

Agricultural Intelligence: An Introduction

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ABSTRACT

Agriculture (or farming) provides food required for human survival. Agriculture is the second largest industry in the US after Defense. Today's agricultural businesses must contend with issues like population growth, increasing urbanization, workforce impact from pandemics, financial upheaval, unpredictable climate conditions, increasing water shortages, shrinking arable land, limited availability of natural resources, and fluctuating costs. These challenges put global food supply and food security at risk. To accommodate the needs of the growing population, the agriculture industry needs to adopt new innovative solutions and farmers must look for ways to minimize their risks, or at least make them more manageable. This paper provides an introduction on agricultural intelligence.

Key Words: agriculture, farming, agricultural intelligence, farming intelligence, artificial intelligence

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I. INTRODUCTION

Agriculture and farming are one of the oldest and most important professions in the world. Agriculture is the largest industry on the planet, and it includes crop, horticulture, animal husbandry, forestry, and fisheries. Agriculture is one of the most fundamental human activities. It plays a huge role in shaping national economy and providing employment. Agriculture has become the focus of politicians, consumers, scientists, and environmentalists. For this reason, one is curious about how technology will direct the future of agriculture and, how we need to step up our efforts in order to reach zero hunger. Agriculture industry is unique among all sectors with its diverse stakeholders and complex nature [1]

Agriculture follows a lifecycle shown in Figure 1 [2]. Agriculture has undergone some evolutions. Recently, mechanization revolutionized farming with machinery and replaced horses with tractors. Today, technology has been adopted in an increasing rate to the extent that technology has become an indispensable necessity for every farmer, especially in developed nations.

Today, the agriculture sector is facing several challenges such climate change, increasing

population, increasing labor shortages, land, and water constraints, increasing urbanization, environmental degradation, changing dietary habits, coping with the latest technology, achieving more with less, etc. The United Nations has estimated that the global population will reach 9.8 billion by 2050, indicating the urgent need to produce more food production in order to feed the growing population with less land to grow it on.

Agriculture is in dire need of innovative solutions to tackle the challenges faced by our society today and for eradicating poverty and hunger. The enormous challenges can be dealt with by adopting advanced technologies such as Internet of things, cloud computing, GPS technology, satellites, drones, robots, and artificial intelligence [3].

WHAT IS AGRICULTURAL INTELLIGENCE?

Agriculture is the industry that feeds people around the globe and contributes largely to the global GDP. It is the backbone of many developing countries, providing job opportunities, and serving as a source of food security. Modern agriculture requires technological tools that can improve production efficiency, meet the increasing

demand of food, and reduce their environmental impact. To achieve this goal, new technologies and solutions are being applied in agriculture. One of the key solutions is agricultural intelligence.

Agricultural intelligence is a concept that allows agricultural exploitations to use the collected information in order to be able to efficiently adjust to changes, improving global performances. It is an emerging technology for farmers. Figure 2 shows the agriculture intelligence architecture model [4].

Agricultural intelligence may be regarded as the intersection between agriculture and intelligence. The concept of intelligence has been central to the field of psychology. The characteristic of intelligence is usually attributed to humans. Agricultural intelligence is one of the multiple intelligences [5]. As discussed in the next section, application of artificial intelligence in agriculture is also regarded as agricultural intelligence.

Agricultural intelligence is used in developing agricultural intelligent decision system, which has a practical significance for guiding agricultural production. Such system takes care of data availability from various resources and provides solution by applying agriculture intelligence.

ARTIFICIAL INTELLIGENCE IN AGRICULTURE

Artificial intelligence (AI) is the branch of computer science that deals with designing intelligent computer systems that mimic human intelligence. It is based on the principle that human intelligence can be defined in a way that a machine can easily mimic it and execute tasks. AI tools include machine learning, deep learning, robots, drones, fuzzy logic, natural language processing, neural networks, and expert systems. Typically, AI systems demonstrate at least some of the following human behaviors: planning, learning, reasoning, problem solving, knowledge representation, perception, speech recognition, decision-making, language translation, motion, manipulation, intelligence, and creativity. The ability of machines to process natural language, to learn, to plan makes it possible for new tasks to be performed by intelligent systems. The main purpose of AI is to mimic the cognitive function of human beings and perform activities that would typically be performed by a human being [6]. AI has penetrated business, healthcare, engineering, education, agriculture, industry, security, military, etc. Today, AI is integrated into our daily lives in several forms, such as personal assistants, automated mass transportation, aviation, computer gaming, facial recognition at passport control, voice recognition on virtual assistants, driverless cars, companion robots, etc.

