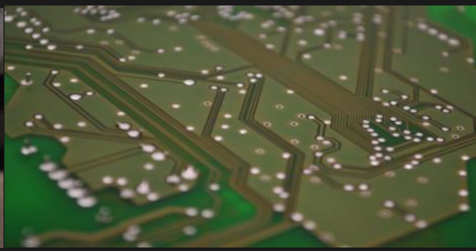
AGRO 4.0 TECHNOLOGY IN THE AVOCADO INDUSTRY

By: AvocadoCoin

https://www.avocadocoin.com

Green Token by GreenGold Project.


INTRODUCTION

Avocado output in Mexico, the world's top producer, has more than doubled in the last ten years due to increased global demand. Avocado production in Latin America reached 2.39 million metric tonnes in 2020. A farm's output may be increased by 45 percent, while water use is reduced by 35 percent with advanced technologies. According to the OECD and the United Nations Agricultural Outlook study, avocado will be the most traded tropical fruit by 2030.

Social Impact

While avocado production has contributed to regional economic development, economic benefits are highly concentrated, particularly in the spheres of influence of American agribusiness, and regional and local environmental problems disproportionately harm indigenous and rural people, the region's most vulnerable communities (Vega-Rivera and Merino-Perez, 2021).

Along with the spread of avocado plantations on community lands, new avocado orchards have been created in formerly wooded areas in recent years, making avocado expansion a significant cause of deforestation in Mexico. Furthermore, substituting privately managed avocado plantations for communal/ejido woodlands erodes community control and territorial management.

Current commons parcellation and land-use change are most prominent in San Juan Nuevo's municipality villages, where 53% of newly planted orchards are located on community/ejido properties, and 31% are older ones orchards are located on communal grounds. Additionally, freshly created avocado farms are regularly seen on community properties in the Municipality of Uruapan and across Michoacán.

Michoacán produces eight out of ten avocados in Mexico and five out of ten avocados consumed internationally. Avocado growing in the state occupies an area equal to 196,000 football fields; the state's regional economy is highly reliant on a commodity with a market worth of around $2.5 billion per year.

What are the consequences of avocado production in Mexico?

Food safety is essential.

The rising emphasis on export-based output has prompted concerns about regional food availability and whether local people have the resources to manage their agriculture. Avocados have been out of reach for many residents with deep cultural attachments to the fruit. Moreover, to increase avocado plantations, subsistence crops have been moved onto the more marginal ground (part of which was formerly wooded). This marginal terrain is much less fertile and hence less productive, resulting in food insecurity in the surrounding area.

The availability of water

Avocado cultivation has influenced freshwater availability. Avocado production utilized around 6.96 km3 of water globally in 2018. This is a significant problem for Mexico, which has already increased its water use in the previous two decades, putting its citizens under physical and economic strain.

Monetary Wealth

Avocado farming is a profitable and appealing sector in Michoacán, and it has enhanced the region's riches. Avocado farming supports around 40,000 permanent employment in Michoacán, with an additional 60,000 seasonal jobs. Moreover, wages in Michoacán's avocado plantations are far greater than those in other low-skilled employment in the area, with an avocado plantation worker earning US$ 60 per day, significantly more than Mexico's US$ 5 minimum wage, making the work particularly appealing.

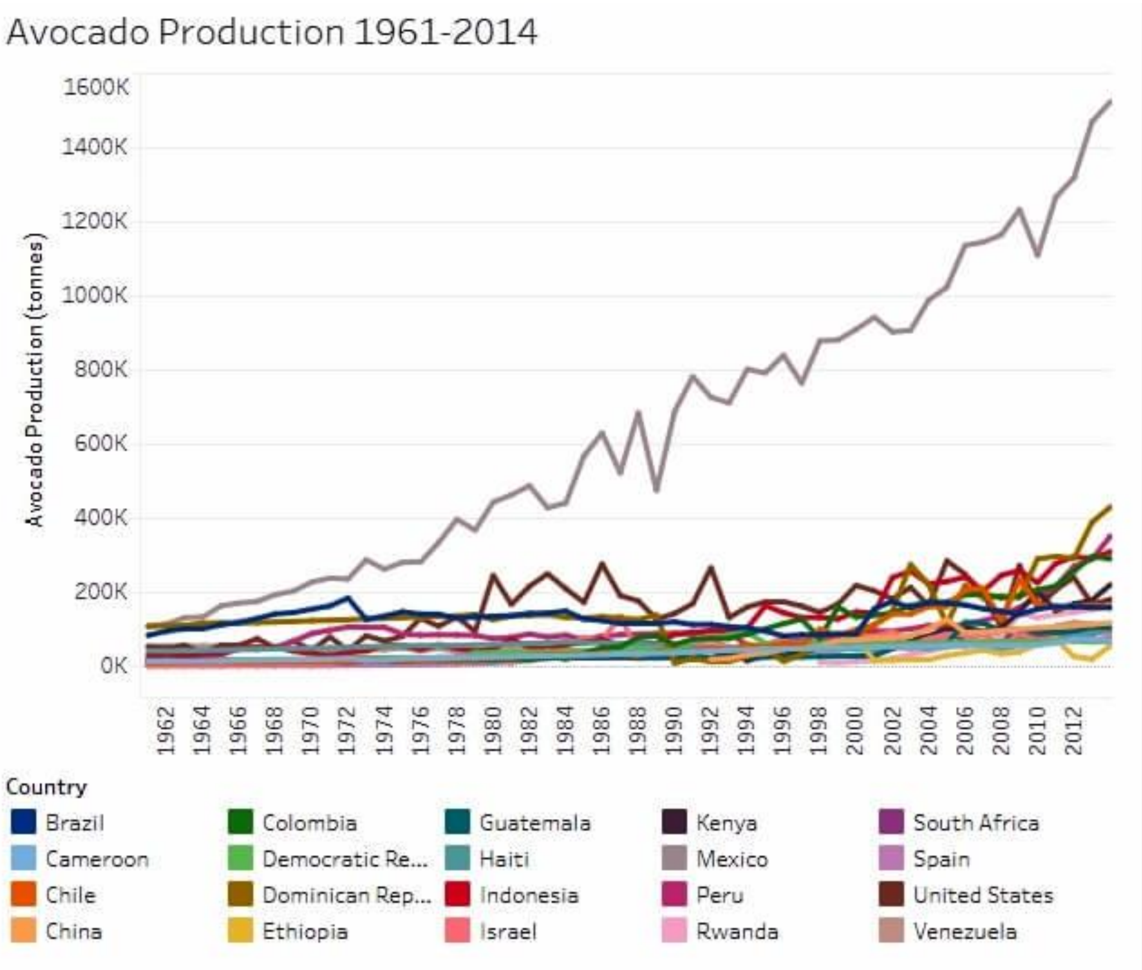
Environmental Impact

In recent decades, industrial agriculture's rise has been a significant cause of deforestation in tropical and temperate forests across the Americas, Africa, and Asia. Deforestation exacerbates biodiversity loss by jeopardizing the livelihoods of neighboring populations.

