques such as data augmentation, normalization, Principle-Component Analysis (PCA), and Deep learning (CNN) are employed to improve the accuracy and reduce dimensions. To facilitate a faster and more efficient identification process, they have developed a high-performance Android application that can be easily deployed, in contrast to current manual grading systems that require more time and energy or embedded systems (sensors).

The authors of (Hassoun et al., 2023) provided an overview of the application of Traceability 4.0 in the fruits and vegetables sector, with a focus on the relevant Industry 4.0 enablers including Artificial Intelligence, the Internet of Things, blockchain, and Big Data. The study indicates that Traceability 4.0 has the potential to improve the quality and safety of many fruits and vegetables, increase transparency, reduce costs associated with food recalls, and decrease waste and loss. However, these advanced technologies are expensive to implement and are not easily adaptable to industrial environments, which has hindered their large-scale application. Thus, further research is required to overcome these limitations and enable the widespread use of Traceability 4.0.

The researchers (Kutyauripo et al., 2023) evaluated the use of artificial intelligence (AI) throughout the entire food production process, encompassing crop and livestock farming, harvesting, and slaughtering, post-harvest management, food processing, distribution, consumption, and waste management. Their main objective (Kutyauripo et al., 2023) was to investigate the implementation of AI systems at each stage of the food system. A systematic review was carried out, in which 110 articles were analyzed after screening 450 articles according to specific inclusion and exclusion criteria. The findings indicate that different AI algorithms are being utilized across all stages of the food system, from crop and livestock production to the management of food and agricultural waste.

In a study presented by (Das et al., 2022) utilized machine learning algorithms and computer vision (CV) techniques to identify the freshness quality of stored tomatoes. The assessment is based on a grading scale ranging from 1 (fresh) to 10 (rotten). To accomplish this, they combined image pre-processing, handcrafted feature extraction, and a shallow artificial neural network (ANN). Their proposed ANN model achieved better results than several state-of-the-art methods, including deep neural networks. For this study, they developed a large dataset that covers the degradation of tomatoes over 70 days, which can be valuable for future research in the field.

Authors (Jurkonis et al., 2023) presented a method to evaluate crop parameters by analyzing mechanical vibrations. The investigation was demonstrated on a cucumber crop grown vertically using a support system in the field. The study involved modeling the cucumber yield, with a focus on the natural oscillation frequencies. A numerical model of the support design was developed, and its natural frequencies were calculated using the finite element method (FEM). The accuracy of the results was verified by conducting a physical experiment that replicated the numerical model.

In central Mexico, vending machines, street vendors, and cafeterias are the primary sources of food in hospitals. While prior research conducted in other countries has shown that the majority of food offered in these environments is unhealthy, there is a lack of information regarding the nutritional situation of hospitals in developing countries. Therefore, the purpose of authors (Murillo-Figueroa et al., 2023) study was to investigate the nutritional characteristics of food sold in hospitals and its compliance with the national Front-of-Pack Labeling Regulation (FOPLR). The findings revealed that the food available in and around hospitals contains high levels of calories, sodium, and saturated fats, and does not adhere to the nutritional guidelines set forth by FOPL.

Current evolutions in computer vision, Big Data, AI and, the symptoms of Fourth Industrial Revolution (4.0 IR), may be seen in each corporation (Sihlongonyane et al., 2020) . The food industry is one such industry that has lately seen a significant impact from AI on its procedures, equipment, and machines. With the advent of AI-driven processes and machines in agriculture and the food sector, crop growing, cultivation, production, and processing methods have altered.

Recently another work focused on that computer can now not only display photos of food, but also recognize and expose details about that item's nutritional content. (Pinel, 2015) Taking it a step further, International Business Machines Corporation (IBMAI)'sin 2016, Watson made history by becoming the first AI chef, offering innovative and imaginative dishes based purely on the ingredients. With its main feature of presenting modifications in a recipe with equivalent components, IBM's Watson silenced prominent chefs.

