



Requirements for Smart Agriculture Success in the Fourth Industrial Revolution - Model Experiences-

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Received: 21/02/2025	Accepted: 06/04/2025	Published: 30/06/2025
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Abstract:

The study aims to analyze the most important aspects of the digital transformation that agriculture has experienced, in the modes and methods of production, management and storage, in the sense of integration and use of the results of the fourth industrial revolution related to digital technology, and remote control, in order to achieve development goals and access sustainable smart agriculture.

The study concluded building on the analytical approach a set of findings, the most important of which highlights the need for countries to embrace the concept of transition and transformation towards smart agriculture and adopt it as a strategic vision that responds to the challenges of preserving the environment , ensuring food security and eliminating hunger and malnutrition.

Keywords: smart agriculture, fourth industrial revolution, digital technology.

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1. INTRODUCTION:

Our world is now living in the era of the Fourth Industrial Revolution, which is based on the achievements of the Third Industrial Revolution, especially with regard to the unprecedented development of communication networks and information technologies. Just as the First Industrial Revolution used water and steam to move machines, where it developed the steam engine, and the Second Industrial Revolution used electrical energy for large-scale production, where the main technological developments during this period included the telephone, the electric light bulb, and the internal combustion engine, and the Third Industrial Revolution focused on the use of electronics and information technologies to automate production, where it focused on the simple digital revolution, and the developments that occurred during this period included the personal computer, the Internet, and information and communications technology, while the Fourth Industrial Revolution is based on the creative digital revolution and technological progress with the aim of crystallizing an economic model based on new concepts and trends in resource management, wealth creation, and environmental conservation, which overturned previous traditional concepts and practices in favor of a rapidly changing virtual digital economy based on new inputs based on knowledge. Information technology, communication, information technology and the Internet have invaded various aspects of life, and the development witnessed by the world today is often attributed to the ability of each country to generate and manage knowledge. Knowledge accumulation, artificial intelligence, technological development and technical innovation have become key words for what has become known as the Fourth Industrial Revolution, which, thanks to the digital transformation of the economy, has opened up broad horizons and possibilities for developing broad areas in industrial, agricultural and service activities and everything related to improving the quality of life within the goals of sustainable development, by maximizing opportunities for value creation, increasing productivity and optimal utilization of available resources to improve the well-being of society and solve the problems that hinder its development. Thanks to innovative digital devices and technologies in the fields of artificial intelligence, robotics, the Internet, software, nanotechnology, biotechnology, etc.

This contributes to adopting smart agricultural practices and thus bridging the food gap resulting from population growth and scarcity of resources, considering that agricultural research is a thousand-mile step towards food security.

1.1. Statement of the Problem:

The study focused on analyzing the various aspects of the following problem:

What are the motives and opportunities for the application and success of smart agriculture in light of the trends of the Fourth Industrial Revolution? What are the most important global and Arab smart agriculture and what are

the most important requirements for its success to achieve sustainable development?

1.2. Hypotheses:

To answer the question raised, we decided to put forward the following hypotheses:

The outputs of the Fourth Industrial Revolution represent essential inputs for the development of smart agriculture;

Increasing productivity and achieving food security are the primary goals of developing smart agriculture;

- Benefiting from successful experiences in the field of smart agriculture is the main key to its advancement. - The future success of smart agriculture is linked to the infrastructure and human resource qualification that are requirements for its success.

1.3. Study objectives:

This research paper aims to study the Fourth Industrial Revolution and the motives for the shift towards smart agriculture as a newly used approach in the field of agriculture and to attempt to analyze the impact of the ongoing digital transformations in enhancing the opportunities for developing smart agriculture and its importance and role in responding to the challenges of achieving food security and increasing productivity by improving decision-making methods, providing infrastructure and qualifying human resources for sustainable development. And to present the most important global and Arab experiences in smart agriculture in order to know the requirements for its success.

1.4. Study methodology:

In order to be able to answer the raised problem and discuss the hypotheses presented in order to reach the desired goals, we relied on the descriptive analytical approach that is compatible with the nature of the subject in presenting and analyzing the various aspects of the study, through the definitions provided for the Fourth Industrial Revolution and the motives for the shift towards smart agriculture, and the principles of smart agriculture. We also relied on the case study method by addressing the most important global and Arab experiences of smart agriculture.

2. Fourth Industrial Revolution Motivations for the shift towards smart agriculture

Given the climate changes that nature is experiencing, which have affected agricultural crops, and the increase in the population of the Earth, the challenge for governments and countries has become to provide food, but in a new way that eliminates the problems on the ground, and smart agriculture is among the ways that can achieve this.

