



Artificial Intelligence as a Tool to Confront the Food Security Challenges that Face the World

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Abstract:

Food shortage is the biggest dilemma facing the world; it has threatened food security in several countries, especially the poor ones, and in the first place the African continent, which, by nature, depends on agriculture as a basic sector to secure its food. This dilemma is due to several besides the undeveloped and traditional local agricultural sector. The present research reasons paper aims to highlight the reasons behind this dilemma and what artificial intelligence can achieve in the field of food provision by developing a reliable agricultural sector.

Keywords: food insecurity, food shortage, artificial intelligence, developing agriculture.

Introduction -1

Food is one of the necessities and basics of life for man and all living creatures; providing it on a daily basis, given the world's lack of its provision, has become like a war. Countries have made achieving food security one of their national priorities and one of the bases of achieving sustainable development for everyone and all generations.

Despite the development the world has witnessed since the Industrial Revolution and its interest in development policies and working to improve the economies of countries to advance development, it has not got rid of the fears of food insecurity. Providing food remains the concern of all countries of the world in the face of the astonishing rise in the population of the planet, and the threat to wealth as a result of several factors, many of which were caused by human behavior and the policies of its government that have exhausted food sources, in addition to climate and environmental problems that have begun to threaten what remains of it, especially in areas that mainly suffer from poverty and scarcity of resources, such as the African continent.

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Technological development today, through artificial intelligence and thanks to automation systems, allows the provision of programs and applications that allow achieving good results with regard to providing food in the agricultural sector and what is related to it. The present research paper aims to highlight the possibilities and ways that artificial intelligence provides to improve agricultural productivity and food quality in a way that ensures the achievement of food security, especially for countries that suffer from severe food shortage.

On the basis of the above, the research problem can be stated as follows:

How can artificial intelligence work on increasing agricultural production of food and confronting the food security dilemmas that many countries in the world suffer from?

To answer the above asked question, it can be hypothesized that the more artificial intelligence methods are applied in the agricultural sector, the more the productivity and quality of agricultural sector's food products will increase. Hence, the following questions are to be asked:

- What is the level of threat to food security in the world in general and in the African continent in particular?
- What are the main causes of food shortage and food security threat?
- What are the potentials of artificial intelligence and the conditions required through it to develop economy and improve productivity?
- How can artificial intelligence develop the agricultural sector and provide food to avoid the food security threat?

The study aims to highlight what artificial intelligence can achieve in the agriculture sector and food provision through a group of elements that should be taken care of, since food shortage raises the fears of many countries, especially with the presence of several reasons that increase the severity of the threat to food security.

The importance of the present study lies in the fact that several political, economic, environmental and human factors threaten to increase the severity of this dilemma, which requires searching for solutions to it. Artificial intelligence allows it to be reduced in a thoughtful way, based on automation in a way that achieves better and higher quality results.

A descriptive approach in studying the situation is used in terms of the size and degree of decline in food security in the world, especially in the African continent, the reasons for that, and the presentation of the means by which artificial intelligence can improve the economy, including food production through developing the agricultural sector.

The topic has been divided as follows:

- 1- Dilemmas of food security and food shortage in the world.



2- Artificial intelligence and its capabilities in developing agriculture and achieving food security.

Conclusion

Dilemmas of Food Security and Food Shortage in the World -2

2-1 Food Security in the World, Africa - the Weak Link

Food security in the world and its provision have become a very worrying matter in a world that is witnessing a record increase in the number of its population. The number of countries suffering from food shortages and food insecurity has reached alarming numbers. The number of people who suffer from food insecurity, moderate or severe, has reached a sharp increase between 2019 and 2020, by about 29.6%, equivalent to 2.4 billion of the world's population. In 2022 it reached 900 million, i.e. 11.3%, the majority of whom are from rural areas and whose size has increased with the Covid-19 pandemic. The African continent is the most affected; as it witnessed an increase in the aforementioned period, compared to the Asian continent, Latin America, and the Caribbean, which witnessed an improvement in the situation.⁽ⁱ⁾

With regard to the situation of the African continent, the causes of its suffering are multiple and relate to the environmental factors that the region is experiencing (drought, desertification, and an increasing shrinkage of arable areas), in addition to irresponsible human behaviors.