In a study presented by A. Singh. (*Singh, A. K. (2012). Mobile Technologies for Enriching... - Google Scholar*, n.d.) About Tech behemoths like Microsoft and Google are supplying these countries with technology and assisting in the formationof global economic stability. For example, Microsoft and ICRISAT collaborated to deploy Microsoft Cortana Intelligent Suite for agricultural data gathering and analysis b y using machine learning techniques Through public, private partnerships and state investment, the Indian government developed 13 pilot areas for learning through soil laboratories on soil analysis, smart irrigation systems, and IMOD techniques to support farmers.

In a recent study (Kakani et al., 2020) work focus on worldwide scale increased population has a remarkable effect on the points like regime services and policies.With number of increasing populations, the important responsibility respecting this problem is to stabilize the supply and demand for food in emerging countries. The corresponding increase in technological progress paves the way for the country's good economic position, with this factor as a foundation-governments and privatized investors are running on inspiring AI and CV techniques into sectors like industry of Agriculture and food for resolving distinct issues and rising productivity.

The authors (Lecun et al., 2015) worked on AI principles like deep and machine learning enabled the processing of photos using a computer vision. Till 2012, image processing and vision of computer were areas that analyzed images and trained computers to interpret their contents, allowing them to perform actions on certain judgements. The introduction ofmachine and deep learning expanded the breadth of computer vision behind its limits, get to the pinnacle of scientific achievement in tasks such as device identification, recognition, facial recognition, and so on. Data, photos, movies, linguistic sequences, and so forth.

In (Becker-Reshef et al., 2010) the author told that as automations advanced, current inventions put back old gear, utmost often in wealthy nations where to reach the public R&D takes short time. Through frequent field surveys and data assessment, the integration of computer vision and robots created a new inventive way to farming. Unmanned aerial devices and drones for crop imaging, are among the most recent breakthroughs in site-specific crop management. These are outfitted with sensors like multispectral, allowing farmers to examine their field, make decisions like the requirement for irrigation of water, and evaluate the soil fertility in areas throughout the land.

In a study presented by (Lele & Goswami, 2017) worked on the study of tech. Giant’s sites that collect data from many variables like historical rainfall data ,water, soil, Prediction of weather , yield crops, and other features to construct a trained system that can forecast season and best time of crop production. It is delivered precisely to agriculturalist smartphones, by making it more user-friendly and ultimately increasing crop yields. ICRISAT picked one seventy farmers and urged them to postpone planting activities until pilot sites, tell them that it is safe to do so. On this year in June third week trial sites sent an SMS to all farmers using Microsoft's machine learning skills of inspecting meteorological data and training on numerous aspects. This strategy allows agriculturalist to grow their seeds closer to the time of year when it rains., increasing agricultural yields by 30–40 percent. Nearly 2000 farmersreceived assistance in the latter months of 2017 to help them boost output on their farms.

In a recent study presented by (Eaton et al., 2008), Udio, a California-based agricultural technology start-up, has been working on sustainable AI-driven agriculture to quadruple production by concentrating on water irrigation strategies. Their basic idea is to Combine meteorological data, farm data, irrigation, and characteristics of soil to produce insights on filed level as recommendations for farmers to nearly double their comprehensive generation rate.

Several approaches have been developed in the literature to measure size, shape, color,and textural aspects, which have been thoroughly examined by Du and Sun (2004) (Murillo-Figueroa et al., 2023). These characteristics are objective data that are used to represent food goods and may be utilized to create the training set. After obtaining the training set, the learning algorithm extracts the knowledge base required to make a judgement in an unknown scenario. An intelligent judgement is created as an output based on the information and is simultaneously fed back into the knowledge base, generalizing the process used by inspectors to perform their obligations. The two primary applications where learning techniques have been used for developing knowledge bases are artificial neural network (ANN) and statistical learning (SL). Decision trees, Fuzzy logic and evolutionary algorithms also been utilized for learning in the meanwhile.