Artificial intelligence is making a revolution in agriculture by replacing traditional methods with more efficient methods. It tries to simulate human reasoning in intelligent systems. It is making a revolution in agriculture by replacing inefficient traditional methods with more efficient AI-based methods. AI is used in agriculture in various ways such as automation, robots, drones, soil and crop monitoring, and predictive analytics. The agriculture industry is turning to AI technologies to help yield healthier crops, control pests, monitor soil, organize data for farmers, automate farming, etc. [7]. AI tools are also helping farmers in irrigation. Robotic systems offer the potential to reduce costs and increase efficiencies. Robots are used for harvesting. Sensors play an important role in the efficient implementation of irrigation robotics. An agricultural robot is shown in Figure 3[8]. Drones, based on sensors and microcontrollers, are used for crop health monitoring, spraying, irrigation equipment monitoring, weed identification, herd and wildlife monitoring, and disaster management.

AI is transforming agriculture in many ways. Farmers are relying on AI technology in their crop production. Some companies are leveraging computer vision and deep learning algorithms to process the data captured by drones. Machine learning algorithms are used to identify the sense of strengths and weaknesses in soil. Food producers are using AI to sort products and reduce labor [9].

The major factors driving the growth of the AI in agriculture market include [10]:

- the growing demand for agricultural production owing to the increasing population
- rising adoption of information management systems and new advanced technologies for improving crop productivity
- increasing crop productivity by implementing deep learning techniques
- growing initiatives by worldwide governments supporting the adoption of modern agricultural techniques
- crop selection, where AI-based solutions are ideal for selecting crops
- crop monitoring, where data can be collected using technologies like IoT, drones, and satellite imaging, from the fields

The role of AI in the agriculture information management cycle is shown in Figure 4 [11]. AI can provide real-time insights for farmers, allowing them to identify areas that need irrigation, fertilization, or pesticide treatment.

BENEFITS

Farmers continually look to improve efficiency and profitability through cost reduction and obtaining better prices for their produce. Artificial Intelligence has seen a lot of direct application in farming solutions that will enable farmers to do more with less. It can potentially change agricultural practices, enabling farmers to achieve more results with less effort while bringing many other benefits. It also will allow farmers to make necessary changes to grow more food using fewer resources, such as by reducing fertilizer and water use. Technological advances in the use of AI in agriculture are taking place rapidly. AI-based systems are constantly evolving, and its transformational effects will continue to have great impacts on society. Since the lion's share of agriculture processes are manual, automation and robotics in agriculture are emerging across the world to eliminate manual labor.

Other advantages of implementing AI in agriculture include [10]:

- AI provides more efficient ways to produce, harvest, and sell essential crops.
- AI implementation emphasis on checking defective crops and improving the potential for healthy crop production.
- The growth in artificial intelligence technology has strengthened agro-based businesses to run more efficiently.
- AI is being used in applications such as automated machine adjustments for weather forecasting and disease or pest identification.
- Artificial intelligence can improve crop management practices and help many tech businesses invest in algorithms that are becoming useful in agriculture.

AI solutions have the potential to solve the challenges farmers face such as climate variation, an infestation of pests and weeds that reduces yields.

CHALLENGES

Agriculture industry faces major challenges like absence of irrigation system, change in temperature, growing population, density of groundwater, food scarcity, wastage, and substantially more. Labor availability for agriculture is under threat. Agriculture is a risky business due its dependence on the weather [12]. Although different cognitive solutions available in the market for farming, the solutions need to become more affordable to ensure that the technology reaches the masses [9]. New technologies often seem complex, confusing, and expensive because providers fail to clearly explain why their solutions are useful for. AI requires a proper technology infrastructure for it to

work. Even those farms that are already using some technology can find it difficult to change.

