

# TECHNOLOGY IN AGRICULTURE AND THE FOURTH INDUSTRIAL REVOLUTION (4IR)

By

## Ikechi Kelechi Agbugba, PhD

*Professor, Faculty of Indian Oceanic Sciences, University of the State of the African Diaspora (USOAD)*

*Professor, College of Agriculture & Agribusiness Management, Cavalla International Univ. (CIU)*

*Senior Academic/Researcher, Dept of Agric. & Applied Econ., Rivers State University (RSU)*

*Faculty Member, Agribusiness Management, Rome Business School (RBS)*

*Chair, International Advisory Board, African Council on Small Businesses*

*and Entrepreneurship (ACSBE)*

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### What is Technology?

Technology is the set of knowledge, skills, experience, assets and techniques that enables creation of further improved assets, tools, machines, products and services that meet the needs of mankind. It refers to all assets by which humans explore, transform, condition and control their environment to make it as conducive as possible and satisfy the needs of society.

Etymologically, the word technology comes from two Greek words, *tekne* (meaning an art or technical skill) and *logos* (literally meaning knowledge). Hence technology can be said to be a body of knowledge and skill that is aimed towards a more sustainable world.

It is important to note that the proceeds of technology may be tangible, as in the case in the case of manufacturing and production, or intangible as in the case of discovering the causes of an illness or abnormality in society following extensive research.

### Classification of Technology

Though there exists a myriad of classifications for the different technologies that finds application in our contemporary society, it would be helpful to broadly classify technology into these nodes:

- i. Construction technology.
- ii. Manufacturing technology.
- iii. Medical technology.
- iv. Energy and power systems technology.
- v. Transportation technology.
- vi. Agriculture and bio-technology
- vii. Information communication technology

### Relationship between Industrial & Agrarian Revolution

Agriculture has never been left out in the various technological and scientific advances of man. Indeed, how far the agriculture sector has come in development and production is testament to the excellent breakthrough our modern world has achieved industrial revolution. Industrial and agrarian revolution always go hand-in-hand, and that is the

reason why economies in which agriculture is stagnant does not show industrial development.

### Agriculture and Biotechnology

Technology has enabled the venture of food and industrial raw materials provision to transcend beyond just manually orchestrating and performing the activities that makes such provisions possible, but utilizing as much of the knowledge and experience mankind has garnered from the environment guide this. A concrete instance of this very apparent in what is obtainable in the agriculture sphere today. Today's agriculture routinely uses sophisticated technologies such as robots, temperature and/ moisture sensors, aerial images, and GPS technology to monitor and facilitate farm activities. These advanced devices, precision agriculture and robotic systems allow businesses to be more profitable, function efficient, safe, and in the most environmentally friendly manner. The process by which technology transformed agriculture from its most basic state far back at the Stone Age to the level of sophistication abounding at the present time can be referred to as Industrialization.