3. Comparative Analysis

Computer vision systems and image processing are a rapidly increasing study topic in agriculture, and they are an important analytical technique for pre- and post- harvesting of crops. To the best of our knowledge, Figure 6 depicts the number of research articles published each year. The trend in this subject of research may clearly be noticed from this graph. Between 2011 and 2022 Table 1 describes the best paper of Food Science and technology category. The average number of publications each year was 262.36 in 2016, with the greatest value of 385 in 2020, while there is a half-year break in 2022. Each article in the WoS (Web of Science) is classified into one or more subject groups. In the science version, there are twenty-eight web of science subject classes, along with Food Science and Technology classes (total 254 categories), and 21 research areas. Food Science Technology (2,887 papers, 100 percent of 2,887 papers), Chemistry Applied (1051,36.417 percent), Nutrition Dietetics (821, 28.4 percent), Agriculture Interdisciplinary (201, 5.999 percent), and Toxicology (202, 6.999 percent) are the top five categories (96, 3.326 percent).

Food Science Technology (2,887 papers, 100 percent of 2,887 papers), Chemistry (1067, 37.937 percent), Nutrition Dietetics (823,29.482 percent), Agriculture (317, 10.019 percent), and Toxicology (318, 11.019 percent) are the top five research areas (96, 3.326 percent). The WoS allows for the classification of journals or publications into two or more classes, reflecting the interdisciplinary nature of this field of

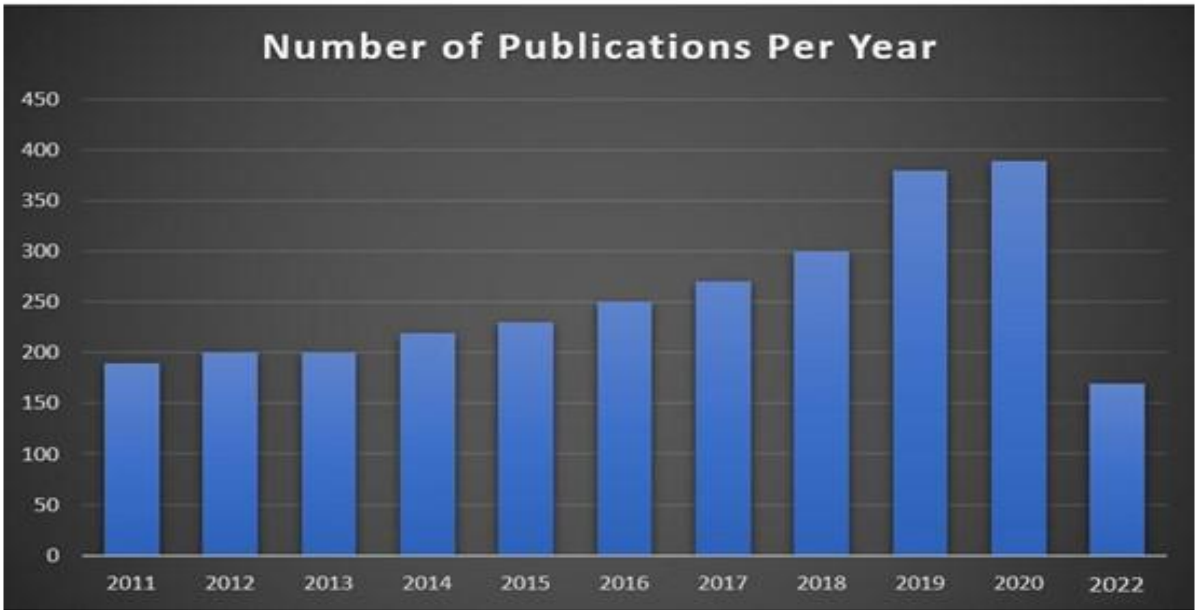

Figure 6: Publications of paper

research (Elango & Ho, 2017,2018). In web of science each document is assigned to one or more study categories. Publications are assigned areas, which are subsequently mapped to each document (paper) within them. As a result, publications can be categorized in several different ways. Despite its flaws, this broad database-specific mapping is often used in bibliometric analysis. Advertisements are also connected to web of science classes, that are major specific than fields in WoS (Stopar et al., 2021).