2.1 Smart agriculture concept

Smart agriculture is a modern system based on the adoption of advanced technology in food cultivation in ways different from those known to man in traditional agriculture. It also contributes to the economy and rationalization of the use of natural resources, especially water. One of its most prominent features is its reliance on information management and analysis systems to make the best possible production decisions, at the lowest costs, as well as the automation of agricultural operations such as irrigation, pest control, soil monitoring, and crop monitoring. (Al-Yaqoubi., 2022)

Smart agriculture is a new concept that refers to the use of the technology of the Fourth Industrial Revolution and modern information and communication technologies in farm management with the aim of improving the quality and quantity of production and raising the efficiency of agricultural resource management and rationalizing their use. Therefore, smart agriculture is known as the third green revolution after the plant breeding and genetics revolution. The smart agriculture system relies on the use of modern technologies such as remote sensing devices, geographic information systems, the Internet of Things, drones, artificial intelligence, and data analysis and processing systems in order to raise the efficiency of farm management, starting from land leveling, through seed placement, irrigation, fertilization, pest and disease control, and up to the final product. Smart agriculture technologies allow monitoring crop growth, identifying pests and diseases before they spread, determining the amount of fertilizers and pesticides required, and the appropriate time to apply them to the crop, as well as the appropriate dates for irrigation and the amounts of water required for each plant. This undoubtedly achieves the concept of high efficiency in farm management by making the right decision at the right time, which in turn positively reflects on production and quality, maintains soil fertility, and reduces costs. (Mohammed, 2022)

2.2 The importance of smart agriculture is a necessity at the present time

With the world's population continuing to grow, it is expected that the world's population will exceed 9.7 billion people by 2050, concerns are increasing about providing food and achieving food security for the Earth's population, and preserving arable land, especially with the worsening problems of climate change, depletion of oil resources, and pollution of water and soil. To keep up with these developments, farmers must: (Aisha, 2020)

- Use natural resources wisely.
- The inability of traditional farming methods to cope with climatic conditions.

In the face of this challenge, modifying agricultural activity to adapt to climate change has become an urgent necessity, which must go hand in hand with diversification processes in production sources, by employing advanced agricultural technologies and innovative artificial intelligence solutions such as "Internet of Things" applications that have become adopted by farmers in rich countries. (opcit,

s.d.) Agriculture must play its role in responding to the challenges of sustainable development, which are mainly related to the need to increase food production.60% of its previous levels to meet the additional needs of food demand in terms of quantity and quality, and ensure food security for all, taking into account the sustainable management of natural resources (water, energy resources, arable land), in addition to creating jobs, improving income, eliminating poverty and achieving economic growth, especially in isolated rural areas, at a time when agriculture has moved from the traditional approach to the intensive use of knowledge, technology and smart production methods that rely more on creativity and innovation.

However, family farming remains the dominant form of agriculture in most parts of the world, with more than 570 million farms in the world, of which more than 500 million are small family farms, are responsible for at least 56% of global agricultural production. (Nation, 2017) Some experts believe that most of the increase in food and animal production should occur in developing countries that suffer from major problems of food shortages, poverty, hunger and the spread of diseases resulting from malnutrition. It will be necessary to achieve a doubling of current agricultural crops and cultivated areas in the hope of meeting the increase in the population's food needs, especially with the increase in demand for proteins, as consumption has been 225 million tonnes of meat worldwide, a 3% increase in total in 2014 compared to 2013. (ISAAC, 2015)

India for example has consumed 50% more meat in 2014 than in 2009. However, to produce one kilogram of meat, we need 7 kilograms of grain. (opcit I. H.).

The second major challenge for agriculture is related to its relationship with its environment. Agriculture must be more economical in its exploitation of natural resources and more respectful of environmental conservation standards. Agriculture and livestock are now largely involved in environmental degradation because they are responsible for Deforestation, chemical fertilizers, fossil fuels, ruminant digestion and tillage account for 24% of greenhouse gas emissions, consume 70% of fresh water and have caused a 60% loss of vertebrate biodiversity since the 1970s. The cost of these negative externalities is \$12 trillion, according to the Food and Land Use Coalition, which exceeds the market value of \$10 trillion. (Bank, 2020).

In general, the entire agri-food chain, including the manufacturing of raw materials, the processing of products, their transportation and marketing until consumption, is responsible for 30% of global energy consumption.

On the other hand, farmers are not only responsible for environmental degradation; they are the first victims of climate change, drought, floods and the spread of serious diseases that affect their crops and bodies. Thus, on a global level, climate change will cause agricultural yields to decrease by 2% per decade on average.

In light of all this, farmers are striving to achieve safety standards and preserve the environment by establishing more environmentally friendly means of production and

distribution, within the concept and goals of sustainable development. (Lewis, 2017, p. 17).

Another challenge facing agriculture is its declining profitability, which has become fluctuating between the high cost of equipment and seeds, loan interest, market pressures, and the intervention of intermediaries that affect the decline and fluctuation of prices as a result of farmers' lack of control over the distribution and marketing chain, which has reduced farmers' profits and their ability to finance and expand their investments and ensure a good relationship with financial institutions and stakeholders.