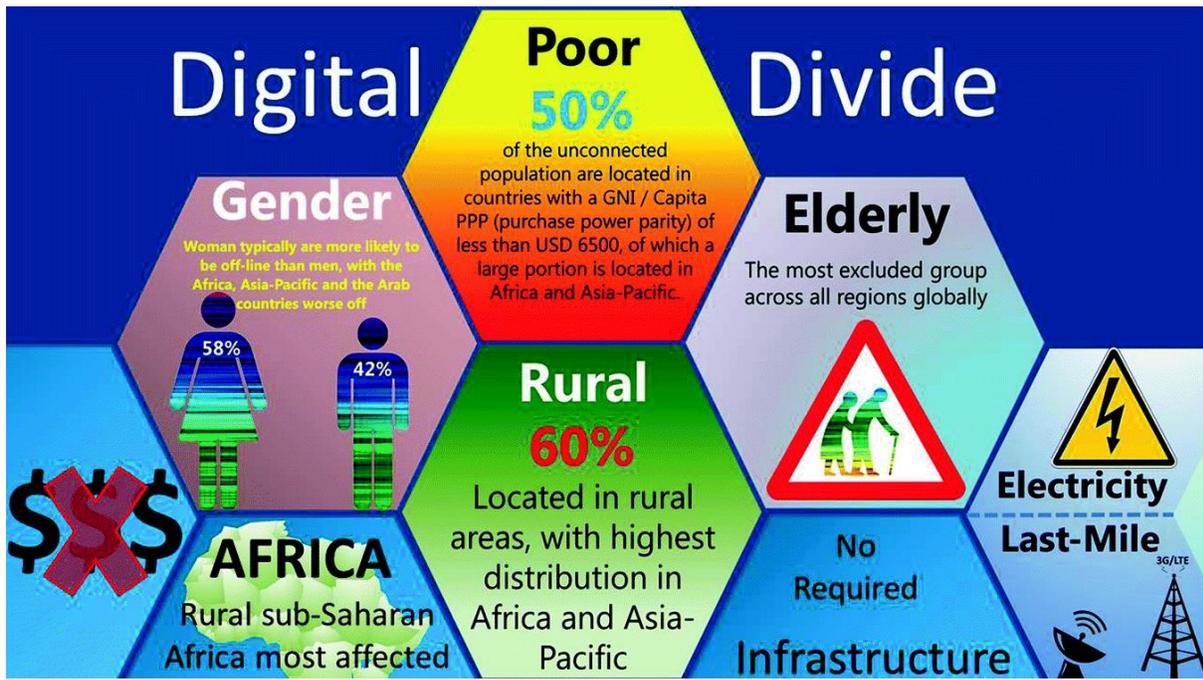


Figure 1.0: Info-Agritech: A Potential Game Changer for sub-Sahara Africa

### Industrialization and Its Effects?

All the afore mentioned categories of technology are responsible for initiating industrialization processes in different dimension and for different facets of the society. Industrialization has enormously positive impacts on wages, productivity, wealth generation, social mobility and standard of living. During industrialization, all wages tend to rise, though the wages of some rise much faster than others.

Generally, it is reckoned that the world has gone through 3 cycles of industrialization referred to as the industrial revolutions, and is currently at the verge of entering fully into a fourth one (4IR).

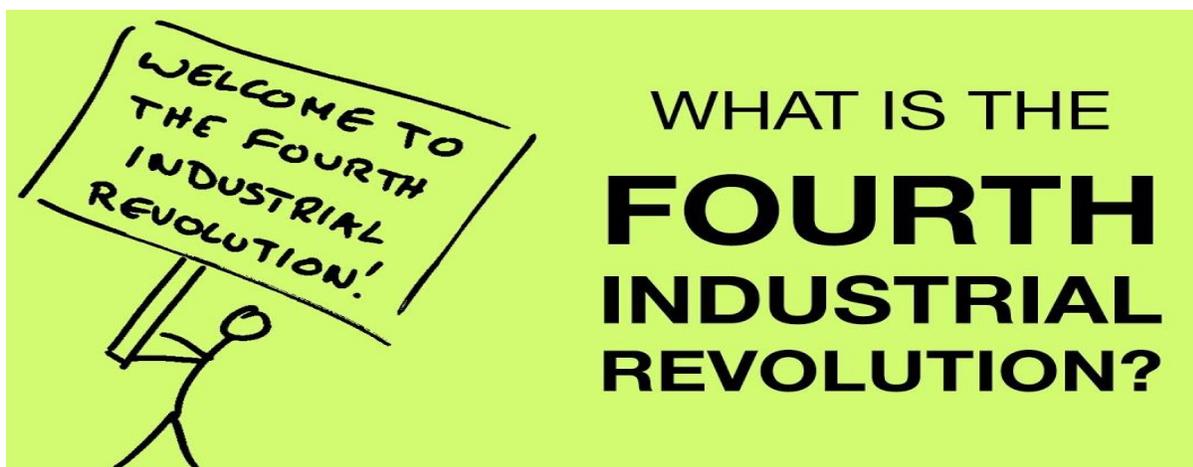
Important advantages of industrialization include:

- Growth of industries has resulted in large scale production of goods which are available to the consumer at much cheaper rates.
- With industrialization, there has been remarkable savings in time and labor in different areas of human activities.
- Industrialization has resulted in a considerable rise in the standard of living of the people.
- A number of substitutes in consumer goods are available by virtue of the healthy competition that has accompanied industrialization.

### **How did Technological Advances in Agriculture Appear during the Previous Industrial Revolution?**

The first, second and third industrial revolution (1IR, 2IR & 3IR) as indicated in Figure 2.0 carried along the agricultural sector in full participation. While the 1IR saw the replacement of crude tools and implements with constructed machines for different agricultural processes, the mechanized farming achievable at the time was limited by a need for still yet, massive human involvement with these machines. Historically, the three of the most influential of the inventions of this revolution were the coke fueled furnace, steam engine, and spinning jenny; all of which increased production capabilities for agricultural goods.

During the 2IR, the introduction of the assembly line manufacturing procedure was unarguably the most prominent of the technologies born during the period, and agro-allied industries were not left out, as production lines for slaughterhouses and the textile industry were fully operational in the time period. This epoch also saw advances in all major facets of transportation, most notably the jet engine and the railroad network, that helped facilitate the movement of crops, livestock and actors in the agricultural value chain.



The 3IR, also aliased the information age, saw technology transforming from mechanical to digital forms, with so much replacement of actual human operators for technological equipment and/ facilities with computers, from the microprocessor calculating farm inventory and records to database engines archiving billions of rows of farm business data in remote servers. This age witnessed improved record keeping and business analysis of farm businesses. Genetically modified crops, hybridized animals and improved seed varieties and/ resistant species of plants and animals were also researched into and developed. In addition to better farming equipment and better practices, advances in technology during this time period helped increase the supply and quality of food, though the better food supply created a population boom—which created a potential problem as jobs were already being lost due to the invention of the silicon chip, and even still the environment was positioned unprecedented population explosion. Hence the need for a more sustainable way form of emerging technologies became expedient, and innovations and solutions towards addressing the challenges posed by the 3IR gave birth to a 4IR.