This had an impact on the production of agricultural crops and grazing, since agriculture constitutes its primary resource, and since the methods used in the region are still traditional and have poor returns. Studies highlight the inability of African lands, until 2025, to provide foodstuffs except for approximately a quarter of the population. This further deepens the problem of food security, which is already widespread in the region, and threatens to increase the severity of starvation and malnutrition, especially among children.⁽ⁱⁱ⁾

Environmental reasons, therefore, have a significant impact in reality, which has led to a scarcity of the product, together with the government economic policies that do not give much importance to this sector, which still relies on primitive methods to the present day in several regions, as it is primarily directed to family consumption. This essentially requires developing the sector and adopting agricultures that do not require that much irrigation, since the climate in the region is irregular.

While World Resources Institute experts believe that the threat of food shortages is inevitable, as the food gap reaches 50% between the food produced and what humanity needs in 2050, humanity is, accordingly, required to increase



production, but without being accompanied by an increase in the use and depletion of resources and the remaining lands used in agriculture.⁽ⁱⁱⁱ⁾

2-2 Reasons of Food Security Threat in the World

The reasons of food security thread are multiple and intertwined, which has led to the complexity of the situation and the difficulty of confronting food security threats. The reasons are as follows:

- Violent conflicts and all that result of that as losses in human lives, homelessness, disruption of economic activities, including food production, and the resulting difficulties in delivering food and relief to war victims, and the loss of job opportunities and loss of sources that guarantee income for individuals and the disruption of everything that could provide livelihoods for people.
- Food scarcity or the difficulty that individuals may face in obtaining it
- Crises that the economy may experience in some countries, which lead to a deterioration in production
- Drought, floods and other climatic causes
- Deteriorating economic conditions and widespread poverty
- Weakness of economic institutions and their productivity
- The shortage and decline of natural resources and competition over what remains of them
- Bad political conditions, widespread repression and their unjust distribution
- Expansion of the phenomena of migration and exodus.^(iv)

In view of the above reasons, it can be seen that the African continent is the most suffering region in the world from the previous reasons which combine in a way that complicates any process that works to support economic development on the continent, especially the Sahel region, which is known for its political instability, lack of wealth, bad distribution, lack of production, bad climatic conditions, and others.

Artificial Intelligence and its Capabilities in Developing Agriculture and -3 Achieving Food Security

3-1- Artificial Intelligence and its Capabilities in the Economic Sector

3-1-1 The Concept of Artificial Intelligence

Artificial intelligence is a field of computer science that works to solve cognitive problems that usually relate to human intelligence, through which several data are collected from several sources through advanced devices, whether sensors or used in monitoring, or from previous record systems, and through which autonomous systems are formed. It works automatically and draws inferences from



the data it obtains about any new problem presented to it, comparing it to previous recorded data. It provides through that solutions and makes decisions in a way that resembles the human mind.^(v)

Thus, this program becomes an alternative to the thinking and planning of human mind through the information and data it carries that are similar to man's life experiences, from which he learns how to face any problem that confronts him by recalling those experiences and the results he draws from them to solve the new problems that he may face.

3-1-2 Artificial Intelligence and Economic Sector Development

All countries are aware of the role artificial intelligence plays in developing their economies. Developed countries have made strides in integrating it into economic activities compared to less developed countries. All the governments of developing countries need to do is to take necessary measures to correct the delay. Among the elements that the latter must pay attention to in order to achieve that are:

- Providing digital infrastructure
- Competent human capital
- Drawing appropriate policies about the labor market
- Working on encouraging innovation and economic integration
- Regulation and support of ethics in the field ^(vi)

The shift towards artificial intelligence requires a digital infrastructure of a high-quality that needs updating with any development that may occur in this field. The human element must also be trained to use it and to develop its skills to be creative and innovative in this domain to avoid dependency. The labor market also needs appropriate policies that work on employing the required and available capabilities in the field of artificial intelligence. This actually needs study and care for artificial intelligence in itself may lead many institutions to avoid employing humans and leads to the disappearance of many jobs. On the other hand, this sector needs to continuously encourage scientific research and innovation to stay at the level, face competition, and reduce the gap, especially between the leading countries in the sector and the rest of the countries, while encouraging it in all sectors to integrate between them, with the necessity of regulating this field and ethicizing it so that its use will be for the benefit of humans and will not cause harm to man. This can be done by establishing laws that will control it so that it will not get out of control.

