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Economic impact of artificial intelligence in the field of agriculture

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Abstract
Artificial intelligence (AI) is a new emerging technology which has a positive impact on agricultural productivity (crop production) majorly through the utilization of AI in agriculture. This paper examines the moral challenges of the use of Artificial Intelligence in agriculture in six classes together with fairness, transparency, accountability, sustainability, privacy, and robustness. Artificial intelligence has helped improve efficiency, improve soil health and crop production, and solve many problems of the agricultural sector. Other concerns such as unpredictable climate change, rapid population growth, and food insecurity have prompted the use of artificial intelligence to ensure sustainable agriculture. As the world's population grows exponentially, there must be a lift in food production to cater to the ever-increasing world population. AI-based technologies help solve problems related to weeding, irrigation, cultivation, and control. The ongoing process of climate changes causes many distresses and vulnerabilities, especially in the agrarian sector. The same can be effectively minimized with the deployment of AI-enabled digital solutions. Research in India reveals that rice cultivation contributes 16% in GHG emissions, while wheat adds 56%, and fertilizer production & use in cereals add 52%. India's agri-food sector is heavily reliant on unpredictable climatic conditions and the use of AI can help it produce more with fewer resources. It can shift the methods & processes of food production and help the agricultural sector reduce its emissions by 20%. AI-enabled farming solutions enable farmers to produce more crops at a lower cost while enriching the product's quality.

Keywords: Artificial intelligence, Indian agriculture, irrigation, carbon foot-printing

Introduction
As the world's population grows exponentially, there must be a lift in food production to cater to the ever-increasing world population (O. Calicioglu, 2019) [13]. The boost in food production may be achieved by enhancing agricultural productivity and may be able to successively guarantee food security (Jemaneh, 2012) [14]. With the increasing population, crop production, which is a branch of Agriculture, needs intense management to cater for the ever-increasing population. Also, eutherian production, which is additionally a branch of Agriculture, depends on crop production. To tackle food insecurity and increase food provide to cater to the growing population, agricultural productivity must be improved. Agricultural productivity (Crop production) may be improved by majorly victimization of artificial intelligence. "Information Technology is anticipated to boost agricultural info and farming techniques to realize higher outputs, maybe the maximum amount as 60% by 2030" (V. Lakshmi and J. Corbett, 2020) [15]. The problem of food insecurity and temperature change not to mention the inaccessibility of young farmers creates a threat to the economy and also the world's population at large. AI possesses the potential to enhance crop production thereby eliminating food insecurity for each man and livestock. In developed countries, the appliance of technological advancements just as the use of drones for crop monitoring, and the employment of artificial intelligence in farming within the agricultural business has extremely helped in the production of crops (AU Mentsiev, 2020) [16]. The adoption of artificial intelligence in farms is only to tackle problems negatively moving crop production concerning areas like chemical control, irrigation, weed control, and crop diseases among others (K Jha, 2019) [17]. The research is going to be supported by the advantage of AI in Crop Production. AI applications are an integral and rising part of digital agriculture. AI will facilitate guarantee property production in agriculture by enhancing agricultural operations and decision-making.

Recommendations concerning soil condition and pesticides or automatic devices for milking and apple selection are samples of AI applications in digital agriculture. Though AI offers several benefits in farming, AI systems could raise ethical problems and risks that ought to be assessed and proactively managed. Poor style and configuration of intelligent systems may impose damage and unwitting consequences on digital agriculture. Invasion of farmers' privacy, damaging animal welfare because of robotic technologies, and lack of answerableness for issues ensuing from the employment of AI tools are just some examples of ethical challenges in digital agriculture. This paper examines the moral challenges of the use of AI in agriculture in six classes together with fairness, transparency, accountability, sustainability, privacy, and robustness. A good variety of ethical considerations admire addressing farmers' privacy concerns, guaranteeing reliable AI performance, enhancing the property in AI systems, and reducing AI bias.

Digital agriculture refers to using superior technology which has converted farm operations. This may be carried out with the use of automatic strategies which includes AI, Internet of Things (IoT), and facts series and processing. The software of AI in agriculture and meals has been on the rise. The Market is forecasted to develop from $1.1 billion in 2019 to more than $3. Eight billion through 2024. Market calls for and forecasting can assist farmers alter the sort and quantity of production. Images gathered from plants the usage of drones may be utilized in a number of ways, which includes tracking soil for nutrient deficiencies and tracking farm animal health.