In addition, millions of small farmers around the world face constraints to developing their activities, such as poor access to markets and financial services, low levels of human and physical capital and skills, and poor control over information technology, the use of which has become a basic priority to keep pace with the requirements of communication with the various elements of the environment related to agriculture.

Farmers' information needs will increase in both developing and developed countries as they have to make more and more complex decisions about how to manage their activities and use their land, what crops to produce and how to produce them, and the markets in which to buy and market their inputs and outputs, decisions that also include choices about how to finance their businesses and reduce the risks that continually hinder their business development.

If we want to achieve a world free of hunger by the year 2030, in line with the UN Sustainable Development Goals, new agricultural systems must be developed that are more productive, efficient, sustainable, inclusive, transparent and resilient.

To achieve this goal, it is necessary to urgently transform current food and agricultural systems towards embracing the Fourth Industrial Revolution, because today's and tomorrow's agriculture must produce more and better while improving its economic, social and environmental performance. (Riad, 2020, p. 916).

2.3 Principles of Smart Agriculture

Smart agriculture contributes to achieving food security and ensuring its sustainability through the principles on which it is based, which are as follows: (Ben Shaa Nadia, 2023, p. 225)

- Environmental conservation and protection: through better management of natural resources, through sustainable use of resources, improving land and water sustainability, through techniques that reduce the use of chemicals, improve land mapping and enhance water management.
- Improving productivity: This applies to on-farm productivity in terms of yield, as well as increasing the efficiency of asset management.
- Promoting innovation in the agricultural sector: Smart agriculture technologies allow for the adoption of innovative production methods in the animal and plant sectors, and at various stages of production; from the farm to the market

- Attracting new investments: Given the natural diversity and dry climate in most Arab countries, which in turn will encourage investors to resort to new agricultural technologies in difficult and harsh environments.
- Creating green jobs: Allows for the possibility of adapting to climate change and reducing greenhouse gas emissions.
- Reducing the phenomenon of hunger and poverty: By increasing production and improving the quality of agricultural crops.
- Converting animal waste into biogas: an alternative and renewable source of energy
- Creating climate-resilient fisheries and aquaculture: through storm-resistant fish cages and ponds, and adaptive fisheries management.
- Increased revenues: Value chain transparency will raise the standard of trust in food safety with traceability, leading to increased market value.
- Job creation: New jobs will be created as new entrepreneurs and players join the relatively new smart agriculture sector.
- The dual role of smart agriculture: Smart agriculture plays a dual role in reducing climate change and achieving food sustainability.

3. ICT and accelerating the digital transformation of agriculture

The rapid development of technology and digital technologies has contributed to a real agricultural revolution led by digital technology in the agriculture and food production sector, which has opened up broad horizons for countries and farmers to change production and distribution methods, increase productivity, control costs, and maximize valuation and contracting opportunities, thanks to the expansion of the use of mobile digital technologies, remote sensing services, computing, and innovative applications, which have opened up greater opportunities to employ the Internet and software to access information, inputs, and markets.

Today's digital technologies are driving change on multiple fronts at an accelerating rate by collecting, using and analyzing vast amounts of machine-readable data on virtually every aspect of the food system at near-zero marginal cost. Digital platforms from Alibaba to YouTube are disrupting traditional business models at a systemic level, and venture capital firms have also injected \$2.8 billion in agtech startups worldwide in 2019 (Agriculture, 2016).

Thus, increasing production and productivity, simplifying supply chains and reducing operational costs, leading to adapting the agricultural sector to the outcomes of the Fourth Industrial Revolution and qualifying it to face the challenges facing it in terms of securing food, increasing productivity and optimally utilizing available resources to achieve sustainable development goals.

This technology now makes it possible to collect and analyze data on rainfall, wind speed, humidity and all the vital climatic indicators needed by the farmer to ensure autonomous management and efficient harvesting, in a timely and simple way.

The Internet allows farmers to meet the challenge of making the right decisions, reducing costs and increasing productivity. We are no longer talking about a simple

random distribution of fertilizers and irrigation, but about opportunities to rationalize the use of available resources through the process of analysis, control and remote monitoring, which ensures improved irrigation of plots, maintenance of agricultural machinery, and sound management of climate change risks and variability and raw material costs.

New technologies will allow for an increase in the number of sensors and facilitate data transfer and processing. There will be more and more fixed, stand-alone sensors installed such as hygrometers or temperature sensors, and others mounted on animals such as pedometers and accelerometers. Some can be placed inside the animal's body such as rumen thermometers or vaginal probes. We will see the development of mobile sensors on board machines, and others measuring in real time the biophysical parameters of crops such as sugar levels, water shortages. (OCDE, 2021)

Digital technology will allow for increased accuracy of technical interventions, through data processing, prediction, simulation and insurance against risks and diseases that may affect crops.

Robots will also be able to perform precise tasks such as spraying pesticides, removing weeds, and herding animals, for example.