Table 1: From 2011 to 2021 Web of science areas of research and classes for food science and technology

WoS categories			**Research areas**		
Rank					
Categories	No. papers	% Total papers	Areas	No. papers%	Total papers
Dairy Animal Science	58	1.976	Biotechnology Applied Microbiology	58	1.976
Food Science Technology	2887	101	Food Science Technology	2887	101
Agronomy	37	1.318	Business Economics	15	0.454
Applied, Chemistry	1051	36.4	Chemistry	1066	36.93
Toxicology	96	3.326	Toxicology	96	3.326
Nutrition, Dietetics	821	29.482	Nutrition, Dietetics	821	29.482
Agriculture Interdisciplinary	201	5.999	Agriculture	317	11.019
Biotechnology Applied Microbiology	56	1.975	Pharmacy, Pharmacology	51	1.802
Horticulture	35	1.213	Mycology	7	0.243
Analytical, Chemistry	14	0.51	Neurosciences Neurology	5	0.139
Behavioral Sciences	5	1.139	Public Environmental Occupational Health	2	0.03

Molecular Biology, Biochemistry	91	4.119	Molecular Biology, Biochemistry	91	4.119
Microbiology	61	1.148	Microbiology	63	1.148
Pharmacy, Pharmacology	15	0.52	Physiology	4	0.139
Chemistry, Medicinal	37	0.282	Spectroscopy	15	0.485
Mycology	7	1.243	Ecology, Environmental Sciences,	2	0.035
Policy, Agricultural Economics	20	1.658	Entomology	6	0.173
Economics	17	1.554	Behavioral Sciences	5	0.13
Entomology	5	1.173	Plant Sciences	2	0.03
Spectroscopy	14	0.485	Immunology	2	0.069
Chemical. Engineering	94	3.257	Engineering	95	3.292

The parameters listed above the tables are related to various fields and disciplines in agriculture, animal science, and food production. Here is a brief explanation of each parameter:

a) Agriculture - This field is concerned with the study and practice of farming. It encompasses a wide range of topics, including crop production, soil management, land use, pest management, and agricultural engineering.

1. Dairy Science - This discipline is concerned with the biology, chemistry, and processing of milk and milk-derived products. Dairy scientists study topics such as animal nutrition, milk production, milk quality, and the development of dairy products.
2. Animal Science - This field encompasses the study of animal biology, breeding, nutrition, and management. Animal scientists may specialize in areas such as animal genetics, animal nutrition, animal behavior, and animal health.
3. Agronomy - This discipline is concerned with the study of crop production and soil management to optimize agricultural productivity. Agronomists study topics such as soil fertility, crop physiology, plant genetics, and sustainable agriculture.
4. Food Science Technology - This field is concerned with the physical, chemical, and microbiological properties of food, and how they relate to food processing, preservation, and safety. Food scientists may work on the development of new food products, food packaging, or food safety regulations.
5. Chemistry - This field encompasses the study of the composition, properties, and behavior of matter, including its interactions with other substances and energy. Chemists may work on topics such as chemical synthesis, materials science, or analytical chemistry.
6. Applied Nutrition Dietetics - This discipline is concerned with the role of food and nutrition in health and disease prevention, as well as the application of this knowledge in the development of dietary recommendations and interventions. Applied nutritionists and dieticians may work in fields such as public health, clinical nutrition, or food service management.
7. Agriculture Multidisciplinary - This field involves the study of agriculture from multiple disciplines, including agronomy, animal science, soil science, and horticulture. Multidisciplinary approaches may be used to address complex agricultural problems such as sustainable land use, crop productivity, or food security.