Foundation of Artificial Intelligence in Agriculture

In 1983 AI was born in agriculture when the first application of computers in agriculture was presented. Since that time, the use of computers and technology in agriculture has continued to grow. Today, AI is applied in many fields such as medicine, marketing, finance, banking, education, industry, security, and agriculture to name a few. The application of AI in agriculture has helped improve efficiency, improve soil health, and crop production, and solve many problems of the agricultural sector. Examples of AI-based farming are driverless tractors, smart irrigation systems, fertilizing systems, smart spraying, vertical farming software, and AI-based robots. This AI-based farming has helped farmers to do their jobs easily even without hiring more staff. For example, autonomous tractors or driverless tractors can get the job done with accuracy and precision and fewer errors, which is impossible when a driver drives the machine. (Oluyemi, 2022) [1]

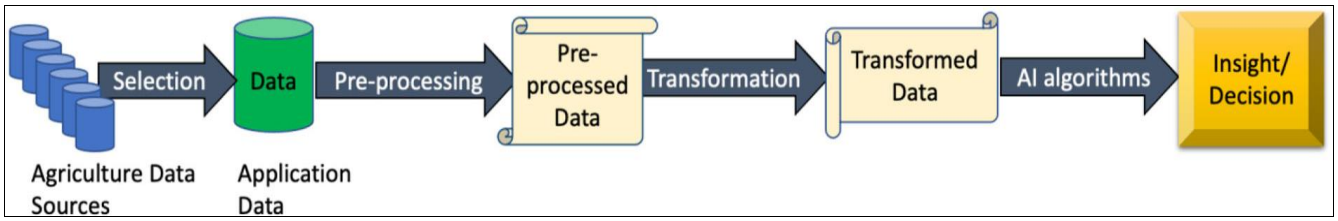

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Fig 1: Knowledge discovery and information extraction process in artificial intelligence.

Types of artificial intelligence

1. Weak or Narrow Artificial intelligence

This type of artificial intelligence is always ready to do a delicate task efficiently. Within the field of computer science, slender artificial intelligence is the most frequent and presently available artificial intelligence. Narrow artificial intelligence cannot work outside of its field because it has only been trained for a single task. Narrow artificial intelligence would fail in unexpected ways if it's allowed to go. Siri from Apple is a good illustration of artificial intelligence, although it only has a limited set of capabilities and functions (Millar, 2000) [2].

2. General Artificial intelligence

It is a type of intelligence able to complete any intellectual work as snappily as a person. The idea behind general Artificial Intelligence is to produce a system that can become smarter and act like a person on its own. As general artificial intelligence systems are still under disquisition, developing similar systems will take significantly further trouble and time (Pilarski T, 2002) [3].

3. Super Artificial intelligence

Super artificial intelligence could be defined as a position of machine intelligence that surpasses mortal intellect and can negotiate any task better than a person with cerebral rates. It's a result of artificial intelligence in general. Embracing its capability, embracing the power to assume, to offer reasons, to break problems, to learn, to make judgments, and plans, and to communicate on its own are some abecedarian features of strong artificial intelligence. Super artificial intelligence is still just a conception in computer wisdom. The real-world development or creation of similar machines remains a gruelling task. Large volumes of data sets are combined with rapid-fire, recreating processing and clever algorithms to produce artificial intelligence at its stylish. As a result, AI software may learn automatically from patterns in those massive data sets. Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL) are all words that are used interchangeably, ML on the other hand, is a subset of AI that includes more advanced models ways and that allow computers to learn from data, whereas DL is a subset of ML that employs multi-layered artificial neural networks to achieve high delicacy in tasks similar as language restatement, speech recognition, and object discovery.