The 3IR had many positive effects. Among which was an increase in wealth, the increase in production of goods and the standard of living, the access to healthier diets, better housing, and cheaper goods, and education which greatly increased during the period. The most important roles played by the 3IR, which greatly facilitated the developments to be accounted for the newer revolution were:

- It developed the economy.
- It led to the emergence of machines capable of being manufactured in bulk amounts, through precision machining and Computer Numerical Control (CNC) knowledge.

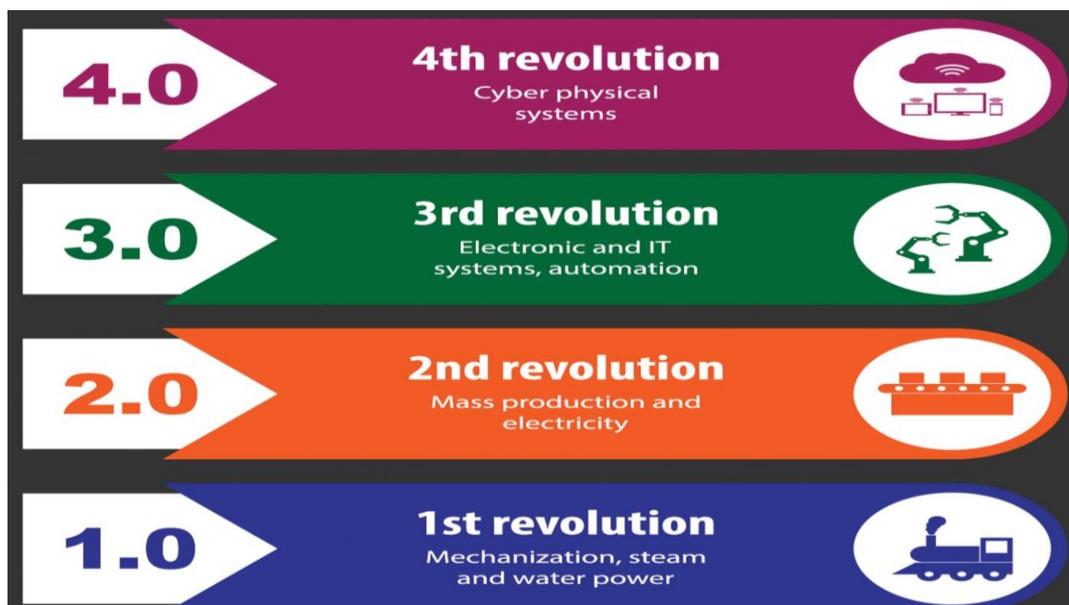


Fig 2.0: Summary of the Industrial Revolutions (1IR, 2IR, 3IR and 4IR)

- It made the full mechanization of businesses, including agribusinesses possible.
- Communication and transportation (for instance the autopilot invention made air travel and other means of transportation safer) improved dramatically.
- Improvements in sanitary conditions and medical care gradually occurred.

As far as agriculture is concerned, it is important to note a subtle role the third (and in fact all previous revolutions) played: the sustained growth of non-agricultural employment and the transfer of part of the rural labour force to the towns had an effect of stabilizing the number of agricultural workers, halting the growth of population pressure on the land, and thus created conditions for improved labour productivity for subsistent and commercial farmers alike.

### **The 4th Industrial Revolution (4IR)**

Though there is not quite a consensus on the actual dating regarding the kick-off of the 4IR, we can argue that the beginning of the 4IR was around 2014 with the arrival of smart fabrics and online production management.

The 4IR is characterized by the fusion of the digital, biological, and physical worlds, as well as the growing utilization of new technologies such as artificial intelligence (AI), cloud computing, robotics, 3D printing, the Internet of Things (IoT), machine learning, computer vision and advanced wireless technologies, among others. In the agricultural domain, the technologies of the fourth industrial revolution have led to such developments as:

- ***Bio-mimicry for Bees and drones:*** If the adverse effects of climate change is not checked, scientists warn that food shortages could be more likely which will drive up prices and lead to economic hardships for some of the population. The bio-mimicry and agricultural drone technology is one of such developments to mitigate against such, as pollination can now be fast tracked with these, thus facilitating the availability of certain food.
- ***Artificial intelligence, manufacturing process automation and the Internet of Things:*** By programming computers and smart machines to carry out tasks, and making smart decisions through connecting with other software facilities all around the globe via IoT, farm and agro-allied activities are now capable of achieving efficiency and performing optimally, as the AI programmable machines carry out their task on a rule basis, thus making room for no error, and in cases where subjectivity needs to be included, remote connection between agents for making such decisions (either humans or some other computer) is readily available by virtue of the IoT. Automation of manufacturing processes not only makes an agro processing plant capable of running non-stop all year round, but it also effectively reduces the cost of labour by at least 2/3 of what was obtainable prior to the automation, as whereas the factory worker may only put in 8 hours a day, the automated machine put in 3 times that time thus being equivalent to 3 factory workers.