In addition to deforestation, the avocado boom has resulted in forest fragmentation, the extinction of flora and fauna of various species, many are threatened and indigenous to the area, erosion, and soil loss. Additionally, it has harmed the country's opportunity to enhance climate change mitigation and adaptation. Significant water extraction from these aquifers is causing unintended repercussions, including the occurrence of minor earthquakes. Between 5 January and 15 February, 3,247 seismic and its environs, the world's largest avocado-producing region. Local officials believe that avocado-related water extraction has exposed subsurface caves, which may be triggering these disturbances. In addition, shrubs and older trees are often felled to make way for avocado trees, leading to deforestation and, as a result, global warming and climate change. There has been a spike in warmth and unpredictable rainstorms in Michoacán's avocado-producing region recently. According to a study conducted by the National Autonomous University of Mexico Campus Morelia, the state is becoming progressively hot and dry, with fewer intense cold seasons required to sustain ecological balance and lengthened extreme hot seasons accompanied by high irregular rainfall and cyclone strength.

Avocado production requires approximately 9.5 billion litres of water each day – the equivalent of 3,800 Olympic pools – necessitating huge water extraction from Michoacán aquifers.

Avocado supply networks are opaque, involving a large number of individuals and spanning great distances. This lack of transparency impairs communication across the supply chain, conceals information about working conditions, and raises the risk of environmental and social damage. For example, Mexican exporters keep a farm-tracking database on a carton-by-carton basis but transmit only the place of origin to retailers and end customers.



Source: Slices of Blue Sky

SDGs

Many of the Sustainable Development Goals (SDGs) will be achieved primarily via improvements in the food system (SDGs). On the other hand, innovative breakthroughs may cause tremendous and disruptive changes, resulting in the concurrent and interconnected reconfiguration of several areas of the global food system. Thus, the advent of new technology or social solutions may have a wide range of impact profiles, with positive repercussions for certain SDGs and unforeseen negative side-effects in other areas. Stand-alone solutions are seldom successful in achieving good results across a range of sustainability criteria. Instead, they should be incorporated into systemic improvements to make achieving the Sustainable Development Goals easier. Eventual trade-offs must be addressed proactively to achieve genuine sustainability, especially those involving social issues such as inequality in all of its manifestations, social fairness, and strong institutions, which continue to be challenging to accomplish. It is possible to tackle trade-offs that have unintended repercussions via the construction of well-planned transition routes, the diligent monitoring of critical criteria, and the implementation of clear scientific objectives at the local level.

To fulfil the projected food demand for almost 10 billion people by 2050, whereas also fulfilling the Sustainable Development Goals (SDGs), food systems must be adjusted to be:

— Inclusive – guaranteeing economic and social inclusion for all
food systems stakeholders in the supply chain, such as small farms, women
and the younger population

— Sustainable – decreasing as much as possible the detrimental environmental effects, Preserving the scarce natural resources, protecting and stopping biodiversity loss and enhancing the resiliency against future disasters

— Efficient – providing proper quantities of nutritious and healthy foods for global demand while also keeping minimal losses and waste

— Nutritious and healthful - supplying and supporting a varied array of nutritious and safe meals for a balanced diet

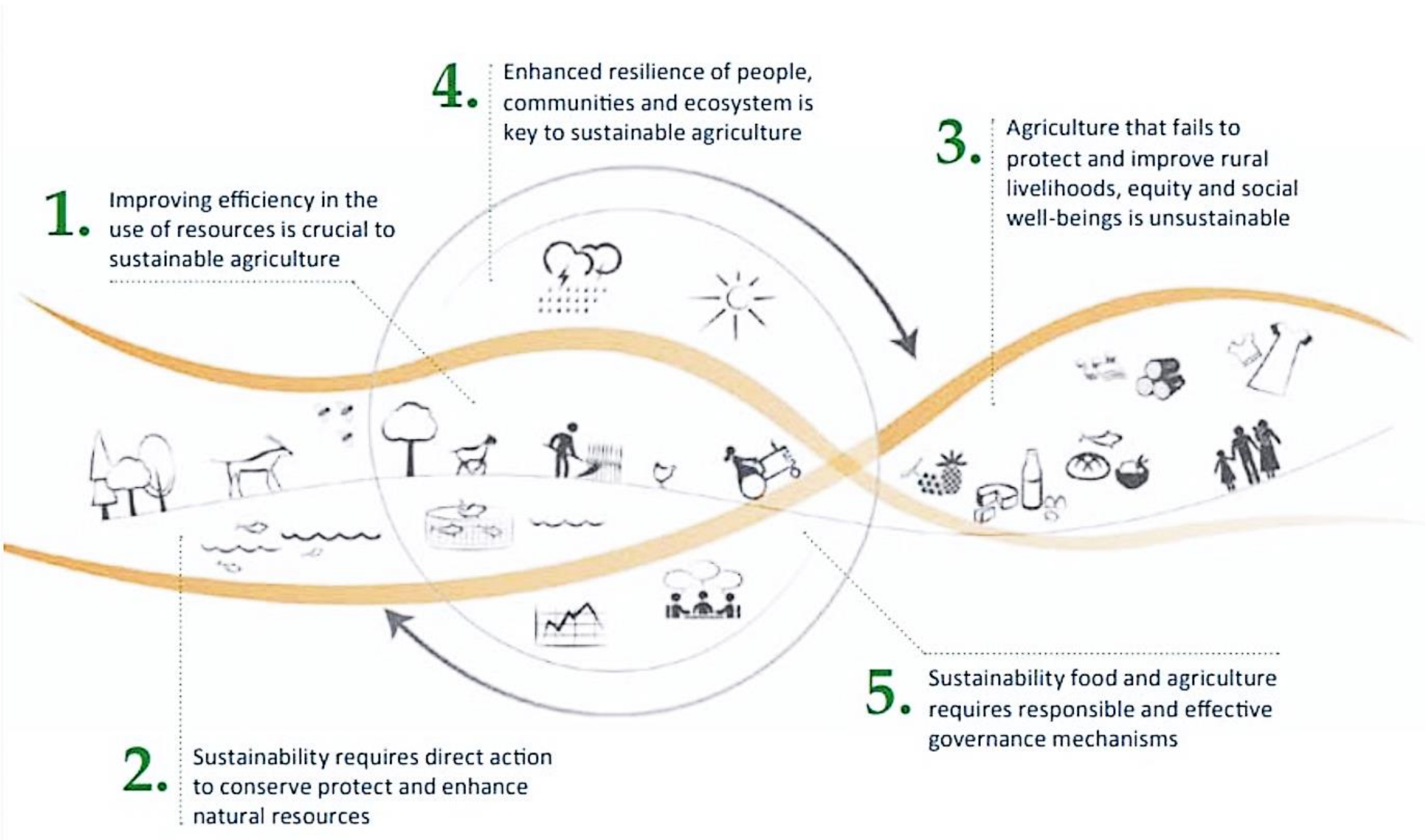
Figure 1: Food and agriculture at the centre of the SDGs
Source: FAO, 2016