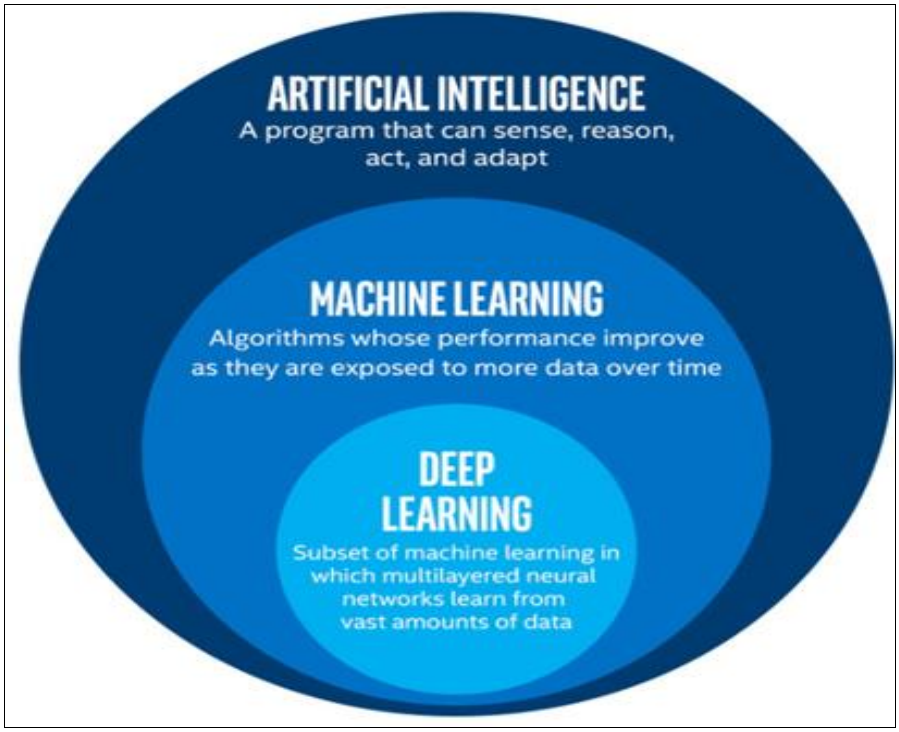

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Fig 2: Venn diagram of AI v/s ML v/s DL

Application of AI in agriculture

1. Artificial Intelligence in Crop Production

Artificial intelligence simply means the ability of machines to perform tasks that are normally found or performed by human intelligence. Artificial intelligence is based on relevant disciplines such as computer science, biology, psychology, and engineering (T. Talaviya, 2020) [4]. AI-based technologies help solve problems related to weeding, irrigation, cultivation, and control, thereby improving farm efficiency and productivity. Also, other concerns such as unpredictable climate change, rapid population growth, and food insecurity have prompted the use of artificial intelligence to ensure sustainable agriculture. AI has been used in numerous areas of agriculture, including but not limited to general crop management systems, pest and disease management, soil and irrigation management, weed management, and performance prediction (Singh, 2020) [5]. So, AI can be used in crop production to monitor soil health, grow seeds, protect crops, feed crops, and harvest. Farmers are now adopting the use of drones and robots on the farm for various farming activities.

2. Artificial Intelligence in Irrigation

As reported by (T. Talaviya, 2020) [4], approximately 85% of the world's freshwater is consumed in agricultural practices, meaning it is vital that we implement an irrigation system that ensures proper use of water resources. Irrigation is the application of water to the soil to provide enough moisture for plant growth. Aside from poor irrigation systems leading to wastage of water resources, it can also lead to chemical leaching into the soil, which in turn leads to poor crop yields. Therefore, it is evident that proper soil management and irrigation are essential to avoid crop losses and soil degradation. Agricultural irrigation is commonly performed by farmers using traditional irrigation systems such as the use of watering cans or buckets that need to be replaced with modern techniques with artificial intelligence. The use of AI with a machine-based irrigation control system ensures soil and water management. Therefore, a good irrigation system will positively enhance crop production by increasing crop yields and stabilizing production, while a poor irrigation system will negatively decrease crop production. To minimize water consumption during irrigation and reduce human labour, agricultural monitoring is used on farms. The machine-driven irrigation system has replaced the traditional agricultural irrigation method (Oluyemi, 2022) [1].

3. Artificial intelligence in Weed Control

Weeds are unfavorable plants that grow where they are not wanted. Weeds pose a significant threat to crops as they aggressively compete for key growth factors such as nutrients, moisture, sunlight, and space. Weed control is critical to successful crop production as weeds compete with crops and this can reduce agricultural productivity i.e., low yields and poor crop quality. The use of herbicides in contrast to mechanical weed control facilitated weed control. However, the use of herbicides is associated with influencing human and environmental health, which is why methods of artificial intelligence are used in weed control. resources in the environment and thus damage crops, which in turn can have a significant impact on consumer health. Therefore, the use of AI methods reduces the use of herbicides through adequate weed control. AI methods, such as high-tech computer systems, can be used to detect weeds, predict crops, identify crop yield and quality, and control weeds. (Oluyemi, 2022) [1]

4. Artificial intelligence in pest and disease management

Pest infestations and crop diseases are a major problems for farmers, both of which are associated with huge economic losses in agriculture. This is one of the main obstacles in the development of agriculture. Crop pests and diseases not only cause economic losses but also pose a major

environmental threat and cause food insecurity. This necessitates controlling pests and diseases of crops using artificial intelligence that can detect and provide diseases in crops Treatment suggestions. Early detection of pests and diseases using AI is important for effective on-farm control. As State: "AI and machine learning can help identify the areas at risk of invasions/outbreaks and assist in plans to contain the spread of invaders or disease".