- **Blockchain technology:** Connecting physical activities via digital models leads to effective tracking of progress and/ fall-outs from an original plan or designed workflow. Such modelling for the stock market has enabled investors in the agricultural sphere make more informed decisions and moves regarding trading and exploring the potential for their return on investment (ROI). Risk on Crypto trading also can be reduced given a proper blockchain design that would deny any attempt to externally modify an original connection design.
- **Urban agriculture and vertical farming:** With the pressure on land resources and the activities of man like bush burning and deforestation even diminishing the quality of land that may be available, methods of farming in the 4IR now incorporates planting on vertical walls which would only require as little space as just what the foundation of such walls may require together with the expected maximum heights of crops grown in view. This breaks the previous paradigm that rural areas are the destination for farming, as urban centres can readily make the little space required for a vertical farming practice.
- **Genetic editing:** Enabling technologies of the 4IR for custom designing deoxyribonucleic acids (DNAs) to meet certain expectations in plants and animals, like disease resistance and rapid growth rate is now being enjoyed by farmers of the 4IR, as the risk of farm losses are now reduced to the barest minimum with such controlled species being used as parent stock by such farmers.

### **Impact of 4th Industrial Revolution**

In the case of the 4IR, its advantages are evident in the increased productivity, efficiency and quality in processes, the greater safety for workers through eliminating unsafe conditions or the need for workers to be physically present in dangerous environments, the enhanced decision making with data-based tools, and the improved competitiveness by developing customized products.

According to the World Economic Forum Global Risks Report 2017, “the 4IR has the potential to raise income levels and improve the quality of life for all people. The 4IR is largely driven by four specific technological developments: high-speed mobile Internet, AI and automation, the use of big data analytics, and cloud technology.

### **Prospects of the Fourth Industrial Revolution**

Asides the general benefit of more conducive, efficient and effective activities being carried out with the utilization of the technologies of the 4IR, the technology of 4IR allows for improved safety in dangerous work environments such as in the mining and construction industries. Lives that could be lost in such industries, as well as injuries that may occur, can be totally prevented by using robotic technology. As an example, the 4IR’s technology for fire-fighting involves using robots or the elide balls in place of any human firefighter in an active fire scene.

In surveys carried out on employees, regarding their endorsement for technologies of the 4IR, most employees, acknowledged that 4IR is contributing to a better work experience

by saving time, enabling corporate work to be carried out from anywhere, improving their organizational skills and productivity through unprecedented software/office tools, and all together providing a better work-life balance. Though some of workers also express some fear regarding their job security, and the possibility of one day being declared redundant to be replaced by a robot.

### **The Need for Innovation in Agriculture in the New Revolution**

We have good reason to embrace innovation in agriculture at every point in time, as It plays a key role in feeding a hungry world, improving the quality of our natural resources and enhancing the quality of life of our citizens.

The 4IR will change production, distribution, and consumption as well as the rural environment and rural life. At the same time, its technologies provide opportunities to further develop agricultural systems by overcoming difficult problems that were not solved during the earlier revolutions, due to the limited technologies during those epochs of history.

The 4IR is starting to change how the world thinks about problems. The goal now is not just to make a problem to cease, but rather to discover sustainable solutions to problems. The problem of food security, for instance can be said to have a plan that would increase farm yields, at lower costs and minimal environmental impact as its solution—and not the production of inorganic food to substitute any dearth of organically grown food.

The technologies of the 4IR have significant impact on contemporary agricultural problems. One of such is the potential to address weather-related problems. Agriculture is heavily affected by the weather, and currently science has no solution for improving rainfall availability in regions with little rainfall, technologies like the water culture farming and smart irrigation can still be used to make effective production possible irrespective of the weather and/ climatic condition of a given place.

### **Positive Implications of 4IR on Businesses**

On the whole, there are 4-main positive effects that 4IR has on business—brighter customer experience and expectations, capacity strengthening for continuous product enhancement, collaboration on innovations, and flexible, dynamic and more responsive organizational structures.

A key player to the accumulated positivity above is the fact that 4IR enables almost anything physical to have a digital component. Physical products and services, can now be enhanced, if not directly, then at least by enhancing their digital capabilities which ultimately increases their value.

### **Implications of 4IR: From an Agriculture Sector Perspective**

In the broad view of 4IR, the advantages are evident: increased productivity, efficiency and product quality in processes, reduced risk of business and operations, and so forth.

The 4IR is however starting to change how every agricultural player, from a family farmer to a global conglomerate, produces food and related products. The spread of the so-called essential technologies — such as AI, blockchain, drones, and the Internet of Things (IoT) — to agriculture is leading to increased yields, lower costs, and reduced environmental impact. These tools are also empowering farms to unlock new plant-based innovations and increasing their resilience to extreme weather events and climate change. The price for the most of these however, is that significant money is at stake. In 2018, agritech startups raised US\$16.9 billion, which marked a record 43 per cent increase over the previous year. As compatible technology and high-speed wireless networks spread more quickly — with telecom operators are planning to invest as much as \$1 trillion on 5G infrastructure by 2025 — the adoption of agriculture-related technology will by all and sundry farmers would definitely accelerate.