It is necessary to address food systems' environmental, economic, and health implications to achieve this goal. It will need ongoing investment in crop enhancement technology, management techniques, policy and governance, business model innovation, and other time-tested tactics throughout the next decade. And it necessitates significant creation and deviations from the current quo.

By lowering exposure to toxic agrochemicals and risky equipment, reducing human injuries (SDG 3, 8), and perhaps enhancing management decision-making by eliminating cognitive biases, automation might have significant advantages for human safety. Automation might also help to save resources by reducing the usage of toxic agrochemicals and their environmental impact (SDG 12, 14, 15). Input waste might also be decreased by using more precise doses (SDG 12). Furthermore, automation may improve supply chain resilience by lowering the susceptibility of labor supply disruptions caused by pandemics, aging, or decreased population growth rates. Every one of these variables has the potential to boost and sustain output while also lowering consumer food costs, eliminating hunger (SDG 2)

Automation will significantly increase the quantity of capital in agriculture, thereby increasing economic and social inequality (SDG 10) by substantially reducing available employment and income prospects in commercial agriculture (SDG 8). Economies of scale and automation work better in more uniform production systems. More convergence in a share of production, processing, and revenue within subsectors is projected (e.g., cereal, vegetable, and fruit monocultures). Variations in farms' size, distribution, and variety might significantly impact landscapes, with ramifications for society, notably small-scale farmers (SDG 10) and ecological processes (SDG 14, 15). Automation would reduce the amount of unskilled labor in agricultural output (SDG 8), potentially leading to increased urbanization due to migration to cities, lower wage rates, increased urban unemployment, and poverty. Nonetheless, technology may alleviate labor shortages in certain places where urbanization and aging agricultural labor limit productivity.

Furthermore, the increasing usage of robotics may boost the need for expertise in robotic device design, manufacture, and maintenance. Ultimately, greater geographical separation of consumption and production might erode a growing urban population's sociocultural links to the land and the natural environment. Furthermore, robots are susceptible to malfunctions, power supply failures, and hacking. As a result, automation may merely substitute labor's sensitivity to interruption for machinery's vulnerability to other destabilizing factors.



Source: The Five Principles of sustainable food and Agriculture (FAO, 2014)

Agriculture might be revolutionized by digital technology that helps farmers operate more efficiently, effectively, and sustainably. They provide the agricultural sector the tools and knowledge it needs to make better choices and boost productivity and enable better agricultural product development, giving customers peace of mind and producers more value. Data-driven insights may assist enhance decision-making and behaviors, which can improve environmental quality and sustainability. Agriculture is transformed by digital technologies, including infrastructure and connection via mobile subscriptions and internet access in rural regions, by increasing and controlling access to money and resources using precise equipment more effectively.