In the past, farmers used their knowledge to control crop pests and diseases. Now companies are using computerized systems to control pests and analyse the disease, thus recommending ways to control it. This early detection and control will reduce the impact of pests and diseases on crops, resulting in high yields in terms of food produced. Artificial intelligence in harvesting agricultural products. (Oluyemi, 2022) [1]

5. Artificial Intelligence in Product Harvesting

Artificial intelligence has been found to improve the proper monitoring of crops, thereby promoting crop harvesting, processing, and marketing (T. Talaviya, 2020) [4]. This solves the problem that requires many workers as the workload is reduced by using artificial intelligence. Robots and AI have been found to do most of the harvesting of produce, including harvesting nuts. Robots are programmed to harvest faster than human workers. Harvesting robots, as a form of mechanization, have also been developed to harvest ready-to-harvest produce using sensors to sense the environment. (Oluyemi, 2022) [1]

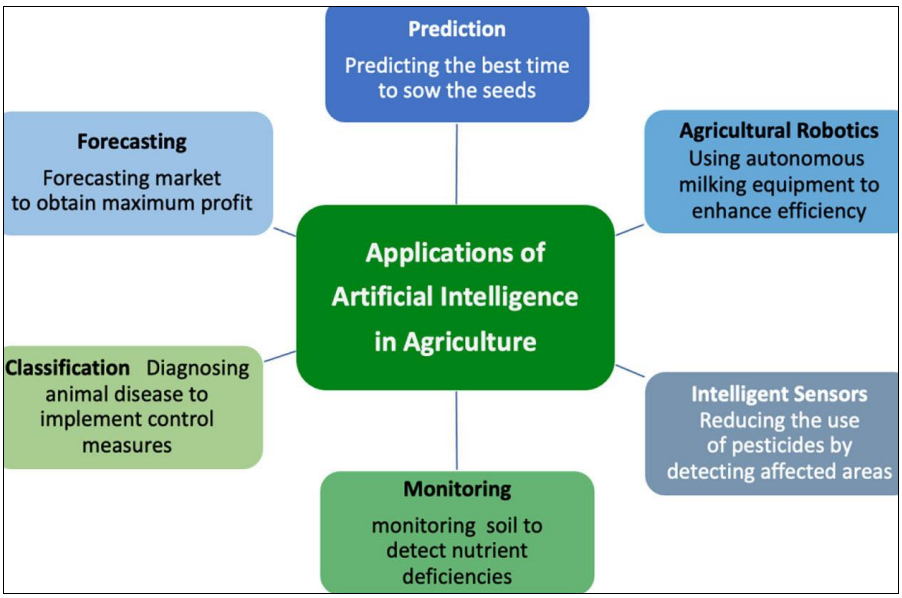

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Fig 3: Artificial intelligence applications in digital agriculture.

Limitation of Artificial Intelligence in crop production

Artificial intelligence as an emerging technology with its rapid growth in the IT (information technology) industry which has a positive impact on crop production. However, there are some restrictions on its use. As stated by (Clara, 2019) [6], some of the limitations include poor implementation methodology, low response time and accuracy, high data cost, and large data requirements. Farmers need to be trained to adapt to the use of AI on farms. In addition, despite the proposed focus on greenhouse automation and environmental data development, there are still concerns about fully equipped greenhouses and crop growth monitoring, particularly in rural areas (D. Shadrin, 2020) [7]. The inability to access this parameter in remote areas makes it difficult to predict crop conditions. In addition, the cost of acquiring AI systems such as drones is extremely high, making it impossible for most farmers to use it in India (Alreshidi, 2019) [8]. And on farms where there is an AI system, it leads to a reduction in human workers. Artificial intelligence has the potential to adapt to reduced labour on the farm. The downsizing could also be detrimental to the economy.

AI, agriculture sector, and carbon footprints

AI possesses the implicit to spark an invention feeding to meet the huge demand for food granules with smaller coffers in the agriculture section in pivotal moments and with the use of varied technology-enabled results like satellites, robots, soil health, crop monitoring, prophetic dissection, is poised to make agriculture more productive, salutary, ready and more accurate. The ongoing process of climate changes causes numerous distresses and susceptibility, especially in the agricultural region, making it more parlous, unsustainable, and changeable and the same can be effectively minimized with the deployment of AI-enabled digital results. AI and confederated farm technologies are directly impacting 70 million framers in 2020, adding the US$ 9 billion to farm profit, and will play a pivotal part in realizing the dream of redoubling ranch profit by 2022 in India. Exploration in India reveals that rice civilization contributes 16 in GHG emigrations, wherein wheat adds 56 and toxin products & use in cereals append 52 to GHGs. Few researchers anatomized the carbon footmark of husbandry crops formed in Karnataka, India. They reported that rice contributed 78 carbon emigration in the shape of methane, carbon dioxide, and nitrate oxide. The energy exercised in various farm missions after its transformation into carbon equivalent CE) reveals that the emigrations from nonidentical tillage missions, scattering chemicals, drilling or sowing, and combined harvesting are-