The previous elements are important for developing the economic capabilities of any country, which it must achieve as a first step in order for its economy to become more capable of realizing its needs, and thus developing its



people. In view of these elements which developing countries must work on to achieve, it seems that the countries suffering from their traditional economies are required to make efforts in order to become countries seeking to create human capital in artificial intelligence and professions interested in innovating in it. This can be considered as a radical change for some of them, as most of them are more interested in traditional sectors such as agriculture and some related industries (basically semi-manufactured products).

3-1-3 Artificial Intelligence and Productivity Increase

Artificial intelligence develops the economy and increases productivity, which may achieve a surplus in production and enables countries to move towards exports to save income that may contribute to further developing the economy and achieving development for their people.

Artificial intelligence works to advance countries through automation and enabling self-ownership of production systems and self-supply chains. Germany has developed a program that combines machines (robots) and collaboration between the so called “Industry 4.0” and cobotics’, which is an electronic physical system that functions by combining (light) factors and the Internet based on a remote and independent organization on which the production and service chain is based, so that it is interoperable between machines, and is linked to the Internet of services (by virtual processes and cloud computing...), and helps, through artificial intelligence, in reducing operating costs, reducing time, providing a sound work environment and safe workstations. It also helps in reducing side costs (for production, delivery, maintenance, communication, etc.), as it is done remotely, tending towards the zero degree, where it is expected to increase work efficiency in various industrialized countries by a rate ranging between 20% and 40% in the medium term, according to a study conducted by McKinsey in 2018. It is estimated that reducing costs will lead to the increase of economic growth during the year by 0.5% and may reach 1.5% if automation is accompanied by better innovations in work processes.

However, the gains that artificial intelligence may achieve are relative; the results in terms of productivity will not be great, but it still achieves important changes in the field of employment.^(vii)

3-2 Providing Food through an Agricultural Sector based on Artificial Intelligence

The most relied upon sector in food production is the sector of agriculture. Artificial intelligence allows, through several elements, to improve its conditions,



the quantities of its crops and their quality. The following elements represent the most important means through which this can be achieved:

3-2-1 Managing Water and Soil Elements

Food production via agriculture requires a vital element represented by water, which is essential for irrigation and production of agricultural crops and food. To preserve the water element and the accurate management of its use, artificial intelligence plays an important role in that.

Several studies have proved the process of water evaporation, which relies on machine learning algorithms that allow predicting actual evaporation (per day, per week, and per month). Estimating the amount of water evaporation accurately is a complex issue and is of great importance in the process of managing irrigation water used in crop production and in planning irrigation systems, and knowing the appropriate amounts of water for each crop to avoid waste and avoid lack of irrigation. Through an experiment conducted in India that included several meteorological stations, researchers managed to develop a method that enables the calculation of average monthly evaporation in arid and semi-arid regions. This makes it easier to accurately know and predict water evaporation and the quantities that crops need for irrigation. This helps, in case of a high volume of evaporation, to find appropriate solutions to confront the problem.

It should be mentioned that studying the soil element and knowing its characteristics allows researchers to understand how ecosystems work and how they affect agriculture, allowing the prediction of the characteristics of this agricultural soil through estimating the level of its dryness, humidity, and temperature. Estimating soil conditions can contribute to improving its management; soil temperature, for example, helps the researcher analyze the impact of climate change and the environmental conditions of a particular area, as it enables farmers to understand the interactive processes that occur between the earth and the atmosphere. As for humidity, it is an important element in the production process of any crop, since measuring it by the use of traditional manual methods takes time and is expensive.

Using machine learning computation techniques provides the opportunity to achieve that in less time, at a lower cost, and more accurately. A method has been developed that allows prediction of soil condition through comparison to a group of models that enable prediction by comparing the contents of stored soil and the contents of soil in the place of cultivation. Expanding studies allows more accurate results to be provided over time, as the study is still developing its data and increasing its size.^(viii)



It, thus, allows the provision of sufficient amounts or what crops require for their growth and production accurately, whether in terms of the elements that the soil must have in order to be fertile, or the water it needs without wastage, or what it needs in terms of temperature, humidity, etc. What needs to be mentioned is that this issue is still being sought by researchers to increase data collection for more accurate results. The positive result remains that what has been planted will not be damaged due to a lack of provision of requirements, and water and effort will not be wasted.