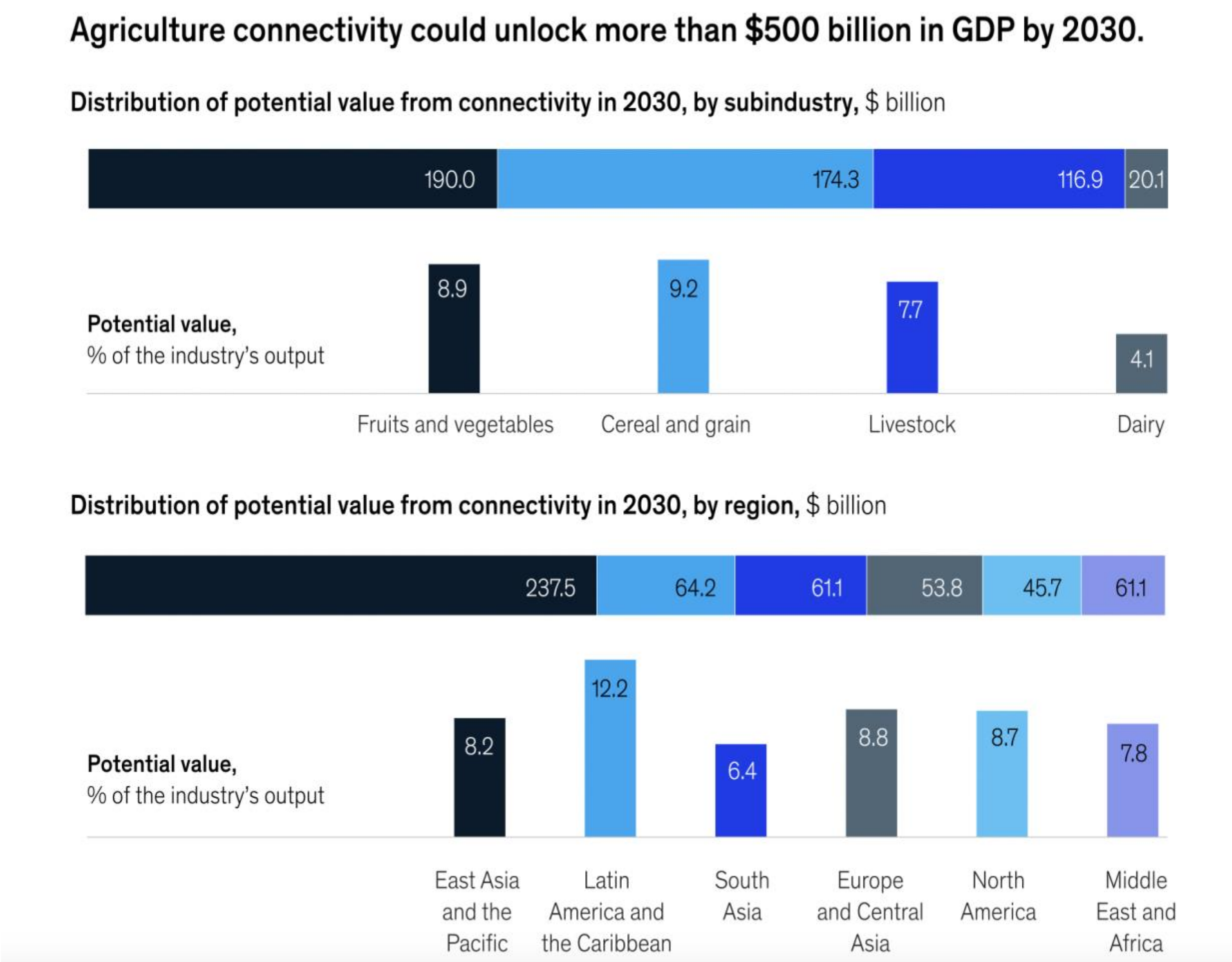
Agriculture 4.0

Agriculture 4.0, the impending agricultural revolution, must be environmentally friendly, centred on science and technology. Agriculture 4.0 will need to include both the demand and supply sides of the food-scarcity equation, leveraging technology not only for the sake of innovation but also to better and answer genuine customer requirements and reengineer the value chain.

Farms and agricultural processes will operate differently in the near future, owing mainly to technological improvements, including sensors, gadgets, machinery, and information technology. Agriculture of the future will rely on advanced technologies such as robotics, temperature and moisture sensors, aerial photographs, and GPS, to name a few. These advancements will enable firms to operate more profitably, efficiently, safely, and sustainably.

To ease decision-making procedures for optimising crop cultivation, Agriculture 4.0 includes an essential function of prediction. Since it is required to employ real-time and historical data to establish effective analytical techniques for anticipating specific occurrences, monitoring and documenting procedures are essential for forecasting.

The ability to determine crop development is critical. Still, it is also essential to approximate agricultural production yield, given the ongoing expansion of the human population and the effects of climate change, deforestation, scarcity of natural resources, and other occurrences on agricultural production.



Source: McKinsey

Through Agriculture 4.0 development tools, it is feasible to estimate crop growth based on important growth characteristics measured in the field (plant ecophysiology, environmental factors, soil nutrition levels, etc.). A new generation of AI-based approaches has been developed to predict crop yields to assist farmers in their planning, storage, and marketing techniques and meet the concerns of food security that will face the world in the coming years.

Thus, what emerging technologies and implementations in Agriculture 4.0 promise to resolve the food shortage crisis? We identify three broad tendencies in which technology is disrupting industries, which we will address by highlighting individual solutions with a high potential for systemic disruption:

1. Produce differently by the use of novel ways
2. Leverage modern technology to bring food production closer to customers, hence enhancing food chain efficiency.
3. Incorporate technology and applications from several industries

Internet of Things (IoT)

The agricultural world is being disrupted by digital revolution. With the rapid acceptance of the Internet of Things (IoT), linked devices have permeated every part of our lives, from health and fitness to home automation, automotive, and logistics, as well as smart cities and industrial IoT.

Therefore, it is only natural that IoT, linked devices, and automation would make their way into agriculture, significantly enhancing practically every aspect of it. How could one continue to depend on horses and ploughs when self-driving automobiles and virtual reality are becoming commonplace?

Agriculture has seen several technical changes over the previous few decades, becoming increasingly industrialised and technology-driven. Farmers have acquired more control over the process of producing animals and growing crops with the use of different smart agricultural technologies, making it more predictable and efficient.

Automation of Skills and Labour

The UN forecasts that by 2050, two-thirds of the world's population would reside in cities, eliminating the rural workforce. New technologies will be required to alleviate farmers' workloads: operations will be conducted remotely, procedures will be automated, dangers will be recognised, and concerns resolved. In the future, a farmer's abilities will increasingly consist of a combination of technology and biology, rather than being exclusively agricultural.

Data-driven Agriculture

When it comes to crop farming, extracting high yields from crops is becoming more difficult due to changing weather conditions. Accurately monitoring environmental crop stress is essential to ensuring that we produce enough food to feed the globe. From monitoring environmental aspects that affect agricultural output to tracking livestock quality, smart agriculture implementations based on Internet of Things devices provide farmers with unparalleled flexibility and ease of use, reducing environmental impact, maximising yield, and decreasing cost in record time. By evaluating and comparing information about the weather, seed kinds, soil quality, disease likelihood, historical data, and market patterns.

SMTC is a pioneer in the area of high performance and mixed-signal semiconductors and complex algorithms. In September 2020, the company announced that ICT International, a supplier of IoT solutions for environmental practical operationalisation and Definium Technologies, a development company and distributor of Internet of Things entry points and gadgets, will use devices highly premised on Semtech's LoRa® and LoRaWAN® protocol to immobilise vehicles. Semtech's devices are used in plant physiology sensors, allowing for precise and faster monitoring of moisture movement within the plants and the rapid response to stressors to increase production. Therefore, producers increase their profits while simultaneously lowering their expenditures associated to product loss.

Artificial Intelligence

In artificial intelligence (AI), technologies are used to do activities that would otherwise need the use of human intellect, such as perception of visual objects, voice recognition, and translation between different languages. It provides a wide range of utilisations, although its usage in agriculture is only expected to develop modestly in the foreseeable future.

Farmers may use AI to get real-time insights on their crops, identifying areas that need irrigation, fertiliser, or pesticide treatment. Additionally, novel agricultural approaches such as vertical agriculture may assist boost food output while conserving resources. Another fast-growing use of AI and machine learning in agriculture is evaluating livestock's health.

For instance, the US company Blue River Technology has created a robotic system (dubbed LettuceBot) that harvests lettuce. With the device, you can tow all over a field, photograph plants at the rate of 5,000 images per minute, and also use computer-vision algorithms to locate excess plants and spray them with herbicide in concentrated bursts just where they are. A single LettuceBot can detect over 1.5 million lettuce plants each hour and operate 90 times per second, all with an accuracy of 2.5 centimetres.

SupPlant, an Israeli company that provides a leading precision agricultural hardware-software solution, specialises in detecting plant stress. They have transformed their knowledge into a system that employs agronomic algorithms, sensors, machine intelligence, intelligent systems, and cloud-based technologies to accomplish their objectives. They have created a data model based on analysing 100 million avocado data points produced using predictive algorithms.