8. Toxicology - This field involves the study of the harmful effects of chemicals on living organisms, including their impact on human health and the environment. Toxicologists may work in fields such as environmental health, public health, or drug development.
9. Chemical Engineering - This field involves the application of chemical principles to the design and operation of chemical processes and systems. Chemical engineers may work on topics such as process design, process optimization, or process control.
10. Biochemistry Molecular Biology - This field involves the study of the chemical and biological processes that occur within living organisms, including the structure and function of proteins, nucleic acids, and other biomolecules. Biochemists and molecular biologists may work on topics such as genetics, protein engineering, or drug discovery.
11. Microbiology - This field involves the study of microorganisms, including bacteria, viruses, fungi, and parasites, and their role in health and disease, agriculture, and the environment. Microbiologists may work on topics such as microbial ecology, infectious disease, or food microbiology.
12. Biotechnology Applied Microbiology - This field involves the use of living organisms or their products to develop new products or processes, including the production of food, medicine, and biofuels. Biotechnologists and applied microbiologists may work on topics such as genetic engineering, fermentation, or bioremediation.
13. Medicinal Chemistry - This field involves the study of the design, development, and synthesis of drugs and other therapeutic compounds. Medicinal chemists may work on topics such as drug discovery, drug design, or drug delivery.
14. Horticulture: the science of plant cultivation, including the production of fruits, vegetables, and ornamental plants.
15. Agricultural Economics and Policy: the study of the economic principles that govern agricultural production, marketing, and trade.
16. Analytical Chemistry: the development and application of analytical techniques to analyze and measure chemicals and materials used in agriculture and food production.
17. Pharmacology and Pharmacy: the study of the effects of drugs on living organisms, including their therapeutic and toxic effects.
18. Spectroscopy: the use of electromagnetic radiation to analyze and measure the chemical and physical properties of materials, including those used in agriculture and food production.
19. Mycology: the study of fungi and their role in agriculture, food production, and medicine.
20. Entomology: the study of insects and their interactions with living organisms, including their role in agriculture, ecology, and disease transmission.
21. Behavioral Sciences: the study of human and animal behavior, including the biological, psychological, and social factors that influence behavior in agriculture and food production.
22. Biotechnology Applied Microbiology - Biotechnology is the application of technology to biology for the development of new products and processes. Applied microbiology is the use of microorganisms to develop new products or processes. Biotechnology applied to microbiology involves the use of microorganisms such as bacteria, yeast, and fungi to produce products such as vaccines, antibiotics, enzymes, and biofuels.

23. Business Economics - Business economics is the application of economic principles to the study of business activities such as production, marketing, and finance. It involves analyzing how businesses make decisions, allocate resources, and respond to changes in the market.
24. Food Science Technology - Food science technology is the study of the physical, chemical, and microbiological properties of food and how they relate to food processing, preservation, and safety.
25. Chemistry - Chemistry is the study of the composition, structure, properties, and behavior of matter. It includes the study of chemical reactions and the development of new materials and chemical compounds.
26. Nutrition Dietetics - Nutrition dietetics is the study of the role of food and nutrition in health and disease prevention. It involves the development of dietary recommendations and interventions to promote optimal health.
27. Agriculture - Agriculture is the science and practice of cultivating land, raising animals, and producing food, fuel, and other products. It includes crop production, soil management, animal science, and agricultural economics.
28. Toxicology - Toxicology is the study of the harmful effects of chemicals on living organisms, including their impact on human health and the environment. It involves the study of chemical exposure, toxicity, and risk assessment.
29. Engineering - Engineering is the application of science and mathematics to solve practical problems. In agriculture and food production, engineering is used to develop and improve technologies for crop production, food processing, and packaging.
30. Biochemistry Molecular Biology - Biochemistry is the study of the chemical processes and substances that occur within living organisms. Molecular biology is the study of the structure and function of biological molecules such as DNA and proteins. Biochemistry and molecular biology are closely related fields that are used to study the biological processes involved in agriculture, food production, and human health.
31. Microbiology - Microbiology is the study of microorganisms such as bacteria, viruses, fungi, and parasites. It is an important field in agriculture and food production as microorganisms play a vital role in food safety, fermentation, and soil health.
32. Pharmacology Pharmacy - Pharmacology is the study of drugs and their effects on living organisms. It involves the development and testing of new drugs, as well as the study of drug interactions and toxicology. Pharmacy is the science and practice of preparing and dispensing medications. Pharmacology and pharmacy are important fields in the development and distribution of drugs for human and animal health.
33. Spectroscopy - Spectroscopy is the study of the interaction of electromagnetic radiation with matter. It is used in agriculture and food production to analyze the chemical composition of samples, such as soil, crops, and food products.
34. Mycology - Mycology is the study of fungi and their role in ecology, agriculture, and medicine. Fungi are important organisms in agriculture and food production as they are used in fermentation, production of enzymes, and in the control of plant diseases.
35. Entomology - Entomology is the study of insects and their interactions with other organisms, including their role in agriculture, ecology, and disease transmission. Insects play an important

