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New Innovative Agricultural Technologies for Modern Sustainable Agricultural Practices

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Abstract

The intersection of scientific advancements, global urbanization, and shifts in food preferences are driving agricultural research towards innovation. With rising incomes in non-industrial countries, changing occupational patterns, and global connections, there's a growing demand for more nutritious and plentiful food. However, traditional agriculture methods have limitations, particularly due to environmental concerns associated with synthetic fertilizers and pesticides. To address these challenges, new farming innovations are crucial that includes vertical farming, precision agriculture farming, drone technologies, IoT etc., By integrating these innovative approaches with traditional agriculture, it's possible to increase production and profitability while mitigating environmental risks. Ultimately, these advancements are essential for meeting the growing global food demand sustainably.

Introduction

Agriculture has seen immense innovations in recent years that are transforming the industry to be more efficient and sustainable. Farmers have embraced the advancements and are constantly seeking new ways to manage their farms effectively. In this blog post, we will explore the six most impactful innovations in agriculture that will revolutionize farm management. From precision agriculture to wastewater treatment, the different innovations offer a promising future for the agriculture industry.

Types of advances in agricultural farming sector

Drone use and artificial intelligence

Drones and artificial intelligence are making the monitoring and treatment of crops far more efficient. Drones and precision agriculture are growing hand in hand, and newer technologies are evolving to enable artificial intelligence to help gather, interpret and act on real-time data. Science has advanced so much that drones and AI can operate advanced sensors and collect crop imagery that helps diagnose the crop's health. In addition, farmers can use this data to plan their next moves and detect any issues like pests, pathogens, or crop stress.

By 2050, the demand for food will surge 70%, in line with rapid population growth. A UN study found that about 9.9% of the world's population still goes hungry, so the thought of feeding almost 10 billion mouths is a daunting prospect. With environmental changes hard to predict, we must turn to innovation in agriculture technology.

Bee Vectoring Technologies

BVT uses commercially reared bees to deliver targeted crop controls through pollination, replacing chemical pesticides with an environmentally safe crop protection system. The system doesn't require spraying water or the use of tractors. Instead, the scientifically designed bumblebee hive allows bees to pick up a trace amount of pest control powders on their legs to spread as they travel within the field. This innovation in agriculture technology supports improved sustainable farming, crop yield, and soil quality. BVT's solution is suitable for many crops, including blueberries, sunflowers, apples, and tomatoes, and it also works for farms of all sizes.

Precision Agriculture

Precision agriculture is an agricultural resource management strategy that collects, processes, and evaluates data and offers insights to help farmers optimize and increase soil quality and productivity. Management decisions count on precision agriculture data points to improve farmland and farm produce across several key areas, including:

- ✓ Resource use efficiency
- ✓ Sustainability
- ✓ Profitability

- ✓ Productivity
- ✓ Quality

This innovation in agriculture technology uses big data to aid management decisions, enabling farmers to control crop yield variables like moisture level, soil condition, and microclimates to maximize output. It relies on remote sensing systems, drones, robotics, and automation to improve crop health and optimize agricultural resources, leading to more productivity.

Indoor Vertical Farming

The average yield of rice per hectare is between three and six tonnes. However, farmers don't have to face this limitation when using indoor vertical farming. This Indoor vertical farming grows farm produce stacked above another in a closed and controlled environment. The technology uses growing shelves mounted vertically to increase crop yield in limited spaces. Quite often, the shelves don't require soil-they're either hydroponic or aeroponic:

- ✓ **Hydroponics** is a gardening practice that grows plants in water and nutrient solutions.
- ✓ **Aeroponics** suspends the roots of the crops in the air, with emitters intermittently spraying them with water and nutrients.

Indoor vertical farms enable growers to control variables such as light, temperature, water, and sometimes, carbon dioxide levels, allowing them to get healthier and bigger yields. Other benefits of the technology include 70% less water usage, which conserves energy, and reduced labour costs due to the use of robots for harvesting and planting.

Livestock Farming Technology

Emerging livestock technologies provide farmers with data-driven insights, allowing them to streamline farm management, improve animal care, and boost productivity.

Here are some of the many innovations redefining livestock farming:

- ✓ **Automated dairy installations** milk cows automatically without human intervention, and the milk sensors also help farmers monitor the milk quality.
- ✓ **Automated cleaning systems** remove waste, enabling cleaner as disease-free environments.
- ✓ **Armenta's non-antibiotic treatment** uses acoustic pulse technology (APT) for bovine mastitis, a cow disease responsible for over $6 billion annual losses in the U.S. and Europe.
- ✓ **Automated feeder systems** provide animals with feeding mixtures tailored to their specific needs and in the right amount.
- ✓ **Faromatics employs robotics, A.I., and big data** to increase animal welfare and farm productivity.
- ✓ **Laser Scarecrows**

Farm Automation

Farm automation brings together agricultural machinery, computer systems, electronics, chemical sensors, and data management to improve equipment operation and decision-making, and ultimately, reduce human input and error. Reduced labour time, higher yields, and the efficient use of resources are driving the large-scale adoption of the technology. Farmers now use automated harvesters, drones, autonomous tractors, seeding, and weeding to transform how they cultivate their crops. The technology takes care of menial and recurring tasks, allowing them to focus on more critical functions.

As with any field (no pun intended), automation can help employees save time, as the technology reduces the need for people to actively partake in a task.

Real-Time Kinematic (RTK) Technology

RTK technology can provide centimetre-level accuracy, which enables farmers to accurately map their fields and constrain vehicles permanently on the same lane. It transmits the correct positioning information to tractors by radio signal, allowing them to stay on track while moving. This innovation boosts soil health and productivity, increasing output with less input.

