Blooming Future: New Emerging Technologies in Floriculture

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ABSTRACT

"Blooming Futures: New Emerging Technologies in Floriculture" summarize the keen impact of technological advancements on the evolution of floriculture. It explained how current challenges like, climate change and resource scarcity have spurred the adoption of innovative solutions within the industry. Through precision agriculture, genetic engineering, vertical farming, and automation, floriculture has more traditional limitations, enhancing sustain-ability, productivity and product quality. The abstract underscores the significance of ethical and regulatory considerations amidst this technological revolution, emphasizing the need for a balanced approach that harmonizes innovation with environmental care and societal well-being. By these emerging technologies while navigating associated challenges, the floriculture sector stands assured to cultivate a future characterized by resilience, efficiency and continual innovation.

INTRODUCTION

Throughout the course of human history, the cultivation of flowers has been an essential component of human civilization. Ancient civilizations such as the Egyptians, Greeks and Romans have used flowers for a variety of distinct reasons. The 20th century saw the introduction of air and refrigerated transport, which made it possible for flower produce to be transported across extensive distances. This resulted in floriculture becoming a special and worldwide operation. This included the development of enhanced post-harvest technology and marketing strategies that completed the value chain. Hydroponics and Aeroponics also crucial role in floriculture industry (Kavana, 2023). Additionally, newer flower kinds and cultivars were created that were able to withstand the of long-distance transit. A modern change in the use of technology emerged in the years after the year 2000, conflicting with the beginning of the fourth industrial revolution throughout the globe. It is now possible for farmers to have access to cutting-edge technology that have completely transformed the flower producing industry. A substantial contribution has been made by genetic engineering, artificial intelligence (AI), the internet of things (IoT), automation, robots and artificial intelligence (AI) in the reduction of labour costs and the increase in efficiency in flower agriculture. However, genetic engineering raises concerns over the potentially harmful effects that transformed plants may have on the environment as well as the safety of the plants themselves. It is possible that the use of artificial intelligence and automation may result in the loss of jobs, especially in the global south, which is where the majority of manufacturing regions are now situated.

Green house and post-harvest technologies: The ability to manipulate temperature, humidity, and insect populations is a key component of greenhouse technology, which is essential in horticulture (Xia *et al.*, 2006). For areas experiencing very harsh weather or growing crops at non-seasonal times, this is of supreme importance. In addition to extending the growing season,

conserving water, increasing output and making the most efficient use of space, greenhouses shield plants from pests and diseases. With the use of sensors and automation technologies, smart greenhouses can track plant development, boost yields, decrease waste and enhance the quality of flowers. Additionally, there has been a great deal of progress in post-harvest technology for flowers, with new methods and technologies being created to increase the quality and vase life of cut flowers. The controlled settings created by modified atmospheric packing (MAP) reduce respiration rates and inhibit the development of germs and fungus, making it an ideal storage method for cut flowers. To prolong the vase life of cut flowers, you may use ethylene absorbing sachets or store them in a regulated environment. After harvest, temperatures drop, respiration rates drop and vase life drops with them. Some methods like hydro cooling and forced-air cooling are used. The water used to care for flowers after harvest is of higher quality thanks to reverse osmosis and UV sterilization. Sugar and plant hormones are examples of treatments that increase water intake and decrease fungal and bacterial development. There has been encouraging evidence that new compounds including nitric oxide (NO), polyamines, chitosan and essential oils may prolong the time that cut flowers remain in a vase. These innovations in flower post-harvest technologies are boosting the sustainability of the floral business, cutting down on waste and making cut flowers last longer and better.