role in pollination, pest control, and food production.

36. Neurosciences Neurology - The study of the nervous system and its structure, function, and disorders. This field includes research on the brain, spinal cord, and peripheral nervous system.
37. Behavioral Sciences - Behavioral sciences are the scientific study of human and animal behavior. In agriculture and food production, behavioral sciences are used to study the behavior of animals, such as cows and chickens, to improve their health and productivity.
38. Physiology - The study of the normal functions of living organisms and their parts. This field encompasses research on the functions of cells, tissues, organs, and organ systems.
39. Immunology - The study of the immune system and its response to infectious agents, cancer, and other diseases. This field includes research on the biology of immune cells and their interactions with pathogens and other cells in the body.
40. Environmental Sciences Ecology - The study of the relationships between living organisms and their physical and biological environments. This field encompasses research on topics such as biodiversity, conservation, and ecosystem dynamics.
41. Plant Sciences - The study of plant biology, including the structure, growth, and reproduction of plants, as well as their interactions with the environment.
42. Public Environmental Occupational Health - The study of the impact of environmental factors on public health, including the effects of pollution, hazardous substances, and occupational exposures. This field includes research on the prevention and control of environmental health hazards.

By 2050 Ag Tech startups have chosen a specific Vision and AI Solutions to enhance productivity and achieve the target of maintaining food amount. Ag Tech Startupslike sky squirrel technologies, imaging of ceres and river blue use computer-assisted visual imagery technology in the form of spectral picture analysis, image capture by robots and drones.

Data of sensor can be a valuable aid in Farm-based experiments like Sen crop, centaur analysis and sponsor technologies use multicenter data for sensing anomalies in the crop productivity and deformity in product supply. Same method has been used by beginners like smart agriculture for sustainable food supply and better productivity, Benson hill Biosystems, agrilyst , trace genomics, agreeable, agrible, my ag data, Cuba, using innovations like plant data analytics and when it comes in term of animal raising and future generations farms for the greenhouse surroundings manipulate guided environment with the clever irrigation like ales a life, brilliant farms, farm note, modern animal diagnostics, crops aqua spy, hydro point data systems are using machine learning and computer recognition technologies for analysis, recording and anticipate the elements which can enhance productivity. Ag Tech Startups making use computer and AI.

In this comparative analysis P. Shah worked on robotics, drones Ceres imaging to identify nutrient deficiencies, establish management zones, enable variable rate applications, and water stress imaging. A. Gertisis worked on robotics drones sky squirrel technologies for the Crop health assessment using drone imagery and thistechnique applied on nova crop. E Waltz worked on robotics, drones, blue river which is based on AI They worked on Herbicide resistant weed control Robotic vehicle and cloud analytics for upgraded yields and these techniques are based on Data Collective, Innovation, and endeavors (Waltz, 2017). A. Guptill worked on sensors (AI) Centaur analytics by Using sensors to monitor each crop and reduce unnecessary usage of chemicals (Μπέλτσος, 2017) .