20, 1-1.4, 2-4, and 6-12 kg CE/ ha, independently. The carbon copy costs of significant inputs have an adding trend over time. They also assessed the greenhouse gas (GHG) emissions from cultivation over the past 50 years (1960-2010) in India. They reported that nitrogen and methane account for 83 and 58 of emissions, independently, and nitrogen exercise effectiveness is declining over the times. Reported that sustainability carbon in food grains product declined over time, indicating declining energy use and its effectiveness. Beyond, the study set up the topmost decline in rice crops, followed by wheat crops, and minimal in maize crops. The research attributed maize with the highest carbon sustainability with the smallest global warming potential. It can reduce the environmental footprint by 46 and recommends diversification of crops to help the carbon traces in Indian husbandry. examined the energy and carbon intensity of rice, sorghum, wheat, pearl millet, and maize by taking into account the volume of water needed, dependence on groundwater, fertilizer, production & machine input, and reported rice as the upmost carbon intensive while millets as the least. AI-enabled technology can be a massive boon for India's farming sector, heavily reliant on fluctuating climatic conditions. The husbandry region can explosively and openly switch over to AI results in various farm practices for swelled and dependable issues. It can transfer the styles & processes of food products and support the farming region reduce its emissions by 2020. Resultantly, AI-fused farming results enable growers to produce further with smaller resources, enriching the yield's quality besides relocating traditional husbandry practices to a quick "go-to-market program" for crops moment (Surender Mor, 2021) [9].

Roadmap of deployment of AI in Indian agriculture

Over 58% of rural households rely on agriculture as their primary source of income, making it the backbone of the Indian economy. India became food grain self-sufficient in the late 1960s thanks to remarkable agricultural advancements, but these advancements are still restricted to a select few regions of the country. Despite this, only 36% of the land is irrigated, so rainfall is essential for much of agriculture. According to (India, 2018) [10], nearly half of India's land is tilled, and agriculture directly employs 41.1 percent of the country's workforce (ILO, 2020) [11]. India became self-sufficient in the production of food grains as a result of the green revolution that began in the 1960s. However, the country still has a long way to go before it can produce, sustain itself, and practice green agriculture. It is interesting to note that one-sixth of India's economy is produced by using nearly half of the country's land. Indian agriculture is far from productive or efficient because only 2 out of 5 people are employed (Mungarwal, 2019) [12].

Conclusion

Artificial Intelligence (AI) is based on applicable disciplines similar as computer science, biology, psychology, and engineering. This solves the problem that requires numerous workers as the workload is reduced by using artificial intelligence. With modern ways with artificial intelligence. Artificial intelligence has the implicit to acclimatize to reduced labour on the farm. Artificial intelligence in harvesting agricultural products. Artificial intelligence in Weed Control Weeds are negative plants that grow where they aren't wanted. The use of AI with machine-based irrigation control system ensures soil and water management. Also, other enterprises similar as changeable climate change, rapid population growth, and food instability have urged the use of artificial intelligence to insure sustainable husbandry. Still, the use of dressings is associated with impacting mortal and environmental health, which is why methods of artificial intelligence are used in weed control. AI in Product Harvesting farmers have a strong desire for mechanization in crop management and harvesting as it saves time and reduces labour. AI has been set up to improve the proper monitoring of crops, thereby promoting crop harvesting, processing, and marketing. This necessitates controlling pests and diseases of crops using artificial intelligence that can detect and give diseases in crops treatment suggestions. AI simply means the ability of machines to perform tasks that are typically set up or performed by human intelligence. So, AI can be used in crop production to monitor soil health, grow seeds, protect crops, feed crops, and harvest. AI-based technologies help solve problems related to weeding, irrigation, civilization, and control, thereby improving farm effectiveness and productivity. Crop protection products do not contribute significantly to the carbon footprint of any of the five main staple crops (cotton, maize, rice, soybeans, and wheat). The production and use of fertilisers makes the most significant contribution to all the crops and scenarios assessed. Increased productivity which crops protection products provide is highly beneficial to addressing climate change challenges, compared to their small carbon footprint.

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