3-2-2 Rationalizing the Process of Planting and Harvesting

Studies and analyses, and the forecasting capabilities they provide, allow to guide farmers to use optimal methods for more efficient planting and harvesting, higher quality production, less polluting to the environment, and harvesting without waste and with less cost and time. Managing agricultural operations leads to quality production in ways that are less polluting to the environment. It also contributes to the linking of relationships between farmers via computers and smart phones, as it helps in exchanging information, and, hence, gaining and exchanging experiences between them. Modern methods also facilitate the process of monitoring via satellites and analyzing weather data in order to monitor crops.^(ix)

Artificial intelligence contributes to improving the performance of the workers in the sector of agriculture in various activities that relate to agriculture, whether in irrigation, fertilization, or fighting epidemics that may spoil crops. This is done by using drones equipped with sensors hovering over farms to collect data about crops, soil, humidity, and what may affect the crops. This process saves irrigation water and lessens the use of insecticides and protects the environment.^(x)

The above reasons lead, in agriculture, to the improvement of the product quality and provision of farmers with what they need in a previously controlled amount thanks to studying the needs and forecasting productivity. It also helps monitor the process from planting to harvest and enables a better selection of seeds and fertilizers made with techniques and in quantities that minimize pollution. From the above, artificial intelligence allows rationalization of the planting and harvesting process and allows the application of smart agriculture for better results, with the ability to develop and improve.

3-2-3 Protecting the Environment for Sustainable Development

The availability of the necessary data about the environment helps train artificial intelligence systems more effectively. The wide availability of data allows for an increase in the volume of information about the environment and, thus,



taking more effective ways to protect it. The fields in which farmers work help provide information (about humidity, temperature, soil type and its degree of acidity, salinity percentage, etc.). By collecting this information via the Internet, satellites and drones, farms can be monitored over large distances and areas and in record conditions, and the process of obtaining images and comparing them with previous data helps to find out inappropriate and harmful characteristics in crops. There are platforms with good reputation and networks led by innovators that provide images and data for farmers to rely on.^(xi)

The above allows farmers to be guided and have expertise based on accurate scientific foundations thanks to artificial intelligence. Rather, it helps them know the reasons for poor results in productivity and crop quality. This is done by looking at the crop and comparing it with images and data of good crops that have been reached through the results of studies and data available thanks to artificial intelligence, including correcting subsequent crops and avoiding errors, which ultimately enables the farmer to gain experience. In the end, even if the farmer benefits from improving the quality and quantities of his crops, the first beneficiary is the environment, which will avoid the substances causing its pollution, which are the result of farmers' excessive use of materials and pesticides inaccurately. This will ultimately preserve the rights of every generation to obtain development and the right to a pure and sound environment with the continued safety of its elements.

3-2-4 Reducing the Waste of Food Products

What most threatens food security is the waste of materials, especially when countries suffer from their shortages and sometimes from their scarcity due to their limited capabilities to produce them, whether due to their limited economic capabilities or their traditional methods that lead to little production, or due to their harsh environmental and climate conditions that hinder agriculture.

Artificial intelligence appears as a savior in front of food waste, as it allows providing a solution by predicting the surplus production that agriculture may achieve and managing it well through the various stages of the supply chain. This is done through algorithms that analyze the available data and work through it to predict the demand of various merchants, producers, and consumers (restaurants), anticipating the fluctuations that may occur, and planning accordingly for the storage process, which will thus result in reducing the risks they may face regarding the matter of surplus. Artificial intelligence even allows for monitoring the expiry date, and more than that, it provides solutions by suggesting what dishes can be prepared to use the product before that date. On the



other hand, it contributes to educating the consumer and helps teach him to manage his consumption and become more responsible and contributes to preserving food from waste and working on its sustainability.^(xii)

The main problem with food is not its scarcity, but rather in its management; food may be available to some people but not others. The party in which food is available does not realize its value and wastes it, while the party that suffers from its shortage, as in poor countries, managing it is the best way to ensure that everyone gets it in equal shares. Artificial intelligence provides the opportunity to improve the management of food distribution and provision, and can inform us of the places that know of a surplus of it and those that suffer from a shortage of it, and thus opening an opportunity to export it to the latter, which will reduce the food gap.