Caplan worked on Sensors (AI) Technologies by using Smart sensors for weed detection, estimation of great pests by using impending Modifications (Caplan et al., 2014) . B. Foubert worked on sen crop by Employing sensors such as wind gauge, rain gauge to precise and efficient prediction. The Sencrop weather stations require a global network that is universally accessible to assist farmers from anywhere on the planet. However, the coverage provided by Sigfox is inadequate for the purpose. Sigfox is only capable of handling a limited amount of regular monitoring data and is not equipped to support a complete firmware upgrade. Sencrop is a company that produces and markets weather stations that collect data autonomously. The purpose of these stations was to assist farmers in accurately predicting the weather, such as the risk of frost, and to make informed decisions during the crop cycle, including determining the required amount of water and fertilizer. The weather stations gather precise, parcel-specific weather-related data, such as temperature, humidity, pluviometry, and wind speed. (Foubert & Mitton, 2019) . Fraser uses Precision Agriculture and Predictive Analysis (Computer Vision) by using Wadsworth, easily Investments. Precision agriculture is a farming management approach that is focused on watching, measuring, and responding to crop inter- and intra-field variability. Precision farming is a method of increasing average yields by using exact amounts of inputs in comparison to traditional gardening approaches (Fraser, 2019) . N. N. Prescott worked on Precision Agriculture and Predictive Analysis (Computer Vision), forecasting harvest times and guiding planting cycles using data-driven systems to achieve high yields (Prescott, 2016). A. K Khulemann focused on precision agriculture and predictive analysis (computer vision) by utilizing data systems to assist producers in locating value in the supply chain and developing proprietary crop designs that can assist growers in streamlining operations. D. Knowler worked on plant data analysis (computervision) by using Machine learning is being used to learn information from agricultural soil. Vision Automations are completely described in Table 2.

The metadata summarizes basic information about data, making working and finding with instances to make data easier. It can be produced manually to be more efficient, or automatically and it consists of the more basic information (Knowler & Bradshaw, 2007). H. D Priest worked on plant data and analysis (computer vision) by using plant biology, cloud computing and big data analytics through predictive learning engine for the superior crops (Priest et al., 2014).

D.H. Sloane worked on smart irrigation (Computer vision) and aqua spy by Tracking crop behavior of both water and nutrients through profiling modeled using predicted parameters of soil moisture. In the beginning they collected data on the soil moisture levels in the field over time, as well as on the nutrient levels present in the soil. They have gathered data using a variety of techniques, such as soil sampling, remote sensing, or on-farm sensors. After the collection they have used to build a predictive model that takes into account the various factors affecting crop growth and nutrient uptake. Which shows that how different changes in soil moisture levels and nutrient availability will affect crop growth over time and this model was based on a number of factors, including soil type, climate conditions, and the specific crop being grown. Soil moisture is frequently forecasted using data from nearby weather stations and soil and crop factors using one of three methods: empirical, regression, and machine learning. (*AquaSpy - A Revolutionary New Soil Moisture Sensor*, n.d.).

There are various methods that are being used for forecasting soil moisture levels. Some examples include physical-based models that simulate the movement of water through soil layers and evapotranspiration, empirical models that rely on statistical relationships between past weather conditions and soil moisture, remote sensing techniques that use satellite or airborne sensors to indirectly measure soil moisture, machine learning algorithms that can predict soil moisture levels based on input data such as soil characteristics, climate data, and vegetation indices, and on-farm soil moisture sensors that provide real-time data to

Table 2: AgTech startups using computer vision and AI and automations: precision agriculture, drones, plant analysis, smart irrigation, robotics, sensors