This revolution in agriculture imposes new demands on producers and the organizations that serve them. To thrive in 2030 and beyond, agricultural companies must choose carefully among the new technologies, to avoid wasting time and money or worse — missing out on critical opportunities. Many companies will also need to change how they organize themselves and their business lines to best use these technologies. The right approach to all these challenges requires that companies define their place in the digitized world of agriculture, then identify and develop the right capabilities system to succeed in it.

We cannot know exactly how the world will look in 2030, but existing megatrends indicate the likelihood of more people, more of whom will live in cities; more extreme weather shocks and natural disasters; greater pressure on fresh water, arable land, and other natural resources; and overfished, overheating, and rising oceans. All these may sound bleak, but with the right approach, agricultural companies can feed this near-future planet better than ever, while reducing pressure on resources.

A tremendous variety of technologies are currently in development. One Brazilian company, for example, offers a system that uses drones and IoT sensors to gather data on pigs and their environment. It enables swine farmers to enter further information, such as the pigs' weight or births, into the system by simply speaking into their phones. Analytics, synchronized across a swine farmer's entire operation, provide visuals on every stage of production. Farmers can share the information with suppliers of feed and medicines, or establish key performance indicators for supervisors and managers. Other companies have similar solutions on the market for other types of livestock.

Amazingly, some 4IR agriculture technologies seem to come straight out of science fiction. One firm is developing a swarm of miniature autonomous robots that can plant seeds. Controlled by a farmer's handheld tablet, which is operated with the help of satellites and cloud-based software, the swarm will be able to put each seed in the right place with greater precision than current approaches can. Not incidentally, the technology will eliminate the need for planter bars, tractors, and tractor operators. Because the swarm can adjust seed locations for changing conditions, this development will increase

yield, with lower costs, speed up planting operations, and reduce the impact of tractors and other diesel engines on soil structure and on the atmosphere.

So many new technologies, products, and services are appearing that the entire sector will soon be unrecognizable to participants of a generation ago. To prepare for this future, agricultural companies must take the right steps right now, which can be summarized as follows:

- Improve on available digitization with innovation
- Questioning the results of automation
- Collaborating and networking with actors in the same business line
- Creating unique business models based on core strengths
- Monetizing business opportunities from sustainability

### **How the fourth Industrial Revolution can be Fully Harnessed by Farmers and Agribusiness Practitioners?**

The 4IR provides a lot of opportunities to drastically change we live, work, and communicate. It's reshaping government, education, healthcare, and agriculture—and just too many aspects of it. If harnessed properly, the technologies of the 4IR would be able to improve the future of agriculture, provide more value from the 'as is' development currently of value in the sector future, and the change the value system of the population. Whether an agribusiness is in the midst of a full-on effort to implement 4IR solutions, or is just beginning to understand the need, 5 steps can help set a company on the right path, course-correct along the way, and arrive quickly at the desired future state:

#### ***1. Improve on available digitization with innovation;***

The most common response of companies has been to plug new technology into old business models, with the hope of enhancing those models with smarter tools and more data. But that tactic is flawed. Making old models work better isn't enough — not when technologies are enabling all-new models that can render the old ones obsolete.

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Many pesticide and fertilizer companies, for example, are using 4IR technologies to provide better products and roll them out faster than before. That might sound like a success story, but precision farming — which uses IoT sensors, high-resolution 3D aerial imagery from drones, and AI-powered analytics to analyze the characteristics of soil and the behavior of crops down to the square inch may soon significantly reduce the need for fertilizers and pesticides altogether.

A better approach for manufacturing companies is to discover and develop these new business models, creating new markets along the way. Instead of looking for a better product, companies should look for better *solutions* for the problems that their customers face, whether those customers are farmers, agricultural suppliers, or end consumers.

Many successful solutions will bring together products and services from multiple companies, rather than just using products manufactured by the solution provider.

To determine which solutions to offer and how to offer them, companies need to fully understand their current competitive position, including its strengths and vulnerabilities. Leaders can then determine where they want to compete in the agriculture ecosystem of the future. In whichever competitive position they choose, they will need the right capabilities to win. Organic innovation, joint ventures, incubators, and acquisitions should all be considered to get an organization learning and evolving. Companies will need many different capabilities, depending on their chosen competitive position.

### ***2. Questioning the results of automation:***

Digitization is perhaps the clearest example of how 4IR technologies can, and should go, beyond simply making traditional business models work better. Such technologies are leading an all-new agriculture value chain, with digital businesses at each link of that chain tapping into new revenue streams. The forward-looking agricultural companies don't just capture and harness data. They help clients figure out what data they need and how they will get it; they also help standardize and analyze data to recognize patterns and formulate recommendations. In other words, they generate a "so what" from the reams of data in which so many organizations are currently drowning.

In practice, producing this "so what" usually means applying analytics in order to operate equipment more efficiently; determine more accurate feed formulations; manage animal well-being; create marketplaces; and better manage logistics, pricing, customer performance, and more.