In five different locations on the plant (deep soil, shallow soil, stem/trunk, leaf, and avocado), SupPlant's devices detect the stress experienced by the plant. These sensors track plant and fruit growth pathways and the amount of actual water present in the soil and the plant's health. Along with this information, SupPlant monitors real-time and expected meteorological data, along with predicted plant development trends, among other things.

Crop pest infestations, that encompass weeds, insects, microbes, and rodents [70], as well as illnesses, are also seen as significant factors affecting agricultural productivity globally. Therefore, there is an immediate need for efficient technologies that reliably identify weeds, crop pests, and illnesses in real time and yield preventative steps to avert large agricultural damages. Lately, smart identification systems based on artificial intelligence-based image processing methods have become critical for agricultural management, enabling for early diagnosis of such issues before they spread and cause major crop damage. Once the infecting agent has been identified, the technology gives farmers with quick diagnosis, feedback, and remedies that include prevention measures. Numerous AI-based detection techniques have been explored and developed for weed identification and classification [71,72], insect pest identification and classification [73], and crop disease identification and classification [74,75,76,77].

Remote monitoring of fundamental soil characteristics might be viewed as one of Agriculture 4.0's potential utilisations for ensuring appropriate and sustainable agricultural management. Along with many other factors, they comprise temperature, moisture content, electrical properties, pH value, and nutritional composition (main nutrients such as nitrogen (N), phosphorus (P), and potassium (K), secondary nutrients such as calcium, magnesium, and sulphur, and micronutrients). Farmers are enabled to manage their fields more efficiently and sustainably via the combination of IoT sensors that monitor these factors in real time, AI-based data processing methodologies, and decision-support systems (DSS) This approach brings significant advantages for farmers, including an increase in production and product quality, a reduction in spoilage caused by incorrect or excessive fertiliser use, a reduction in crop loss risk, and a reduction in the time and cost associated with agricultural practises.

Water impact

There are a variety of various water efficiency solutions available today. The most remarkable is the use of plastic mulch (a protective cover) to maximise evapotranspiration, and also a novel drip watering system, which is more efficient and direct, and does not cause erosion of the soil. Other trials are being carried out, such as using glass roofs to "recycle" the evapotranspiration of trees and seeing the results. "These three projects are assisting us in our long-term campaign to be as environmentally friendly as possible," says Francisco Contardo-Sfeir, general manager of Chile's Hass Avocado Committee. "Better efficiency and less water use are two of our top priorities, and these three projects are assisting us in that pursuit," he adds.

Another unique technique comes from Aqua-4D and its patented technology, which has improved growth while also achieving considerable water savings of up to 30%. The Aqua4D is a technique developed in the early 2000s and uses electromagnetic signals to cleanse water before it is used. These impulses are low-level and non-invasive. They influence the formation of water and its surface tension, causing the molecules of water and the minerals inside it to be rearranged as a consequence. As a result, when the water molecules are divided into smaller elements, they can penetrate into the soil with greater ease. Because of the capillary effect, the plant could retain more water, which means that it could absorb the exact quantity of water that it needed to survive.

Blockchain

Blockchain adds an additional layer of protection and transparency to their data by preventing them from changing any of the data in their database later. A drawback of this system is that the hashes are still uploaded to the blockchain through a centralised database, resulting in a single point of failure. When one person's identity is linked to a blockchain wallet, each transaction that originates from that address may be linked to that person. Transactions coming from this account may be utilised to verify claims if this individual has a specific authority, such as an organic certifying agency. For instance, a transaction from this account might certify that a particular batch of food is organically certified.

Automation of the Supply Chain

Supply chain participants must defend themselves against the particular risks of international commerce, such as currency movements, political turmoil, non-payment concerns, and the creditworthiness of one of the unknown relevant parties, while participating in international trade. To mitigate the risks indicated above, several agreements with diverse third parties must be established. This procedure is both expensive and time-consuming.

This procedure might be totally automated with using smart contracts. The details of the credit agreement between the supplier and the financing entity and the tokenized inventory as security may be encoded in a smart contract. The smart contract then functions as a lockup for the payment vs delivery, speeding up the process while lowering costs and the risk of human mistake (Hoffman, Strewe and Bosia, 2018).

The physical position, transit temperature, and estimated arrival time may all be recorded and stored into the blockchain using Internet of Things (IoT) sensors, providing extra assurance concerning the proper execution of the contingent agreements made in the smart contracts. Modern sensors are capable of sensing pressure, movement, acceleration, and sound in addition to location and temperature (Nucleus Vision 2018). In recent advancements, “chemical barcodes” have been developed, in which particular molecules are utilised to track food and pharmaceutical items (Stockhead, 2018). These advancements contribute to resolving the “garbage-in-garbage-out” issue typically associated with BCT and enhancing supply chain automation trust.

Cloud Computing

Cloud computing is evolving as a commercial Internet-based architecture model that enables hardware, infrastructure, framework, software, and storage capabilities to various IoT applications. Cloud computing has acquired tremendous attention in the agriculture industry over the last decade owing to its capacity to provide: (a) reasonably priced data storage facilities for text, image, video, as well as other agricultural relevant data, which significantly reduces storage expenses for agricultural firms; (b) intelligent large scale computing devices, which enable the transformation of raw data

A cloud-based farm control system represents a practical implementation of cloud computing in the agricultural environment. It enables the connectivity of internal and external services and provides a marketplace of innovative and complex technologies and services that end users can employ. This method may be seen as a critical instrument for agricultural business management, as it supports farmers in optimising agricultural operations on their farms.

Notwithstanding its many advantages, cloud computing does have certain drawbacks. IoT apps are expected to create significant amounts of data (which may include private data in certain situations) and reply in a very short period. They are, however, vulnerable to network latency, which makes cloud computing unsuitable for these applications, which need a continual interchange of data amongst devices and infrastructure.

Edge and fog computing approaches seem to address this constraint. Edge computing allows computer services to be provided closer to information sources, at the network's boundary. As a result, it enables near-real-time analytics while keeping data safe on the device if necessary. Fog computing, which exists as a buffer between edge and the cloud, tries to act as an intermediary between end-devices and standard cloud computing data centres by offering computation, storage, and networking functionalities. This virtual layer is generally, but not always, found near the network's edges. Fog computing can mitigate for edge computing's low processing capability and also perform data fusion, combining data from numerous sources for further computation in the cloud.