3.1 Digital technology and accelerating the digital transformation of agriculture

Rapid innovations in digital technology have opened up great opportunities for the expansion and development of the agriculture and food sectors around the world. Multinational ICT companies provide individuals, governments, farmers, large machinery manufacturers, small and medium farm input suppliers, and even consumers with innovative digital services and applications in countless fields, particularly related to the collection, analysis, and exchange of information by creating a virtual world that brings together these various parties thanks to public and private digital platforms specialized in providing advice, support, qualification, transfer of knowledge and expertise, and facilitating the communication process between the various parties with each other at much lower costs than before. Thus, digital technologies enhance efficiency and inclusiveness, as many tasks can be carried out at low costs and many services can reach people who previously lacked them, especially in poor areas of developing countries.

Adopting the digital transformation in agriculture will allow us to identify and implement the best technical intervention in the right place and time, facilitating timely prediction and accuracy, whether the process is related to the land, the animal or the material means of production. For example, we can automatically adjust the doses of herbicides and the allocations of irrigation water within the plot according to the needs of the soil and the yields of the previous year. We will know how to automatically adjust food rations for each animal. It will also be possible to organize the equipment according to the evolution of the environment in which the farmer works, which will

lead to better technical efficiency and performance and reduce costs and environmental impact. (Huet, 2019).

3.1.1 Digital communication platforms and opportunities for agricultural development in developing countries

Digital platforms can help deconcentrate and increase the number of markets up and down the food system, leading to better outcomes at both ends of the supply chain. A study comparing transaction data from a digital platform that auctions physical goods weekly with farm gate prices in coffee-producing regions of India found that producers received higher prices when they sold the commodity through the digital platform rather than at the farm gate via brokers. (Elba, 2022).

The company announced US-based Microsoft, through its Afrika4 initiative, on September 22, 2020 signed a new partnership agreement with AGRA (Alliance for a Green Revolution in Africa, an agricultural products organization) aimed at co-creating technological solutions that will improve food security for 30 million farming households in 11 countries in Africa, including Nigeria, Rwanda, Ghana, Tanzania, Uganda and Malawi by 2021.

The new agreement between Microsoft and AGRA are a result of the success of a previous agreement signed at the Africa Green Revolution Forum (AGRF) held in September 2019 in Ghana that allowed, in collaboration with the Kenyan Ministry of Agriculture, to develop the Kuza Bot chatbot to support the Village Advisors and Farmers Programmer.

According to the regional director of the initiative, this collaboration will contribute to the creation of “locally relevant technological solutions that take into account the challenges faced by local farmers, and provide solutions for farmers and policy makers to make a significant impact on agricultural land productivity and improve production methods.” (Ministère de l'Agriculture, 2018).

In developing countries, ICT applications are critical in reducing information costs and coordinating between farmers and their front- and back-end markets. The spread of mobile phones in rural areas has already brought significant changes to the agricultural sector, enhancing market access, facilitating financial inclusion and risk management, contributing significantly to early warning, and could be pivotal in revolutionizing agricultural extension.

A growing body of evidence suggests that in many circumstances, ICTs, specifically mobile phones, are believed to increase access to information and capacity building for rural people in developing countries. In rural Niger, agricultural price information obtained through mobile phones reduces search costs by 50%.

In Senegal, the website facilitates access to information on climate change adaptation for vulnerable communities. It supports a community of practice where members can share updates on their work and adaptation techniques.

Lack of access to an organized market forces smallholder farmers in Ghana to sell to middlemen who buy at ridiculously exploitative prices, thanks to a company AgroCenta Startup Ghanaian farmers are increasingly using digital technology to sell their produce. The startup is improving the agricultural value chain in Ghana, by solving two critical problems facing small rural farmers: access to markets and access to finance.

Platforms work Agro Trade and AgroPay solve both of these problems, as AgroTrade is a trade supply chain platform that farmers can use to access the market. AgroPay, a financial inclusion platform, provides any small farmer trading on AgroTrade with a bank statement that they can use to access financing.

Digital technologies in agriculture have enormous potential to change the current information gap in the agricultural sector in Ghana and increase the productivity of farming systems. With the advancement of digital technology in Ghana, the infrastructure constraints in agriculture have been greatly reduced.

Through innovation and investment, agriculture in Ghana can transform productivity, profitability and climate resilience into a force not only for feeding people but also for creating jobs.

3.1.2 Digital communication platforms and opportunities for agricultural development in developed countries

In developed countries, large agribusinesses, through their digital platforms, provide a wealth of information to their customers about agricultural technologies. On the demand side, e-commerce platforms connect farmers directly to the food manufacturing and retail stages of the value chain.