Minichromosome Technology

Genetically modified food has taken some flak over recent years, with studies suggesting it may be linked to allergic reactions or include harmful toxins that can expose humans to health risks. Another issue is that G.M. food production can disrupt natural biodiversity or release toxins into the soil. Agricultural geneticists can apply minichromosome technology to enhance a plant's traits without altering the genes in

any way. Since minichromosomes contain small amounts of genetic material, it's possible to use this technology to make plants more drought-tolerant or resistant to pests without interfering with the host's natural development. In short, minichromosome technology allows genetic engineers to create crops that require fewer pesticides, fungicides, and fertilizers, reducing reliance on harmful chemicals. It also lets them achieve bio-fortification and enhance a plant's nutritional content.

Farm Management Software

Many farmers burn the wick at both ends as they struggle to keep on top of a heavy workload with little help. The bigger the farm, the more daunting it is to oversee all operations. Farm management software is an integrated platform that provides real-time data and information, like a digital checklist, to assist farmers with tracking daily activities. With this monitoring and reporting software, farmers can improve decision-making throughout all operations. Farm ERP, an enterprise resource planning solution, allows farms to streamline their processes and enables seamless collaborations. It lets users manage procurement, supply chain, finances, and processing from a single hub. This innovation in agriculture technology will continue to advance as internet-enabled devices become ubiquitous. Mordor Intelligence predicts the farm management software market will witness a CAGR of 11.2% in the ten years leading to 2026.

Water Management Technology

Irrigation is a vital method of providing water to drylands that usually have insufficient rainfall in order to make them arable. However, while this is a crucial aspect of farming today, many farmers still irrigate their fields with wasteful amounts of water the same way the Mesopotamians did over 4,000 years ago.

Besides wasting over two-thirds of the water, flood irrigation can overwater plants, affecting their growth. It could also carry excess fertilizers into streams and lakes, contaminating freshwater sources.

For instance, N-Drip, a micro drip irrigation system, allows water to slowly drip to plants' roots, creating the right environment for crops to thrive. The technology reduces water usage by up to 50% and improves crop quality.

Industrial Automation

This involves using robotics and other automated processes to perform tasks like precision field seeding, planting, fertilizing, spraying pesticides/herbicides, and harvesting crops. This technological advancement in agriculture has allowed farmers to increase yields of agricultural produce by increasing efficiency on farmlands. They can now use drones to map crops, monitor crop growth, and improve irrigation systems. Drones are also used for aerial surveys to get a bird's eye view of the land, assess fallow fields or monitor irrigation levels across large areas. More farmers are turning to drones to map out their land for optimal grow times, crop rotation schedules, and harvesting needs. In livestock farming, robotics have also allowed the development of machines that can milk cows, shear sheep, and more.

Automated Irrigation Systems

The impact of technology on agriculture is better demonstrated with the automation of irrigation systems. These systems have revolutionized how water is supplied to crops, improving the efficiency of water distribution and the quality and quantity of agricultural production. Advanced irrigation systems provide water when it's needed most without wasting any resources. This precision allows for more efficient water distribution and better crop yields. Farmers in regions with water shortages due to drought or climate change can benefit the most from this technological advancement in agriculture. With irrigation becoming a key driver of agricultural success, the future looks promising for farmers and their crops. Farmers who embrace this can be ahead of the game.

Remote Monitoring of Crops Using Sensors

Remote monitoring of crops using sensors such as drones and satellites is becoming increasingly popular. This allows farmers to monitor their fields from home, improving productivity by catching problems earlier and allowing for more efficient use of water and fertilizers. Crop sensors enable farmers to monitor their crops remotely from anywhere in the world using an app or web browser. With such technological advancement in agriculture, farmers

save on labour costs and increase their crop yields, making it possible to end food scarcity. Remote monitoring of crops using sensors is not only for large-scale farmers but also for smallholder farmers. A recent study showed that remote sensing could improve the accuracy of yield predictions by smallholder farmers in Africa by up to 30%. This will help these farmers make better decisions about their farming practices.

Genetically Modified Crops

Genetically modified crops are one of the most significant technological advancements in the agricultural sector. These types of plants have been altered to contain specific traits that will benefit farmers and consumers alike. They offer lots of benefits for farmers producing specialty crops like fruits and flowers. These include increased resistance to pests and diseases, tolerance to herbicides, better nutritional value, and resilience to adverse weather conditions. Over the last 20 years, GMOs have significantly reduced the number of pesticides that farmers need to spray on their farms by up to 8.2% while increasing crop yield by 22%. This technological advancement in agriculture may not always be popular with consumers, but the science is clear they are a safe and valuable tool for farmers. Planting GMO crops also helps preserve soil, reduce carbon emissions, and conserve water.

Merging Datasets

Datasets can be merged and analyzed to uncover new results that may have been overlooked or discover relationships between various datasets that were not known before. One example of how merging datasets is used in agriculture is the work done with genomic data. Genomic data is becoming increasingly important in agriculture as researchers learn more about various crops and livestock genomes. By combining genomic data with other types of data, such as weather information or soil composition, scientists can develop new ways to improve agricultural production. With better data management, information can be shared more easily, making finding answers and solutions for agricultural problems easier.

Conclusion

Modern agricultural technology has been developed with keeping two important things in mind: first thing is to obtain the highest yields possible and second thing is to get the highest economic profit possible. It can be stated that along with coping up the major challenges such as climate change, boosting farmers' income and feeding the billions, recent developments in agricultural research such as agri-farm-tourism, big data analytics, integrated farming and advanced marketing models are seen as ray of hope for sustaining Indian agriculture. There is a severe need for aligned amalgamation of various stakeholders like producers, consumers and public private partnership in order to bring new dimensions of Indian agriculture and sustain for upcoming challenges.

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