For example, John Deere is increasingly selling data management services in addition to farm equipment. The company's Operations Center system enables farmers to collect data from equipment (whether or not that equipment was manufactured by Deere), see and analyze that data on dashboards, share data with partners (including a suite of third-party, software-as-a-service providers), and operate machines remotely.

For instance, John Deere and other companies like it, data analytics is no longer a cost center, targeted for cuts. It is a strategic capability that can create new business models.

### ***3. Collaborating and networking with actors in the same business line:***

It's impossible for any single company to gather, manage, develop, and use all the sources of data and all the new technologies that emerging agricultural business models depend on. The autonomous super-farms and bio-factories that may soon provide much of humanity's food will still require multiple stakeholders, from conglomerates to startups to farmers in the field, working together.

Leading agricultural companies will be skilled at partnering with other companies, large and small, and with universities and other sources of innovation to identify trends and capitalize on external knowledge. They will be "extroverted," outward-looking organizations, with the vision to orchestrate new agriculture ecosystems. And they'll use mergers and acquisitions to fill gaps in 4IR-based business models.

Collaboration should always be grounded in a company's objective assessment of its own strengths and where it will be better off capitalizing on the strengths of an external partner. For example, one company may be strong in food processing but need partners for food formulation insights. Another may have exciting R&D but need partners to get its inventions into the marketplace. The key is to understand one's role in the agricultural value chain of tomorrow, then build the partnerships and make the deals to strengthen that role.

Consider how McDonald's (at the end of the agriculture value chain) recently acquired an Israeli AI startup called Dynamic Yield, which has strong capabilities in using analytics to personalize customer options. McDonald's will use the new asset's tools to vary digital drive-through menus based on the time of day, the weather, how busy the restaurant is, and trending menu items. When a customer places an order, the AI system will instantly suggest other items to complement it. Using the data, it gathers the system and will improve its own performance over time.

#### ***4. Creating unique business models based on core strengths:***

Every company, inside and outside agriculture, wants to be more innovative. But the winners will be those that base their efforts on a sound understanding of their existing corporate strengths and culture.

For instance, Cargill assisted in the development of an open source blockchain solution to provide reusable digital tools for supply chain use cases, including food safety and traceability. Because the system is open source, it does not exclusively sell Cargill's products. But the company is putting itself in the middle of global innovation, connecting with potential suppliers and clients, and giving itself the potential to help shape blockchain to its benefit.

Whatever their specialty, agricultural companies will need procedures to systematically screen, evaluate, and prioritize emerging technologies. They will also need cross-functional collaboration to better identify and more quickly develop and implement the best ideas; internal R&D and technology units capable of rapidly building pilots; and an agile approach to get the most promising ideas into the market quickly, based on continuous feedback loops that take advantage of real-world customer input. It's critical for companies to test a wide array of solutions, "fail fast" on less-promising ideas, and reallocate capital and other resources to the winners.

#### ***5. Monetizing business opportunities from sustainability:***

Sustainability is not just a good idea. It's also one of the largest profit opportunities for the agricultural sector. A United Nations backed study put the potential value of business opportunities related to food and sustainability at \$2.3 trillion by 2030. Such opportunities go far beyond marketing. They're based on reducing food waste; reformulating products and packaging; developing new fertilizers and more precise ways to improve plant characteristics; managing farms, forests, and oceans with a smaller carbon footprint; promoting micro-irrigation; and increasing composting and energy capture, for example. To succeed with these and other opportunities, companies must understand the societal expectations, ecological changes, and technological advances behind them. They must

be able to quantify the sustainability of their products and activities and integrate sustainability in all their investment and business decisions.

For instance, Coca-Cola and Unilever have both set ambitious and measurable sustainability goals: Coca-Cola will collect and recycle the equivalent of every bottle or it sells globally by 2030, and Unilever will reduce its environmental footprint (as quantified in sectors such as greenhouse gases, water use, and packaging) by half, also by 2030. Quantifying targets in this way requires integrating nonfinancial metrics into business models and long-range strategic planning.

Notably, sustainability requires all three of the other foundational capabilities: top-notch data and analytics, collaboration across the value chain, and in-house innovation.

Preparing for a new world is a daunting task, but many agricultural companies — as well as the technology, industrial, and logistics companies they work with — are already moving quickly.

By choosing the right place to compete in the agricultural ecosystem of the future — and building the right capabilities to win — agricultural leaders can keep growing into 2030 and beyond, all while helping to feed and sustain the world's communities.

### **Agricultural Innovation**

Agricultural innovation is the process whereby individuals or businesses bring new or existing products, processes or ways of organization into use for the first time in an agro venture in order to increase effectiveness, competitiveness, resilience to shocks and environmental sustainability, and thereby contributing to scalable social impacts.

Below are top five innovative agricultural practices and technologies that are changing the world:

- Urban Agriculture, Smart Design, and Vertical Farms.
- Bio-mimicry.
- Artificial Intelligence, IoT, and Robotic Process Automation.
- Blockchain Technology.
- Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) technologies and Genetic Editing.