Specialized digital platforms have also allowed the concept of the collaborative economy to be widely exploited among farmers. Digital communication sites have emerged between farmers in recent years to facilitate access to certain agricultural tools or services. In France, for example, to share agricultural machinery with others, you can refer to WeFarmUp or YourMachine.com, while to find people capable of doing agricultural work, you can go to LinkinFarm, and to connect farmers with each other, there is also Farmr, a professional social network between farmers, and to finance its projects, Miimosa has launched a crowdfunding platform for projects around agriculture, on the same concept as Kickstarter, but with the addition of a loan feature for farmers so that individuals have the opportunity to finance their agricultural investments (Nations, 2019)

Digital technology makes it possible to ensure traceability of a product once it is finished, as consumers increasingly want transparency about the products they buy, this is impacting the way farmers have to manage their inventory, solutions that use Blockchain is emerging in order to track the entire production from the field to the consumer's plate and is a kind of record book that allows access to all information related to the production of the commodity.

This kind of demand for more transparency is often initiated by major agri-food industry leaders such as Carrefour, which has collaborated with IBM since 2018 (Numbers for irrigation efficiency, agriculture and innovation, 2021).

Many agricultural markets have emerged in recent years such as: Amazon for the general public, these sites allow you to purchase products and tools needed for agricultural activities online.

I achieved Agriconomie is one of the leading companies in France with more than 45,000 customers and has achieved great success, thanks to its transparency in the prices charged.

To face the competition, launchIn Vivo, the largest French cooperative federation, recently launched an online sales platform for farmers called Aladin farm, with an initial budget of €70 million over 3 years.

In addition to production, digital solutions are also available for farmers to resell their crops, for example, the startup offers Perfarmer is a tool to monitor the price of agricultural production and sell it at the best time. Agricole Comparateur offers a hybrid service between the sale of raw materials online and information on the price of agricultural production.

3.2 Digital technology and the establishment of new models for agriculture

Many farmers in various developing and developed countries are increasingly using digital technologies such as smartphones, tablets, on-site sensors, drones and satellites; these technologies offer a range of agricultural solutions such as remote measurement of soil conditions, better management of irrigation water, and monitoring of crops and livestock. By analyzing the data collected, farmers can better anticipate potential developments in terms of making sound decisions based on the analysis of the development of information related to agricultural and livestock activities.

Potential benefits of using digital technology could include better performance of tasks and production factors, which would increase crop and animal productivity, optimize input utilization, and reduce costs, which would allow for increased profitability rates for agricultural projects. (opcit, s.d.).

Digital technology can also improve farmers' working conditions and reduce the environmental impact of agriculture.

Often especially on large farms there is an increasing use of solutions that allow the operator not to travel and work remotely so the use of drones to control farms and collect data has started by startups such as Wefly Agri, Aeromapper, Airinov all offer drone services.

Some companies also offer machines capable of processing plants directly, such as: CDSI has developed a drone dedicated to plant health treatment and local eradication of pine caterpillars.

For breeders it is also possible to equip their animals with sensors, for example the company French startup LITUUS equips animals with connected collars to analyze their health problems and improve the animals' overall well-being.

In Texas, USA, cows are being fitted with chips to understand their eating habits and sleeping patterns and link this data to milk production rates.

In Russia, they even tried to make cows wear virtual reality helmets to please them, and in England, they were equipped with 50 cows with 5G collars to make it easier for them to move around the farm.

Moving towards the generalization of the farm mechanism model and the performance of agricultural activities in its various forms to reduce the costs of incomplete and unskilled manual labor to enhance efficiency in France, the company has collected NeoFarm raised €1 million in 2019 by implementing the concept of an automated farm, IronOx in the US has already launched a concept for a fully hydroponic automated lettuce farm, and in the Netherlands they are testing fully automated dairy farms. (Agriculture S. , 2020).

In addition to automated farms, increasingly efficient agricultural machines have been created to carry out daily operations, such as smart tractors that will be able to map the entire terrain and in turn collect data and choose the best strategy to adopt.

The brand has acquired John Deere, a leading agricultural equipment manufacturer, recently acquired Blue River Technology, which allows it to use See and Spray technology to automate field work and save up to 90 percent on chemical use.

There are also many innovative experiments in Australia, with SwarmFarm Robotics in particular, which offers an autonomous machine capable of weeding, mowing and even seeding. More and more smart digital machines are being introduced, such as Kubota's X-Tractor, which looks more like a sports car than a tractor but offers innovative features such as autonomous driving, data collection, the ability to sync with a drone, remote control and onboard artificial intelligence.

There is also a wide variety of small robots capable of performing tasks in this field, such as: EcoRobotix distinguishes weeds from crops to spray up to 20 times less herbicide.

3.3 The most important smart agriculture in the world and in Arab countries

We will try to address the most important smart agriculture cities in the world and in the Arab countries.

3.3.1 The most important smart agriculture in the world

The international community adopted in the year 2015 Agenda for Sustainable Development to 2030, which includes the Paris Agreement on Climate Change, provides an international framework for increasing the effectiveness of national actions and collective international efforts to achieve sustainable development. In order to implement the 2030 Agenda, FAO Member States have adopted five principles for sustainable food and agriculture (including crops, livestock production, fisheries, aquaculture and forestry), by balancing social, economic and environmental considerations and promoting smart agriculture as an approach capable of transforming and reorienting agricultural systems to effectively support development and ensure food security in the context of climate change. The goal of promoting sustainable

agriculture has thus been integrated with the goals of ending hunger, achieving food security and improving nutrition by 2030. (opcit M. , s.d.)