Technological components	**Organization**	**Founded**	**Use-cases**	**Shareholders**
Robotics, Drones	Ceres Imaging	P. Shah [44] Established in 2014, California,USA	Find shortage in nutrients, set up. Management areas, allow applications of variable rate and image of water pressure.	Imagine H20, Lemnos Labs, Silicon Bada
Robots, Drones AI(Automations)	Sky Squirrel	A. Gertisis [45] Established in 2015,Halifax, Canada	To detect plants health with the help of drone imaging	In NOVA Crop
Robotics, Drones (AI) Technology	Blue River	E Waltz [46] Established in 2017 Sunnyvale, CA, USA	Herbicide resistant weed control Robotic Automobile and cloud analytics for progressed yields	Data Collective, Innovation Endeavors
Sensors (AI)	Centaur Analytics	A. Guptill [47] Established in 2017, Los Angeles, USA	Using sensors to see each plant and limit the use of unneeded chemical	Our Crowd, PJ Tech Catalyst
Sensors (AI)	Sensa Technologies	S. Caplan[48] Established in 2014, Great Lakes, USA	Intelligent sensors for weed detection, prediction upcoming of pests	Innovations
Sensors (AI)	Sen crop	B. Foubert [49] Established in 2019, Lille, France	Employing sensors like wind gauge, rain gauge to accurate and systematic estimation	Brega Capital, Enertech Gestion
Precision Agriculture and Predictive Analysis (CV)	My Ag Data	A. Fraser [50] Established in 2017, Great Lakes, USA	Using accurate agricultural data development tactics to bridge the gap between data collected and used by farmers, crop insurance firms	Adams Street Partners, Alpha Capital Partners, Don Wadsworth, Early Investments
Precision Agriculture and Predictive Analysis (CV)	Agrilyst	N. N Prescott [51] Established in 2016, Brooklyn, New York, USA	Harvest forecasting and guided planting cycles Using data-driven systems that result in high yields	Brooklyn Bridge Ventures, Metamorphic Ventures
Precision Agriculture and Predictive Analysis (CV)	Agrible	A.K Khuleman [52] Established in 2017, Great Lakes, USA	Uses data systems to assist producers in locating value in the supply chain and developing proprietary crop models to assist growers in streamlining operations.	Archer Daniels Midland Company, Flyover Capital, Serra Ventures
Data of Analysis (CV)	Trace Genomics	D. Knowler [53]	Machine Learning is used to learn metadata Illumina Ventures, from the farm soil	Fall Line Capital

optimize irrigation and fertilizer applications.

C.D. Hergert worked on smart irrigation (computer vision) and hydro points data system. They worked on leaked detection, smart irrigation solutions and technology. The hydro power data system does site inspections, irrigation system efficiency audits, leak detection, weather analytics, installation or upgrading of existing systems, and continuing maintenance and training are all available through it. Gonçalves, J. L. Worked on Animal Data (Computer Vision) and enhanced animal diagnostics by utilizing precise animal care and on-site illness diagnosis via machine vision and pattern analysis. AAD develops and commercializes diagnostics for diagnosing and controlling disease conditions, reproductive, nutritional, and general health status of producing animals. (Gonçalves et al., 2017)

4. Conclusion and Future Directions

This review paper describes the technologies like artificial intelligence and computer vision in the branch of food and agriculture industry. Mainly the current review gives a complete knowledge of intelligence and computer vision technologies which manages many agricultural applications like data of plant analysis, agriculture-based applications, next generation farming, smart spraying, and food processing. More ever this paper focuses on the underlying plan of employing sustainable for industrial revolution technologies through which mankind can attain the essential foodsupply by 2050 in a user-friendly manner. The significance of the Agri Tech Industry, as well as financing based on Vision and AI automations, was explained with suitable sources and application examples. Startups based on AI and computer vision applied in the food and agriculture industries have been thoroughly analyzed and discussed in terms of many uses. Behind agriculture-based startups and food industry this paper describes a few other startups like animal data and next generation farms. With respect to the agriculture and food sector this paper provides a single window path for interdisciplinary material integrating Vision and AI strategies.

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