GIS and GPS agriculture software, satellite imagery, agricultural drones and advanced aerial imagery cameras, together with farm value chain software and online databases are also innovative giants on the current industrial revolution.

### **Technology Transfer in Agriculture**

Technology transfer is a multi-level process of communication ideas and materials involving a variety of senders and receivers of. In agriculture, it denotes the effective and timely information sharing on best practices for a given agricultural venture. The core objective of technology transfer in agriculture is to inform timely decisions on strategies and technologies to be adopted in the farm for maximum harvest, and agricultural technology transfer forms the basis for advancing rural development.

Nowadays, technology is significantly helping growers and farmers in several ways, including precise forecasting, data-driven decision making, and more.

## **Agriculture at the Epicenter of the Fourth Industrial Revolution**

The industrial revolution, refers to the anticipated changes from familiar technologies to completely new technologies, particularly the use of AI to make smarter planning/business decisions and powerful autonomous robots. These describe the requisite stance of the agricultural sector, given the triple challenge of global economic distress, environmental concerns and food security.

Agriculture plays a significant role to both human and economy of a nation; that is to say, it is the backbone of a nation's economy. In addition to providing food and raw material, it also provides employment opportunities to very large percentage of the population. That being said, any new wave to be experience in the globe has its number one target as the agric sector. A discussion on the agricultural model in the fourth industrial revolution would be discussed in two broad headings: Agricultural Information Technology and Agricultural Unmanned Aerial Vehicles (UAVs).

## **What is Agricultural Information Technology?**

Agriculture Information Technology (agricultural IT/agri-tech) is an refers to digital and ingenious technologies that cover all areas of agriculture in their application. These technologies are significantly helping farmers and agribusinesses today in simplifying and optimizing agricultural activities. Some of the agricultural IT are:

1. Online databases, cloud storage and computing facilities for agribusinesses.
2. Geographical Information Systems (GIS) and Global Positioning Systems (GPS).
3. High accuracy Sensors for monitoring purposes on farm lands.
4. Mobile devices with abundance of mobile software and applications for remote business operations and farm monitoring.
5. Smart farming practices like robotic seed planting and crop harvesting enabled by top notch programming.

Adoption of agric-tech over the last few years has been very thrilling, with reports showing that nearly half, about 49%, of farms in the U.S. use a desktop or laptop computer to conduct farm business. Generally, in the US, Computer usage for farm business is widespread, ranging from 30% in New Mexico to 72% in Colorado Farmers need information on latest varieties, changing weather patterns, crop production techniques and improved agronomic practices for them to produce. Agricultural information technology plays a vital role in ensuring the farmers get access to this information, regardless of their agro-ecological location. The end result being improved productivity of the farmers.

## **Merits of Agricultural Information Technology**

- Modern machines can be programmed to bear the tedious efforts otherwise required of a farmer.
- Timeliness of farm operations and better estimations regarding timing can be made on the farm.
- Agri-tech facilitates transportation of farm inputs and outputs.
- Irrigational technology can be devised, and used to support effective farming in regions of low rainfall.

- Accurate combination of plant requirements in the production of synthetic fertilizers.
- Improved combination formula for chemical pest control.
- Better marketing and exposure to the price through information sharing on the
- Higher tendency for greener/environmentally friendly processes than what is obtainable manually.

### **Demerits of Agricultural Information Technology**

- The rule-based of robots may lead to continuous application of a farm input at the set time, when ideally that input should be suspended. For instance, in the case of a robot installed to water crops at a set time, if not checked, the robot would still go ahead to water the crops after a heavy downpour.
- Lack of the knowledge on the working principle of a programmed machine may lead to disastrous results.
- The cost of operations and maintenance of a farm utilizing agri-tech is very high.
- Overuse of machines may lead to environmental damage.

### **What is an Agricultural Unmanned Aerial Vehicle?**

Agricultural Unmanned Aerial Vehicles (agricultural UAV/agricultural drones) are drones designed specifically for performing agricultural tasks that are manual, repetitive in nature, rule based and can be carried out with little or no supervision by more experienced farm workers. Agricultural drones can help do challenging and time-consuming tasks, all while minimizing costs for the farm.

Currently, there are six common uses of agricultural drones which are listed below:

#### **1. Soil and Field Analysis**

In the end, the beginning. And the middle of the crop cycle, agricultural drones can be used to help get useful data about current soil quality. 3D maps of the current soil taken by these drones can also be used to detect and analyze issues with soil quality, nutrient management and/ pointing out dead zones of soil. This information can help farmers identify the most effective patterns of cultivation, crop management, soil improvement, and more, to be adopted. Constant monitoring like this helps make better use of water resources, as well as better manage nutrient levels in crops.

#### **2. Sowing Seeds**

Agricultural drone cultivation is a relatively new technology and not yet used in most farmlands, but so much experiments are being carried out on it, one of which involves manufacturers experimenting with dedicated systems that can release seedpods into prepared soil. Agricultural drone startups have played a fundamental role in research and development for developing these unique UAVs, and on widespread usage, these agricultural drones are expected to help with a wide range of environmental and agricultural issues bordering on manual seed planting. For example, a startup, DroneSeed has worked on using drones capable of delivering up to 57 pounds of payload, which could be seeds, herbicides, fertilizers or a combination of all three. These UAVs were also equipped to water the farm land on every flight—a capability which could be scaled up to help with reforestation and replanting projects. When such

agricultural drones are fully available, they will serve the purpose of reducing planting times and labor costs across the board.