3-2-5 Towards better Food Quality

The use of artificial intelligence not only improves productivity and production and reduces the pests facing it, but also guarantees a better quality product; it not only provides food, but seeks to improve its quality.

Through artificial intelligence via the system known as genetic modification, scientists are seeking to develop seeds in a way that makes them more resistant to the climate and more able to achieve higher crop yields, but by exploiting fewer resources. This method makes crops less water-consuming and more resistant to drought.^(xiii)

It also allows the development of the quality of the product through automation – through the automation of greenhouses for agriculture – during which the appropriate conditions and climate are provided inside the greenhouses, where sensors are used that monitor the development of plants via the computer to monitor their nutrition and safety and measure their needs for heat, humidity, and other conditions for their growth.^(xiv)

3-2-6 Reducing the Impact of Climate Problems

There is no doubt that the changes that occur in the climate increase the anxiety of investors and farmers working in agriculture, especially owners of small properties, which threaten the source of their livelihood.

Weather fluctuations, decrease in rainfall amounts, changing seasons, high temperatures, and extreme climate phenomena, such as floods and others result in a decrease in crop production and yields, including food shortages. Artificial intelligence allows farmers to establish more efficient agriculture based



on studied data instead of traditional methods of facing climate change and resource scarcity.^(xv)

This technique allows studying the needs of crops without any waste and with acceptable characteristics. Protected agriculture also allows that by providing conditions, as it monitors and preserves crops, and provides them with what they need. As a result, it will enable areas that suffer from a productivity deficit to provide products and crops of good quality, without such losses as those resulting from crops in areas that suffer from fluctuations in climate or drought.

The expansion of the use of these techniques should be encouraged, especially in areas with limited capabilities, poor, and isolated areas (rural ones), whose nature is rugged, low standards of living, and far from urban areas, which are more affected by climate change than others. This is because their situation is considered to be difficult, even without climate problems. These areas are known for their practice of agriculture and grazing, and thanks to artificial intelligence, they can improve their productivity, confront poverty, and achieve food sufficiency.

3-2-7 Food that can be Stored for a Longer Period

An artificial intelligence program is being developed that contains several chemical reactions for more than a million food components, with the need to update it with all new reactions, through which artificial intelligence can detect the contents of food, any food mixture and combination, and their interactions. This is a method that enables scientists to develop capabilities that help, through artificial intelligence, preserve food for a longer period.^(xvi)

This method allows countries that cannot provide food or do not guarantee its provision in the future or want to preserve it for a longer period to confront crises that may be caused by, such as climate problems (fluctuating and irregular precipitation and harsh climate). This method will allow them, in the case of local food production, to develop these methods to produce food with a longer lifespan. If imported, they require foodstuffs that have been developed using the previous method to ensure they will not spoil during storage, their longevity, and that they are not subject to spoilage. This, thus, avoids the crises of food shortage and guarantees achieving food security for longer periods.

3-2-8 Protecting Farmers Investing in Agriculture regarding Financial Problems through Advance Estimation and Minimizing Losses

Thanks to artificial intelligence, large investor farmers who rely on bank loans to finance their investment can be tracked to know the condition of their



products, and estimate potentials and losses in case of bad seasons. This makes banks aware of their situation, predict their incomes and be able to assess the risks they may face and take them into consideration if they request a loan or insurance.^(xvii)

4 – Conclusion

The results obtained through the present research paper is that the problem of achieving food security is a problem that faces the whole world, especially poor countries. This requires taking the necessary measures to confront it. Although there are many reasons that led several countries to suffer from food shortage and its expansion, including political, economic, environmental, human and other reasons, what has been reached is that applying artificial intelligence techniques in the agricultural sector, which is the first and even the primary source of food in the world, is the most appropriate way to provide guaranteed production and relatively greater productivity with better quality and the possibility of storing in better conditions and for a longer period. However, the countries concerned with this problem must provide an advanced digital infrastructure, high-level human resources, and develop open policies in the field of the labor market, with the need to moralize this field so that it does not get out of control and exceed the limits of individual personal rights.