Among the most important smart agriculture cities in the world we mention: (opcit A. A., s.d.):

- Japan:

As a challenge to the Japanese in Fukushima, the city of the recent nuclear disaster, they decided to make it the nucleus of the country's vertical farming project, as proof that this agriculture, which does not need sun or soil, can overcome the problem of lack of space, or its dangerous conditions. The Japanese company Fujitsu, which manufactures semiconductor chips for computers, decided to exploit a basement that was no longer in use, in a different way. The chip basement was transformed into a small green farm inside the company's headquarters, where lettuce is grown, which the company chose to make special by its low potassium level, to make it suitable for kidney patients, whose bodies cannot tolerate high levels of minerals; If you want to see this unique little farm, all you have to do is take off your shoes at the doorstep, put your head covering on your hair, then there is the sterile air bath that you have to pass through, and be amazed by the layers of green lettuce before your eyes. The name of the project is "Kurai Yasai", which means "clean vegetables", as the company grows vegetables in its clean room that was previously dedicated to electronic chips, where there is less dust and bacteria than outside, and where there is no mud at all, as the plant depends on a nutrient liquid that flows into it from pumps, running from layer to layer. In front of the amazing view, you can only wonder, how much lettuce is here? To be surprised that you are in front of fifty thousand heads of lettuce in this small place.

- United States:

Aero Farms The world's largest vertical farm, in a former steel mill in Newark, New Jersey, is now the world's largest vertical farming project, covering an area of 69 thousand square feet, and the project's founders are looking forward to spreading their healthy, high-quality production to all local markets, and while such projects rely on the hydroponic method to dispense with soil, this project relies on a different method called "Aeroponics". The new method is similar to hydroponic feeding in that it relies on seeding and growing the crop in fabrics, and using night lights instead of the sun for the photosynthesis process, as the wavelength of this light is allocated to achieve the maximum benefit from the photosynthesis process, with the least energy consumption, but the essential difference is that hydroponic feeding relies on the nutrient solution that flows to the planted layers, while aerial feeding relies on spreading the nutrition through dust, which is the method that the company says speeds up the plant's life cycle, and it also carries better biomass than other methods.

The project offers more than the usual advantages of vertical farming. In addition to the speed of obtaining the crop, the ability to grow it throughout the year, reducing the use of pesticides, not having to wash vegetables that do not touch soil or pollutants, and reducing wasted water and energy, there is more. This project offers the maximum

benefit from the space vertically, as one square foot provides you with 75 times more than conventional farming, uses 95% less water, and can produce an estimated two million pounds of leafy greens per year.

- London:

The city's forgotten underground tunnels are turning green. The idea came to businessman Richard Ballard and Stephen Dring. Why not make use of all these forgotten World War II tunnels under London? And so began the project of the largest underground farm in the world to date. The project specializes in selling herbs and salad vegetables, and is located thirty-three meters below the streets of London, less than two miles from the city center. It promises the public that the journey from farm to table will take only four hours!

The project relies on green energy sources and uses about 100% less water than traditional agriculture. 70%, and Ballard and Dring hope to produce crops with “zero impact” on the environment, and plan to produce a variety of crops such as peas, different types of radishes, mustard, coriander, celery, and parsley, and they plan to expand the concept into neighboring tunnels in the future.

- South Korea:

A vertical farm on the top floor, a classroom below. The architects and designers of the vertical farm in Seoul plan to make it three stories high, with vegetables and crops grown on the second and third floors, while the first floor will be used as a classroom for teaching agriculture. The vertical farms will be controlled by computers, to provide extreme precision in allocating the right light, as well as adjusting temperature and humidity conditions, and monitoring carbon dioxide levels. The western Yangcheon area has been chosen as the location for this first-of-its-kind farm in Korea.

- Singapore:

Panasonic From exporting screens to vegetables, Panasonic was the best choice when it decided to invest in vertical farming. This country is one of the countries with low food self-sufficiency, and it also complains about the lack of land available for agriculture in the country, which is one of the most densely populated countries in the world. The situation has even deteriorated to the point that Singapore imports more than 90% of its food needs. This has led the country to allow vertical farming projects and fund research, such as Panasonic's Sky Greens, a three-storey high project that was planned to feed Singaporeans and help solve the land and food crisis. It has already started production successfully, and has even started exporting to some Japanese restaurant chains, making it the first vertical farm project in Singapore.

Panasonic's farm, which spans an area of the 248-square-meter factory on the outskirts of the city is lit by pink night lights of a specific wavelength. The company limits visitors to precisely monitor temperature, humidity and carbon dioxide levels. The company was able to increase the types of crops it grows to 30 in 2017, and says it hopes its crops will cost half as much as those imported from Japan.