Nanotechnology and biotechnology

Ornamental crops have been considerably enhanced by biotechnology, which has led to the development of novel varieties that possess desired characteristics and production methods that are more environmentally friendly (Bhardwaj *et al.*, 2024). Tissue culture, genetic engineering, marker-assisted breeding, RNA interference and genome editing are some of the techniques that have been used in the process of developing new types of attractive crops. The commercialization of genetically modified (GM) ornamentals, on the other hand, has been met with obstacles because to the limits forced by economic and regulatory factors. Many different applications in the flower business are now being investigated for the use of nanotechnology, which is a branch of science that involves the manipulation of matter on a tiny level. By affixing molecules to nanoparticles, nanoparticles have the potential to enhance the efficiency of fertilizer and pesticide applications, therefore minimizing their impact on the environment and boosting their effectiveness. Additionally, they have the ability to transfer nutrients directly to plant cells, which in turn improves absorption and decreases waste. Nano biosensors have the ability to monitor the development and health of plants by sensing changes in temperature, humidity, and nutrient levels. This provides farmers with early warning indications of possible issues that may arise. It is possible to make use of this information in order to increase flower quality and also optimize growth circumstances. Nanomaterials with one-of-a-kind qualities are now being created for the flower business. These nanomaterials have the ability to absorb and release water slowly, which may assist in ensuring that floral arrangements have the appropriate amount of moisture.

Smart irrigation and soilless cultivation

When it comes to growing flower crops, irrigation technology is vital because it helps plants get just the appropriate quantity of water, which in turn increases crop productivity and makes better use of available water resources. Soil moisture monitors, fertigation technology and drip irrigation systems are examples of technological advancements in irrigation. Improved yields, lower water consumption and more controllable fertilizer and water application are all outcomes of these technological advancements. A smart irrigation controller and a network of wireless sensors may reduce water use by as much as 38% in automated surface watering systems. In order to measure soil moisture, you may use one of many commercially available sensors, including tensiometers, gypsum blocks, granular matrix sensors, time-domain reflectometers or dielectric probes. These can be used manually or connected to automated irrigation management systems via an Internet of Things system.

One emerging practice in modern agriculture is **"smart vertical farming"** which need cultivating plants in stratified vertical formations inside regulated settings such as greenhouses or indoor facilities. Space optimization, reduced transportation costs and the creation of environmentally friendly employment are just a few of the ways it helps flower farmers. Growing conditions may be fine-tuned using vertical farming, which also helps cut down on water use and the use of pesticides and herbicides. Although it is still in its infancy, vertical farming has great promise as a more ecological, efficient and economical method of flower production.

Robotics

The floriculture sector is at the lead of robotics, a fast-expanding discipline that aims to automate processes associated with flower production, maintenance and harvesting. Few studies have examined how a robot's autonomy relates to its capacity to do several farming duties from a single platform. The key to release mobile robots' full potential lies in the development of efficient computation algorithms. Using autonomous and automated systems to carry out a variety of activities associated with flower crop production, care and harvesting is what robotics in flower crops is all about. The need for automation has been further underscored by the COVID-19 epidemic and the supply of qualified workers is dwindling at an alarming rate. Robots eliminate human fatigue, operate reliably and nonstop and can withstand dangerous conditions without compromising their health. Flower Robotics' "Ryden" and the adaptable "Harvest Crop" system are two examples of robots that gather flowers. To automate the process of floral arranging, Flora Bot is experimenting out cutting-edge technology. Automated floral product assembly, plant growth monitoring, disease and pest detection and faster reaction times to limit chemical treatments and spread of disease are all possible thanks to bots. Using image processing, a method has been built to automatically pick cut *Gerbera jamesonii* flowers in greenhouses. The use of robotics to flower crops is in its infancy, but it has great promise for enhancing the sustainability, efficiency and quality of flower production.

Internet of things, Artificial Intelligence and machine learning

Soil moisture, temperature, weather patterns and other environmental elements may be tracked and monitored in real-time using computerized monitoring systems in agriculture. These systems employ automated data collecting and sensors to keep an eye on crop output. In order to lessen their influence on the environment and save water, these systems assist farmers in making educated choices on inputs such as fertilizer, irrigation and more. With the use of data analytics, farmers are able to make better choices, which in turn increases agricultural yields. Predict future events, like weather patterns or agricultural output, is the goal of predictive analytics, which use data analysis methods. Improved yields with less waste and less environmental effect are the results of precision agriculture's ability to target inputs to particular fields. To gather information on soil moisture, crop health and other environmental variables, remote sensing makes use of satellites, drones and other technological marvels. With the use of data visualization tools, farmers are better able to see patterns and make calculated choices. With the use of supply chain analytics, agricultural product distribution and delivery may be optimized, leading to less waste and more efficiency.