II. CONCLUSION

Agriculture, an essential consideration of any nation, faces many challenges. In order for agriculture industry to thrive in the 21st century, we must confront global challenges and complexities. Technology is an integral component of agriculture and technological advances drive the shape of agriculture. It is the solution to agriculture's problems. The future of agriculture lies with advancements in technology. Our farmers of the future should consider using robots, drones, artificial intelligence, and sensors to enhance their production. Global agriculture will benefit from the rapid advance and diffusion of artificial intelligence technologies.

Agricultural intelligence is a relatively new concept. It is poised to push the future of agriculture to the next level. It can change the future of agriculture. More information about agricultural intelligence can be found in the books in [13-15] and the following related journals:

- *Agriculture*
- *Agricultural Systems*
- *Artificial Intelligence in Agriculture*
- *Journal of Advanced Agricultural Technologies*
- *Journal of Agricultural Education.*

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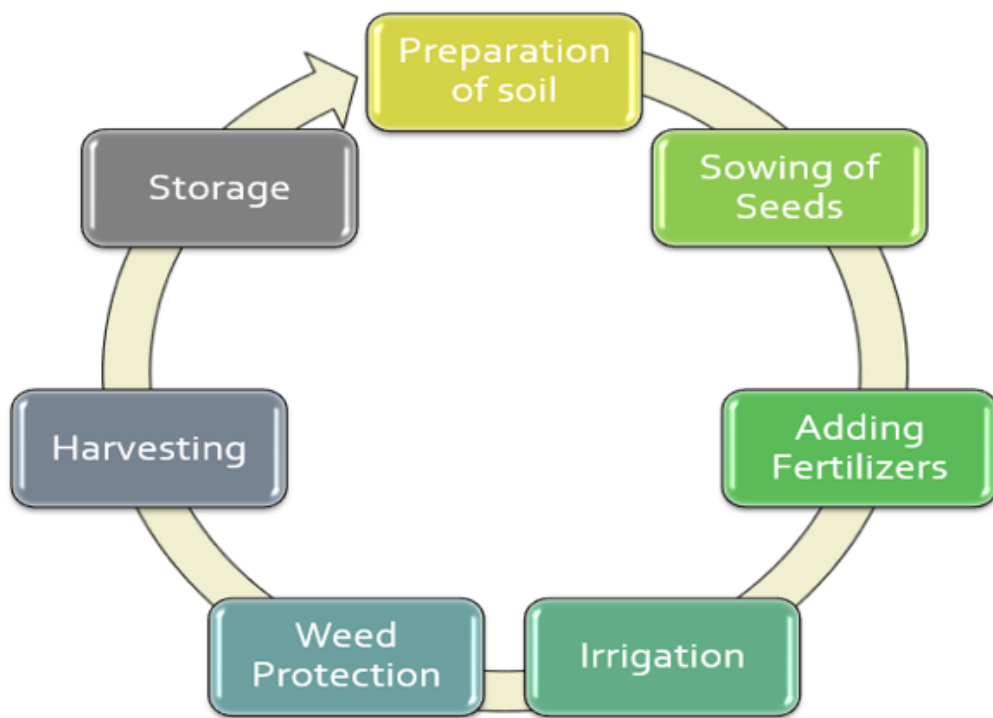


Figure 1 Lifecycle of agriculture [2].