Bibliography List :

- ⁽ⁱ⁾ Food and Agriculture Organization of the United Nations, **Report on the challenges and drivers of global food security**, Rome, December 2023, p. 3.
- ⁽ⁱⁱ⁾ Hamoum F, "Environmental Problems and Development in the African Sahel: Encouragement for Illegal Migration," *Algerian Journal of Social and Human Sciences*, Volume 5, Issue 1, June 2021, pp. 53. (45-59)
- ⁽ⁱⁱⁱ⁾ Schoenberg T, "Food Security Is the Solution in Artificial Intelligence and Genome Editing," DW Center, July 23, 2023, from <https://2u.pw/nrHS7UnK>, Accessed April 16, 2024, at 12:53.
- ^(iv) "Confronting Common Risk Factors between Conflict and Food Insecurity," from <https://www.fao.org/3/y7352a/y7352a08.htm>, Accessed April 19, 2024, at 12:53.
- ^(v) "What is Artificial Intelligence?" DW Center, July 23, 2023, from <https://aws.amazon.com/ar/what-is/artificial-intelligence/>, accessed April 19, 2024, at 10:05.
- ^(vi) GIORGIEVA K, « Artificial Intelligence will transform the global economy making sure that humanity wins » January 14, from <http://2u.pw/v8tLxJh>, accessed April 18, 2024, at 15:48.
- ^(vii) GIORGIEVA K, « Artificial Intelligence will transform the global economy making sure that humanity wins » January 14, from <http://2u.pw/v8tLxJh>, accessed April 18, 2024, at 15:48.
- ^(viii) Fakihi A , "Artificial Intelligence in Facing Food Security Challenges3," *Gulf News Daily*, Bahrain, April 23, 2023, from <https://akhbar-alkhaleej.com/news/article/1328984?trk=article-ssr-frontend-pulse-little-text-block>, accessed 16 April 2024, at 16:30.
- ^(ix) Sayari N, Jabali H, "Smart agriculture is the bet of the future towards developing agriculture and enhancing food security - challenges and prospects," *Al-Basaer Journal for Research in Economic, Commercial, and Management Sciences*, Volume 2, Issue 1, June 2023, pp. 31. (27-48)



- (x) BOURGETV, "Food Security and Artificial Intelligence: Feed the world with technology" April 15, 2024, from <https://www.linkedin.com/pulse/s%C3%A9curit%C3%A9-alimentaire-et-ia-nourrir-le-monde-avec-la-bourget--gzdve>, accessed April 17, 2024, at 15:48.
- (xi) "Artificial Intelligence in Agriculture and the Environment, Intelligence Center, from <https://thakaa.sa/library/articles/ai-in-agriculture>, accessed April 17, 2024, at 09:30.
- (xii) P, KEATS, "Artificial intelligence in food and nutrition: Culinary development in courses"; ONOPIA, January 31, 2024, from <https://2u.pw/ctXmMpvL>, accessed April 17, 2024, at 10:53.
- (xiii) Tim Schoenberg, op. cit.
- (xiv) "Automation of agricultural greenhouses," Intelligence Center, from <https://thakaa.sa/challenges/opportunities/agriculturalreserve>, accessed April 18, 2024, at 09:30.
- (xv) K MARDELLI, "World Food Forum: artificial intelligence and digital tools, powerful allies to build climate-resilient agri-food systems », FAO, 10/19/2023, from <https://2u.pw/S8hIFlCb>, accessed April 17, 2024, at 15:13.
- (xvi) Hazem Badr, "Artificial Intelligence helps extend the life of food products," Al Jazeera Center, 10/24/2023, from <https://2u.pw/gpe2zhHF> on access date, April 16, 2024, at 12:31.
- (xvii) M, KOUAMIE, « Security alimentation. L'IA, L'Agriculture et les finances: a convergence prometteuse », Les ECO, 11/14/2023, in <https://leseco.ma/business/securite-alimentaire-lia-lagriculture-et-les-finances-une-convergence-prometteuse.html>, on April 17, 2024, at 16:05