RPA Technologies

Robotic process automation enables farms and businesses to automate most monotonous operations, freeing up precious time for more critical jobs that need attention and ability. This may result in higher production and, therefore, increased profit.

The corporation and farmers both profit from automation in a variety of ways. Using automation techniques makes it possible to minimise human labour by automating many of the tasks formerly performed by humans. Robotic Process Automation has aided businesses in automating their farms by automatically analysing pricing information, weather conditions, and advantages without human interaction.

Humans are prone to mistakes and exhaustion, and by implementing Robotic Process Automation in agriculture increases job productivity and dependability. Additionally, it boosts the pace, allowing for speedier completion of tasks. It simplifies the monitoring of crops, fields, pricing, and procedures via Robotic Process Automation. They ensure that everything is operating effectively. Robotic Process Automation is effectively managing the market and commerce. This results in more efficient management operations. By eliminating manual labour, stakeholders may cut manufacturing costs and managerial overheads. Farmers and growers may use RPA to effectively automate farm management in order to enhance planning and forecasting, assess pricing, monitor inventory, and optimise accounting.

The Benefits of Robotic Process Automation in Agriculture

Increased Quality

Stakeholders may drastically minimise mistakes and response times using RPA. RPA also improves process stability by managing unstructured data more effectively.

Increased Scalability

RPA can provide superhuman skills and flexibility when automating a process, regardless of the size of the company. Additionally, it might minimise the amount of manpower necessary to complete a task.

Proactive Risk Management

By automating agricultural processes, human error may be minimised. Additionally, it improves the accuracy and agility of data.

Increased human performance

By automating regular, repetitive operations, human employees

Big Data Analytics

Big Data refers to information assets that are so large in volume, velocity, and diversity that their translation into value requires specialised technology and analytical procedures (De Mauro et al., 2016). Business analytics at a never-before-seen size and velocity will be a key differentiator, constantly innovating new business models. Farm management and operations are likely to undergo dramatic changes as a result of access to actual data, real-time predictions and monitoring of physical goods, as well as increased automation and automated operation of the farm as a result of IoT advances. Nevertheless, it is clearly clear that Big Data will result in significant alterations in the power dynamics between the many stakeholders in the Big Data farming ecosystem.

We anticipate that farm operational management will alter dramatically due to the use of large volumes of real-time and historical data from various sources, as well as advanced computation, predicting, and tracking capabilities. This will allow for the constant improvement of business models. Large historical multi-site information may be utilised to optimise agricultural yield by identifying ideal factors (e.g., temperature, rainfall) information from the large historical multi-site datasets.

The initial element of this process — data collecting — is aided by IoT devices. Sensors installed in tractors and vehicles, and also fields, soil, and plants, enable the gathering of real-time data from the surface.

Second, analysts combine the massive volumes of data gathered with other cloud-based information, such as weather data and pricing models, to identify trends.

Ultimately, these trends and insights aid in the problem's control. They assist in identifying current difficulties, such as operational hindrances and soil quality concerns, and developing predictive algorithms that may inform users even before a problem emerges.

Big data has enabled real-time performance improvements throughout the industry by aggregating data from a large number of sources and converting it to actionable information that can be used to enhance business operations and address issues at scale and speed. Today, big data analytics can demonstrate how farmers are using their inputs and what adjustments are necessary to accommodate for impending weather events or disease outbreaks.

Agriculture has continually increased its use of analytics; the industry is predicted to rise from USD 585 million in 2018 to a stark USD 1236 million by 2023, at a Compound Annual Growth Rate (CAGR) of 16.2 per cent. Agribusinesses are getting bigger and more diversified, resulting in an increase in the amount of complicated data that must be maintained on a continuous basis. External data sources include social media, supplier network channels, and sensor / machine data collected in the field. This results in a revolution of the agriculture sector, creating new prospects.

Recent Research in the Avocado Industry

Israel

Avocados have established themselves as a lucrative agricultural product in Israel during the last several years. The pace of planting these green fruit trees has risen dramatically, even at the cost of other fruit species such as citrus.

In an interview with CropX, Matan Rahav, director of business development, says that the firm's soil sensors are placed in the soil and assess moisture, temperature, nutrient levels, electrical properties, and other parameters. Furthermore, the data tracked by the sensors is then transferred to the cloud, where it is processed and delivered to the farmer in the form of management data. "In a recent lucerne study, water consumption was cut by 40%, while yield increased by 10%," says the researcher.

Saturas, an Israel-based firm that focuses on optimising farmers' water management, refers to their unique technology as InTree intelligence, which stands for "InTree intelligence." According to Lilach Zaretski, regional account manager for Saturas, Israel's daily task is to make the most of available water resources.

"This is truly a source of contention for farmers all over the world. The advancement of plant-sensing technology was prompted by the need to save water while boosting productivity. At the moment, farmers have no other option but to use Saturas, which is the only commercial firm that provides them with direct access to the tree's status data.

Rather than climbing the tree, Saturas uses a gadget that is attached to it. This gadget communicates with the farmer by sending information about the tree's health straight to him.

"Our method is based on the stem water potential [SWP] of the tree," says the researcher. SWP is the scientific unit that is used to quantify the amount of water tension in a tree. Essentially, this represents how much energy it takes for a tree to extract water from its surroundings.

Zaretski explains that "SWP is widely recognised by prominent research institutions as the best indication of a plant's water condition and has been regarded as the gold standard approach since 1965." Nevertheless, it has only been employed on a limited scale inside academic contexts up until now, since it is not particularly practical at the farm level. Saturas' InTree gadget claims to have bridged this gap and provided farmers with the science they need daily in a practical package that they can use. Fruit farmers, for instance, utilise InTree's monitors to make intelligent watering choices, resulting in economic outcomes that boost production and quality while simultaneously lowering expenses.

Whereas batteries power the sensors and transmitters, every communication hub need energy to function correctly. The standard power grid or solar panels may both be used to provide this energy. Each hub is linked to hundreds of trees on a single network. You'll also need Internet access, but Zaretski points out that "we operate in a variety of locations throughout the globe and have never had an issue with it thus far."

South Africa

SeeTree, a data gathering and analysis firm, collects and analyses data to provide farmers with the information they need to maintain each tree according to its demands. According to Alexander Rudinsky, SeeTree's South African project manager, the firm began with two modest citrus experiments around a year earlier and has since grown to handle over 6 000ha of South African citrus trees.

"They develop tree-centric digital maps of the farm by combining 3 levels of technology to produce an all-in-one platform for agronomic data," says the author.