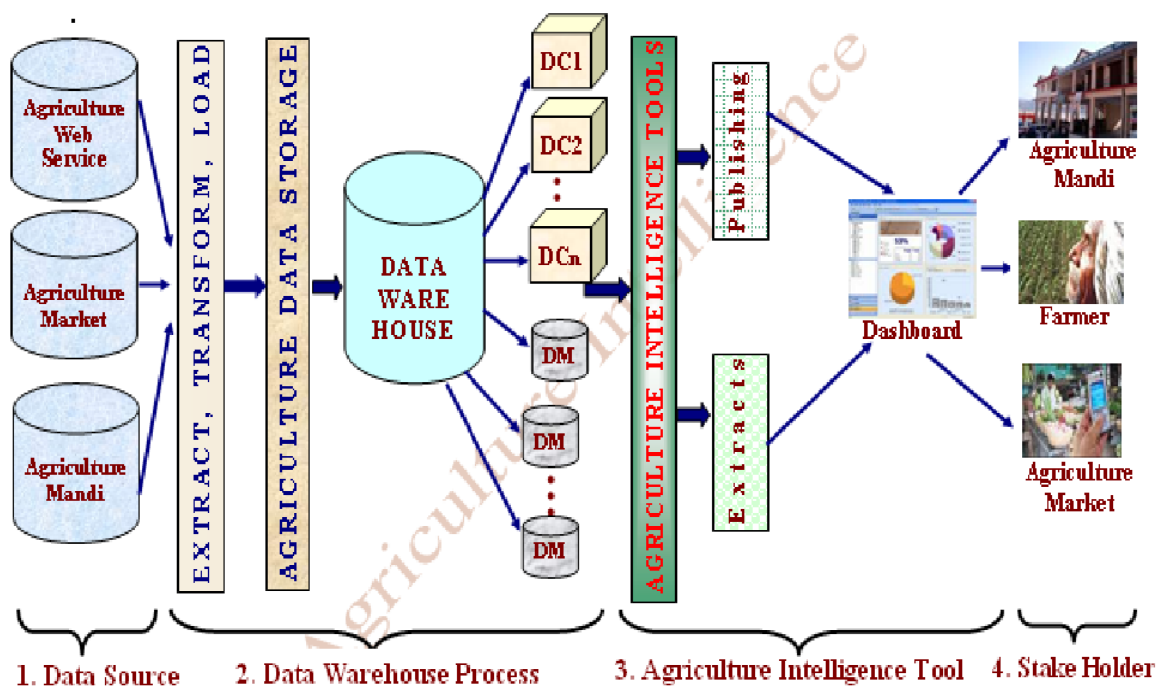


Figure 2 Agriculture intelligence architecture model [4].



Figure 3 Agricultural robot [8].

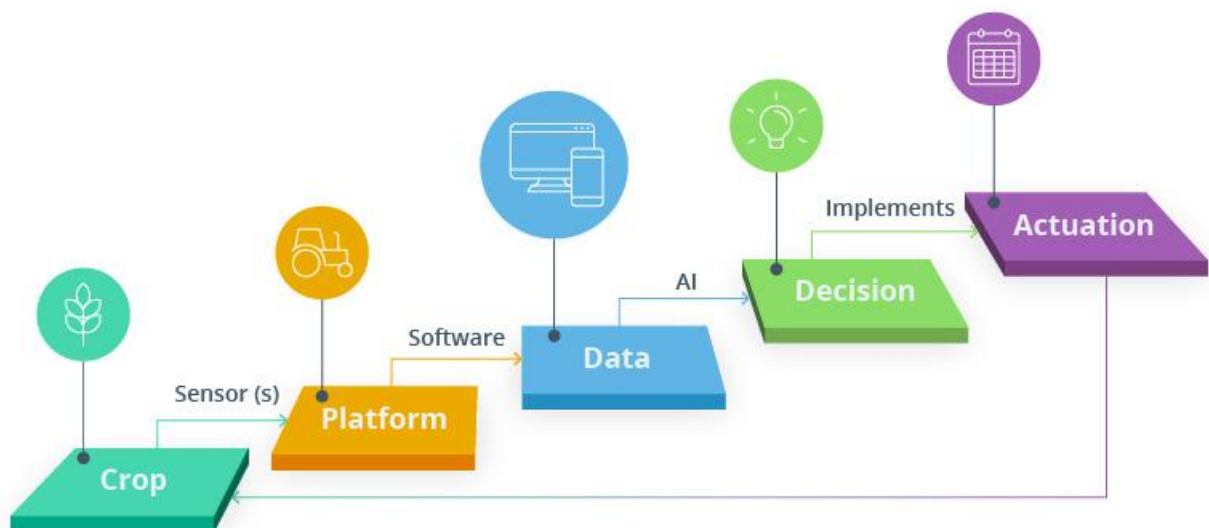


Figure 4 The role of AI in the agriculture information management cycle [11].

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