3.3.2 The most important smart agriculture in Arab countries

Scientists and governments agree that people need a wide range of urgent solutions to protect themselves from hunger. Without a massive increase in food, matched by a reduction in water and fossil fuel use, a billion people or more will suffer from certain famine, especially in Africa. Arab countries do not seem to be an exception. A new report by the United Nations Economic and Social Commission for Western Asia (ESCWA) and the Food and Agriculture Organization (FAO) confirms that most Arab countries will have to import food to cover their food deficit. 40 percent of the population depends on agriculture, while its contribution does not exceed 7 percent of the GDP. Perhaps the most important reason is that most of these countries do not benefit from the technological innovations available in the field of agriculture. Most agriculture in some Arab countries still depends on traditional practices and is at the mercy of unexpected environmental changes. (opcit M. A.-Y., s.d.)

Therefore, adopting smart agriculture policies requires enhancing joint Arab action, exchanging knowledge and ideas about Internet of Things technology, and including information and communication technology as a key factor for sustainable agricultural development. We mention here the experience of the first regional forum for smart agriculture, which was held in the Sudanese capital, Khartoum, under the slogan "Towards sustainable agricultural development through the Internet of Things and new technological trends." This forum can be considered the first attempt towards adopting smart agriculture policies and exchanging experiences at the Arab and African levels in this field and enhancing regional and international cooperation in the field of smart agriculture to coordinate efforts and reach sustainable solutions for the future of the agricultural sector. (Al-Hashem, 2022)

Among the most important smart agriculture cities in the Arab countries are: (mkadam nesrine, 2023)

Morocco:

Smart agriculture is a government priority. In the year 2020, the government launched its "Green Generation 2020-30" strategy, which includes among its objectives "the introduction of new technologies and the digitization of agricultural services." The strategy aims to install more than 100,000 solar irrigation pumps through AgriEdge, an agritech startup that has a precision agriculture platform to determine the optimal level of fertilizer and water for each crop using a wide range of data including weather, satellite and drone imagery.

Egypt:

Egypt has the agricultural power in the region, representing the largest irrigation area among the eleven Nile Basin countries. Agriculture consumes more than 85 percent of the country's share comes from the Nile River, which provides the bulk of Egypt's water supply. Last December, the Egyptian government began testing a new mobile irrigation system as part of a national strategy to use modern irrigation methods. The Ministry of Water Resources and Irrigation, in partnership with MSA University in

Cairo, created a handheld device to measure soil moisture. The device sends a message to farmers' mobile phones about water levels, helping them make informed decisions about their crops. In Egypt, the private sector is playing a major role in driving smart agriculture initiatives. The IrriWatch app, developed in the Netherlands, helps farmers improve irrigation using "virtual sensing" technology that uses different thermal satellite measurements to detect soil water potential and soil moisture data. Tunisia:

A prominent example is the company Ezzarya, a company that installs sensors in irrigation pipes and in the soil. The software-connected wireless box allows farmers to regulate soil salinity and inject minerals that may be needed to improve crop yields. Irrigation and fertilization can be managed centrally thanks to the system, which is also able to detect drip leaks. Lebanon: A startup called Vertical Farming saves up to 90 percent of water use per day by recycling water, while Robinson Agri, a leading greenhouse producer, has implemented smart irrigation solutions.

Therefore, for smart agriculture to succeed in Arab countries, the following must be employed: (Ben Shaa Nadia H. D., s.d., p. 240)

- Employing data, information and knowledge related to the agricultural sector locally and in the Arab world, and the effects of climate change, and managing and exchanging them;
- Engaging in multi-sector networks, alliances and partnerships active in the field of smart agriculture adoption at the Arab and global levels;
- Benefit from previous successful experiences in the field of applying the smart agriculture approach, and coordinate with them;
- Develop, implement and reform agricultural policies that support investment in smart agriculture;
 - Improving coordination between ministries and between the public and private sectors (at the local and Arab levels) with regard to establishing agricultural investments that adopt a smart approach;
- Supporting private investment in particular, as it is a sector that seeks to maximize benefit by maximizing productivity, which allows for the adoption of the latest methods in the field of agriculture;
- Creating integration between the various sectors concerned with agriculture, climate change, agricultural development and food security at the Arab level;
- Building infrastructure and social protection structures, especially in rural areas, to ensure their settlement;
- Raising awareness of the importance of adopting a smart agriculture approach to preserve and sustain agricultural resources;

4. Conclusion:

Through our treatment of the subject of our study, we reached a number of results, the most important of which confirms the necessity for countries to adopt the concept of transition and transformation towards smart agriculture and adopt it as a strategic option that responds to the challenges of preserving the environment, achieving food security, and optimal exploitation of agricultural resources. The Fourth Industrial Revolution has created great opportunities to influence the course of society and revolutionize the way business is managed. Societies have been forced to adopt these developments to increase and exploit the advantages to achieve sustainable and comprehensive growth. The Fourth Industrial Revolution has essentially played the role of a link between all new and emerging technologies to provide enhanced and precisely prepared products and services that improve people's lives. Information and communication technology has changed the way farms, companies, individuals and governments operate. It has also reduced transaction costs and facilitated communication between various parties interested in developing agriculture and who have a common interest with it, in addition to informing people and communicating with each other at much lower costs than before. Digital technologies thus enhance efficiency and inclusion, as many tasks can be performed at low costs and many services can reach people who previously lacked access.