Drones of military-grade construction are employed to capture aerial photographs. After that, the orchards are digitised with the help of both human and artificial intelligence. The insights that cannot be obtained from the air are obtained via the employment of a specialised vehicle. Team members from the ground visit the orchards to verify and calibrate the information.

"They employ multispectral sensors to monitor chlorophyll, water content, vegetation, and a variety of other characteristics to establish the health state of each tree," says the researcher. Farmers get a report and dashboard information, which they may use to make day-to-day and tactical choices about their farms.

The fact that farmers cultivate in areas with many connection challenges does not exclude them from using our services. When you're out in the field, you may use the programmes in offline mode, which we built for you. You may just input the data into the system again whenever you have reception again."

Rudinsky claims that they have created a simple tree health language that enables for the easy control of manufacturing units in their company. A few of the data layers accessible in the SeeTree management tool are tree height, canopy area and volume, weed density and height, and a few examples.

Spain

Trops, Spain's biggest avocado grower, has partnered with digital agriculture firm AgriSmart Data on a program that claims to have cut the required amount of water by plants in half.According to them, this number of 350 litres of water per kilogramme of avocado produced is a "world record," based on established statistics of 600/700 litres per kilogramme. Trops with AgriSmart data enable the production of Hass avocados with a yield of less than 350l / kg fruit. T

Irrigation management via Precision Agriculture technologies created by AgriSmart data is «an illustration of the benefits that the use of new technologies entails for subtropical agriculture and agriculture overall, as it enables more efficient operation of water, a scarce resource and critical to society's development.

United States

Kurt Bantle, an avocado farmer in California, sought to innovate with Internet of Things (IoT) linked technologies to see whether he could lower his 900 avocado plants' pricey water usage.

He invested $8,200 on LoRa stations equipped with soil moisture sensors, valve controllers, a Lora gateway, and cellular backhaul in order to monitor and control soil moisture monitoring and just-in-time watering. The findings were astounding. Watering his 900 avocado plants cost him $47,336 per year. By using IoT technology to link his trees, he was able to reduce his yearly water expenditure to to $11,834... a savings of 75%. Within six months, the hardware investment was recouped.

However, the consequences extend far beyond the realm of this pioneering farmer. It opens the way for millions of small, medium, and large-scale farms worldwide to replicate his experiment and save millions of dollars on fruit and vegetable production.

Challenges

Digital data possession and administration

Individual data is collected via digital technology. Companies utilise the data provided by agricultural equipment sensors for their business models, just as they do in other industries; data analysis and processing are critical for the proper functioning and maintenance of novel technologies. To prevent exploitation by other parties, clear rules and regulations must be in place and should always be on the side of the farmer/individual. The constant requirement for data to develop, create, or manage the AI underlying the software that controls autonomous equipment, on the other hand, may provide an opportunity for farmers to profit from the data collected. Additionally, data creation might be used to track ecological functions or environmental indicators (e.g. carbon sequestration).
Additionally, data creation might be used to track ecological functions or environmental indicators (e.g. carbon sequestration).

Capacity

The pace of implementation of any new technology is determined by three significant factors: education, competence, and capacity. Most farmers may be unable to operate agrobots or comprehend how they function. A competent agricultural practitioner isn't always an expert in digital technology and automation like extension workers and service providers. As a result, capacity development is critical for the adoption and proper use of automation systems; only with ability can farmers realise the full possibilities of novel technologies.

Individuals with innovative ideas might be drawn to the field of agricultural robotics by channelling their interest in digital technology toward applications in agriculture.

If governments are to have the trained labour required to run, maintain, and develop technology, academic and educational programmes must adapt. Furthermore, knowledge acquisition must not be limited to end users: capacity building must include all stakeholders, including policymakers responsible for creating the right environment through legislation, incentive schemes, or training courses (education, industry, and agriculture), as well as extension officers, technicians, and farm workers.

Infrastructure for information technology

Agriculture 4.0 is inextricably tied to the use of ICTs and is highly dependent on the availability of suitable IT infrastructure for data collection, processing, and sharing. Agrobots rely on data from built-in sensors, remote sensors (such as satellite images), external sensors (drone pictures, soil probes), programmed actors, and numerous agronomic criteria stored in its software to perform independently. All of this data must be collected and shared, which necessitates access to dependable IT infrastructure with adequate signal coverage, energy supply, and strength to support data transfer, not only for satellite positioning (GPS), but also for telephone or radio signals. Not only does the agrobot need data to function, but the farm manager and operators must also be able to control the agrobot, analyse the data it generates while in operation, and make choices based on that data. This is a significant difficulty since a phone signal's capacity does not reach to all rural locations, particularly in developing nations. To adapt agrobot ICTs to the constraints of underdeveloped nations, engineering solutions may be necessary for tough locations and settings.

Monitoring and management of irrigation

This significant milestone was accomplished by developing and implementing irrigation management and planning monitoring and control technologies over more than three years of experiments conducted by Trops' technical department using AgriSmart data.

The capacity of the iTelemeter equipment (AgriSmart data) to auto regulate irrigation, the advancement of the algorithms that dictate it, and the continuous monitoring of tree growth and the farm's microclimate have enabled this "to undertake out an extremely efficient irrigation system, minimising tree stressful conditions, to achieve the maximum potential productive capacity with the available water resources.

Precision agriculture, as per Trops, provides a "significant advancement" toward the company's primary sustainable development goals, such as "Ensuring the supply of water and sustainable management." This provides farmers with the skills necessary to manage water sustainably, preserving and even improving the production of agricultural assets.

These digital solutions are now available for use across the region. The objective is for farmers and agricultural professionals to begin using them to enhance agriculture's agronomic, economic, and environmental performance.

Advantages of Agriculture 4.0

Reduced human labour

It relieves individuals of time-consuming and repetitive chores. It accomplishes the same operation more effectively and in less time by using Robotic Process Automation. So, human labour may be employed for more critical and high-priority tasks that need more expertise and attention.

Minimizes error

When individuals are prone to repetitious jobs, the likelihood of making a mistake increases. Thus, robotic process automation significantly decreases human error and improves data accuracy.

Increased Quality

Because machines perform most jobs, the overall quality of work is improved. Additionally, it results in decreased mistakes and reaction time. It performs assignments more efficiently and hence promotes stability. Population growth and altering policies have affected food pricing, availability, and delivery. The corporation must meet these increasing expectations, which is now experiencing a resource and human labour scarcity. By automating numerous processes, we have reduced costs and boosted productivity and profit. Robotic Process Automation has aided in increasing efficiency and reducing costs. Thus, robotic process automation is more lucrative and productive in agriculture.