The **IoT or Internet of Things** is a system of interconnected computing equipment, services and data that allows for "smart farming" in many different sectors. In order to maximize the efficiency of flower cultivation and supply chain management, Internet of Things (IoT) sensors can track variables like temperature, humidity, and light intensity. As a result of its usefulness in optimizing water consumption, remotely monitoring and controlling water flow and assessing crop needs, IoT technology is also an important component of water management. Improving supply chain management, flower quality and manufacturing are all goals of the flower industry's use of artificial intelligence (AI) and machine learning. Algorithms powered by artificial intelligence may sift through data collected by sensors and cameras to determine the ideal levels of water, fertilizer and light for a crop, greatly enhancing both output and quality. By learning to identify the signs of plant diseases and catching them early, AI can also help with disease diagnosis and prevention. Contrarily, machine learning allows computers to automatically learn from data and gradually improve their performance without any explicit programming. By analyzing data from sensors and cameras, it can monitor the condition and position of flowers throughout transit, which helps enhance supply chain management.

Others technologies

Automatic data transmission between an object's tag and a reader is the basis of **Radio frequency identification (RFID) technology**. There are a variety of shapes and forms available for various uses, with two primary varieties being active and passive. Tracking plants and animals, keeping tabs on cattle, managing irrigation systems and more are just a few of the many uses for passive RFID tags, which are affordable and versatile. By using radio frequency identification (RFID) technology, the flower business is able to trace and monitor the movement of flowers from the farm to the retail outlet, thereby improving supply chain visibility and efficiency.

LED technology is changing the face of flower farming. It may be adjusted to certain wavelengths for optimum development and blooming, and it uses less energy than conventional lighting systems. For optimal development in low-light conditions, LEDs may be used in the cultivation of cut flowers, potted plants and indoor flowers. They are also able to manage the blooming time and quality of flowers, which is very useful for seasonal arrangements. There are many uses for digital flowers made using software, including digital

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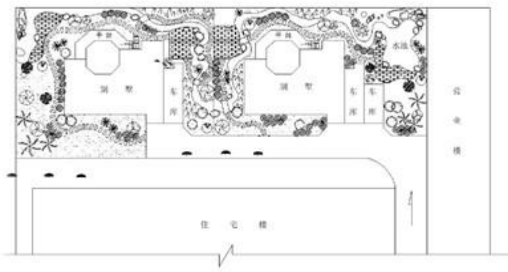
decorations, 3D models, and virtual bouquets or presents. They are perfect for events or occasions in metropolitan or distant regions since they are easy to design and disseminate, and no real flowers or transportation are required. Users are able to choose from a vast array of flower varieties, colors, and arrangements using virtual flowers, making them more customizable and personalized than real flowers.

There are now more resources and methods than ever before for planning, constructing and caring for outdoor areas, all thanks to technological advancements in landscaping. Two well-known 3D modeling programs used



by the landscaping sector are **SketchUp** and **AutoCAD and VectorCAD**. Using SketchUp, designers may make precise 3D representations of outside areas, structures and buildings; using AutoCAD, they can make 2D and 3D representations of the same.

CONCLUSION

In conclusion, the transformative potential is there in cutting-edge innovations within the floriculture industry. It underscores how technologies like precision agriculture, genetic engineering, vertical farming and automation are reshaping traditional practices, offering solutions to contemporary challenges while enhancing sustainability and productivity. However, it also emphasizes the importance of addressing ethical, regulatory and socioeconomic considerations to ensure that technological advancements are distribute responsibly. By clear cut balance between innovation and responsibility, floriculture can top the way for a future characterized by resilience, efficiency and continued growth.

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