Rapid innovations in digital technology have opened up great opportunities for the expansion and development of the agriculture and food sectors around the world, and increased opportunities for the emergence of programs, policies and cooperation projects between international organizations, developed countries and the private sector on the one hand, and developing countries and small farmers on the other hand, for the benefit of transforming agriculture from traditional methods and adapting it to the challenges of the necessity of integration into the knowledge and digital economy.

Multinational ICT companies provide individuals, governments, farmers, large machinery manufacturers, small and medium farm input suppliers and even consumers with innovative digital services and applications in countless areas, particularly related to the collection, analysis and exchange of information by creating a virtual world that brings together these various parties thanks to public and private digital platforms specialized in providing advice, support, qualification, transfer of knowledge and expertise and facilitating the communication process between the various parties with each other at much lower costs than before. Many services can reach people who previously lacked them, especially in poor areas of developing countries.

Investing in new digital technologies has a price, and should be a strategic choice for today's farms, especially in developing countries. Tomorrow's farms must be aware of all these developments in order to make the right choices and support their ability to compete, by understanding the new uses of digital technologies and employing them to increase productivity and preserve the environment and resources.

To meet the upcoming challenges, adjusting agricultural activity to adapt to climate change has become an urgent necessity, which must go hand in hand with diversification of production sources, by employing advanced agricultural technologies and innovative artificial intelligence solutions such as “Internet of Things” applications that have become adopted by farmers in rich countries.

5. References:

- 1- Agriculture, N. I. (2016). Portal of donations for innovation in agriculture.
- 2- Agriculture, S. (2020, 07 14). A Green Revolution for Achieving Food Security... The UAE as a Model. Récupéré sur <https://omran.org/ar>.
- 3- Aisha. (2020, 07 14). Agriculture Smart revolution Green To achieve Security Food... UAE Arabic Model . Récupéré sur <https://omran.org/ar/>.
- 4- Al-Hashem, Z. (2022, 03 18). Smart Agriculture.. Future Technologies for Achieving Food Security. Récupéré sur <https://www.awforum.org/index.php/ar>.
- 5- Al-Yaqoubi., M. (2022, 03 15). Smart farming promises promising solutions to world hunger. . Récupéré sur <https://alarab.co.uk/>.
- 6- Bank, T. W. (2020, 06 08). Beyond the Pandemic Harnessing the Digital Revolution to Improve the Path of Food Systems.
- 7- Ben Shaa Nadia, H. D. (2023, 03 03). Smart Agriculture and its Application Requirements to Achieve Sustainable Food Security in Arab Countries. North African Economics Journal, , 225.
- 8- Elba, I. a. (2022, 02 25). wanted to invest in rural agriculture to help them achieve better. Récupéré sur www.ifad.org/fr/web/latest/-/idris-et-sabrina-elba-appellent-%C3%A0-investir-dans-l-agriculture-rurale-for-lutter-contre-la-faim.
- 9- Huet, J.-M. &. (2019). The new or African alliance has the advantage of digital and agriculture. France: Bearing point.
- 10- ISAAC, H. (2015, 11). Renaissance number 16 propositions to replace the production. france: ÉDITORIAL, Éd.
- 11- Lewis, B. (2017). L'agriculture intelligente. iso focus. mai:join.
- 12- Ministère de l'Agriculture, d. l. (2018, January/Fevrier). The digital revolution. . (dl Ministère de l'Agriculture, Ed.) alima grie.
- 13- Mohammed. (2022, 03 15). Future Techniques Agriculture Smart And provide Security Food Globally In Arabic: "Experience" The UAE Arabic. Récupéré sur <https://omran.org/ar/>.
- 14- Nation, F. a. (2017). Succès stories on information and communication technologies for agriculture and rural development.
- 15- Nations, F. a. (2019).
- 16- Numbers for irrigation efficiency, agriculture and innovation. (2021, 03). Récupéré sur <https://omran.org/areip-agri>. 2018, mai.

- 17- OCDE. (2021). Development dynamics in Africa 2021: digital transformation and employee quality.
- 18- Riad, Y. R. (2020, 05 10). The Contribution of Climate-Smart Agriculture to Achieving Food Security in the Arab World.,. Journal of Humanities, University of Oum El Bouaghi, p. 916.

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