### **3. Crop Spray and Topical Spraying**

Crops must receive consistent fertilization and herbicide spraying to maintain high yields, and this can be done with agricultural drones. With proper connections between these agricultural drones and large tanks filled with fertilizer, herbicides, or pesticides, employing them to spray crops is safer and more cost-effective. The agricultural drones can be programmed to work on specific schedules and methods. For example, if there is an outbreak of fungus in a specific section of crops, they can be used to identify this, and with the speed at which agricultural drones can operate, they can quickly treat this problem via chemical spraying before it becomes a widespread problem on the entire farm. Spot spraying is also available with these set of agricultural drones, so the in a case where the problem on the farm land is a little weed growing at a specific corner or only a specific crop type is being attacked by a pest, rather than spraying the entire space manually; plus the colossal waste of time and resources, the agricultural drones will spot spray to achieve the same end, and the task would be succeeded in less time, with fewer financial resources, and with less environmental implications.

### **4. Survey and Wipe Crops**

One of the most significant advantages of using agricultural drone technology is ease, and their effectiveness for large-scale cropping and land monitoring. In the past, satellite or plane images have been used to help get an extensive view of the farm, while at the same time helping to identify potential problems. Not only were these images expensive, they lacked the resolution that the agricultural drones of today provide can provide. Agricultural drones can provide real-time footage, and then time-based animation that can illuminate crop progress in real-time. Through the agricultural drone mapping and surveying, farmers can now make technical decisions based on real-time data, not old photos or approximate views made by planes or satellites. Finally, also incorporating near-infrared (NIR) sensors into the agricultural drones means that plant health can be determined based on light absorption, thus making it possible to have a view of the farm's health.

### **5. Irrigation Monitoring and Management**

Agricultural drones equipped with thermal cameras can help identify irrigation problems in an irrigation farm, or identify areas receiving too little or too much moisture in a conventional farm. With this information, crops can be better positioned to maximize plant watering and farm drainage, as well as avoid water pooling, which could damage sensitive crops. Finally, not only will the agricultural drones be able to cut down on any cost associated with faulty irrigation or crop damage due to over application/ dearth of water, but the agricultural drones can also spot waterlogging early enough to prevent damages to other farm ICT devices or to the quality of scans of the agricultural drones.

### **6. Check Livestock in Real-Time**

Many agricultural drones are equipped with thermal imaging cameras that enables a them to check livestock during their flight around the farm. This allows farmers to track their livestock much more often, with less time and less employee investment needed. Just

one drone operator is needed who will usually check through a monitor and get to see if any livestock is injured, is missing, is in the process of giving birth and needs assistance, etc. Finally, thermal imaging will also help watch livestock predators which can be a huge advantage for some farm owners.

### **Pros and Cons of the Fourth Industrial Revolution to Agricultural Practice**

Technological innovations have greatly shaped agriculture throughout time. From the creation of the plow to the global positioning system (GPS) driven precision farming equipment, humans have developed new ways to make farming more efficient and grow more food, and to do so in the most environmentally friendly way.

However, a great fear exists, as to the possibility of the computers and robots developed in the new revolution at some point in time gaining sentience and embarking on a plan to eradicate mankind, as in the science fiction movies, although the fact that the computer processors are unable to take initiatives attenuates the situation. However, the issues will still remain one for debate, especially given that machine learning now enables computers to learn over time from the data they have been fed with, and make more accurate replications of human actions, directly or indirectly equivalent to taking initiatives.

Thus, the key take away would be that although the 4IR promises to reduce hardships, poverty and hunger and drive the widening of income, its outcomes should be continuously checked, as some dangers are inherent following these promises, one of which being that the income widening may inexorably lead to social inequality with rich and high-skilled people taking all the advantages of the epoch to the detriment of the poor and less skilled individuals.

### **Conclusion**

Conclusively, traditional agriculture is an extractable process where all resources ranging from human and water to land are taken and applied to immediate usage. Moreover, modern agriculture uses planned technology and emphasizes management practices of conservation and renewability of resources thereby forcing the growth of infrastructure concomitant with rural development, urbanization, and industry. Fourth industrial revolution (4IR) is starting the narrative of transforming every agricultural player from a family subsistence farmer to big commercial producers, produces food and related products. Indeed, this revolution offers crop farmers to map their property, report crop health, improve spraying accuracy, monitor livestock and irrigation systems, among other solutions. Agricultural drones, big data and AI can help farmers gain access to complex information that can inform farming decisions. The dimension of revolutionized agriculture offers farmers major cost-saving solutions, enhanced efficiency, and more profitable opportunities. This clearly explains that overall economic development depends on the effective use of population and conservation of water and land as vital resources of the environment.