Conclusion

Given its natural resources and drive to innovate, Latin America will emerge at the forefront of the convergence between digitalisation and agriculture. Every link in the agrifood supply chain will be affected by digitalization. The system's resources may be managed in a highly personalised, intelligent, and predictive manner. Powered by data, it will operate in real time and in a hyper-connected manner. By tracking and coordinating the whole value chain in great detail, it will be possible to precisely manage various types of agriculture and animals to their own best prescriptions. As a result of technological advancements, digital agriculture will produce systems that are more productive, proactive, and flexible in the face of future challenges, such as climate change. As a result, increased food safety, profitability, and long-term viability are all possible outcomes.

Due to the scarcity of agricultural resources. the only method to raise volume is to enhance production efficiency. There is no dispute about the amount to which smart farming may assist in overcoming this obstacle; rather, it seems that it is impossible without it. Technological initiatives that are implemented in isolation risk failing or exerting little systemic influence. Many complementary and linked technology solutions, on the other hand, may have a greater effect while concurrently addressing multiple difficulties.

Mexico's pioneering initiatives will help even the poorest farmers to produce and sell more crops by combining cutting-edge agricultural science and farming techniques with digital technology. Avocados are one of the fastest growing markets globally, and consumption has expanded significantly in recent decades, notably in North

America and Europe, owing to a mix of socioeconomic and marketing reasons. The avocado boom has increased local companies and employment, prompted investments in technology and equipment, and benefited the industry's transportation fleets, packing factories, sanitary inspectors, and orchard workers.

Per the Agricultural Outlook 2021-2030 review from the Organization for Economic Cooperation and Development (OECD) and the Food and Agriculture Organization of the United Nations (FAO), avocado will surpass both pineapples and mangoes in terms of volume by 2030, the year in which production is expected to reach 12 Mt, with up to 3.9 Mt of that amount being exported, making avocado the most commercialised tropical fruit. This increase is being driven mostly by abundant global demand and attractive export unit prices, which are motivating significant investments to expand production zones both inside and outside of the major manufacturing centres of the world.

To overcome these problems, governments, investors, and agricultural technology innovators will need to work together in a coordinated effort. It will no longer be necessary to apply water, fertilisers, and pesticides consistently over whole fields in order to achieve Agriculture 4.0 success. Instead, producers will employ the bare minimum of resources and concentrate their efforts on very particular areas. As a result of technological breakthroughs such as sensors, gadgets, machine learning, and information technology, farms and agricultural operations will have to be operated in a completely new manner. Robots, temperature and moisture sensors, aerial photographs, and GPS technology will all be used in future agriculture, as will other complex technologies like as genetic engineering. Farms will be more lucrative, efficient, safe, and environmentally friendly as a result of the use of modern equipment, precision agriculture, and robotic systems.

- Cost control and waste reduction are improved as a result of enhanced management over manufacturing. By identifying any irregularities in crop growth or animal health, you can decrease the risk of production loss.

- Increased efficiency of the company via process automation. Agricultor may automate several operations throughout the production cycle by using smart devices, including as irrigation, fertilisation, and pest control.

- Furthermore, novel technologies would result in increased product quality and quantity. By automating the production process, producers may have more control over it and maintain higher standards of crop quality and growth potential.

- Moreover, Increased control over internal processes results in reduced production risks. The capacity to forecast your production's output enables producers to prepare for more efficient product distribution.

Agricultural production, cost efficiency, and market possibilities may all be improved by digital agriculture as part of the Sustainable Development Goals, as can social and cultural equity, diversity, and inclusion, as well as resource efficiency and climate change adaption. Better food traceability will be made possible via the use of IoT technology, resulting in improved food safety. As a bonus, the environment will benefit from more effective water use and treatment inputs and outputs. Because of this, it has a direct influence on irrigation water costs and has an enormous impact on the limited water resources in the area. According to current agricultural trends, farmers are using "smart irrigation" to water their crops in accordance with their demands and the status of the soil. When the water balance is calculated using the sensors installed in the fields, the technology developments will tell farmers when and how much to irrigate to save water.

For decades, farmers made irrigation decisions based on their intuition, experience, and, at most, some scattered data. Traditional watering methods confine producers to a reactive, rather than proactive, approach to avocado protection. Today, technology is assuming control of this region, enabling farmers to irrigate more efficiently and produce more avocados.

According to the United Nations Food and Agriculture Organization (FAO), around one-third of food that is produced for human use is wasted or lost each year. Nevertheless, the use of big data is transforming agricultural techniques, opening up new avenues for assisting those who are harmed in the fight against the food crisis.

Agriculture may contribute to Agenda 2030 in the following ways:

* SDG 1 (No Poverty): Rural people account for 70% of the world's severe poor. Thus, agriculture has the potential to contribute more to poverty reduction than any other industry.

* SDG 2 (Zero Hunger): 33% of global farming production is wasted because of rudimentary labor and inefficiencies. But with the development of aggrotech that will change, and we can even double food production with the current resources.

* SDG 4 (Quality Education): Agricultural extension helps farmers to get the necessary skills, tools, inputs, and information.

* SDG 5 (Gender Equality): In general, women farmers produce 20%–30% less than men farmers, owing to disparities in their access to and utilisation of resources. Due to the fact that women produce more than half of the world's food, closing this gap might help alleviate global hunger.

* SDG 6 (Clean Water and Sanitation): By 2030, worldwide demand for water will have quadrupled, with agriculture alone demanding more than the world's food supply can maintain (even before domestic and industrial needs are met).

* SDG 7 (Affordable and Clean Energy): By 2030, global energy consumption will have doubled, with the majority of the increase coming from emerging nations. More crops are projected to be cultivated for biofuels, perhaps doubling or even tripling their current share of overall consumption.

* SDG 8 (Decent Work and Economic Development): Agriculture may be a source of employment and economic growth that benefits the disadvantaged in rural regions.

* SDG 12 (Responsible Consumption and Production): Average per capita consumption is predicted to increase through 2030, even if around one-third of food produced is wasted.
* SDG 13 (Climate Action): By 2030, agriculture's carbon mitigation potential may reach up to 7.5 percent of total world emissions, depending on the carbon price and agricultural productivity measures adopted.

* SDG 15 (Life on Land): Improving agricultural efficiency may help fulfil food demand while reducing the need to convert natural ecosystems and forests for further farming.