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Novel Technologies Use in Horticultural Crops

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Introduction

Transplanting seedlings is a common method used by horticulturists to increase yield. The quantity and quality of the gardening goods are directly impacted by the seedlings' quality. Nonetheless, there are significant problems facing the seedling sector, like inadequate yield from subpar seeds and incorrect culture techniques. Cultivating crops for use as ornamentals typically involves regulated conditions. Currently, human, semi-mechanical, and mechanical labour dominate protected agriculture in controlled conditions. Therefore, current growing practices are not wise, which severely limits the overall quality of the seedling. Furthermore, ripe horticulture items with high nutritional compound contents, the best flavour, and high ornamental value are preferred by consumers. As a result, the plants need to be harvested, transported, and stored properly. Another key factor to consider is harvest timing.

Two important elements influencing the quality are storage and transportation. Furthermore, there has been a growing focus on health and nutrition. Horticultural crops are a major source of protein, carbs, fat, fibre, vitamins, minerals, micronutrients, and antioxidants for humans. However, improper use of agrochemicals has negatively impacted crop quality as well as food safety, putting the ecosystem and human well-being at jeopardy across the food chain in the name of increased output and profits. As a result, horticultural products need to be produced with little use of chemical fertilizers and pesticides while maintaining a high nutritional quality.

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In addition, the horticultural sector needs to develop greater sustainability. To encourage quick development, novel technologies should be tightly linked with the features of the contemporary industry. This means building a new, emerging technology-based development system that is typified by novel development, novel cultivation, novel transport, and novel sales. Horticultural crops play a significant role in increasing land productivity, generating jobs, supporting export growth in developing nations, enhancing the financial standing of farmers and business owners who either directly or indirectly support the expansion of the national economy, and ensuring food and nutrition security for the populace.

Artificial intelligence has broader uses, such as computer vision and autonomous drones, trace genomics, agricultural and health monitoring systems, and automated irrigation systems. Because they maximize resource utilization and efficiency and significantly alleviate labour and resource shortages, these intelligent technologies are also effective in resolving issues and suggesting particular actions needed to resolve them. With enormous promise for both producers and consumers, the horticulture industry is undergoing a technological revolution.

Novel horticultural technologies during cultivation of crops:-

Robots and other intelligent horticulture equipment can increase productivity by lowering labor input. In production and transportation, robotic arms (hands), ground robots, and aerial robots (drones) are frequently employed. These days, they are frequently utilized for horticultural production jobs like controlling weeds, spraying, pollination, biotic/abiotic stress diagnosis, growth monitoring, and environmental data collection. Furthermore, their introduction may take the place of conventional farming equipment like combine harvesters and tractors. The Global Positioning Systems (GPS), BeiDou Navigation Satellite System (BDS), robotic vision, electromagnetic attraction, ultrasonic detectors, and other technology for automatic navigation are frequently the foundation for these robots' operations. Apart from robots, several other innovative technologies have great potential when grown under protected conditions. First off, hydroponics is a clever method of soilless growing. It makes root analysis of stress and nutritional movement distribution visual in the nutrient flow field.

- **Uses of traditionally to Autonomous Tractor:-**

Historically, bullocks were the physical source of energy used by rural farmers to till the fields. The ploughman, blinded by the intense sun, follows the bullocks. A pair of bullocks ploughs 0.12 to 0.80 hectares on average in a day, which is very labour-intensive. Using better hand tools and implements pulled by bullocks, agriculture began to become mechanized. For instance, adding a three-dimensional metal structure to the main frame of the common plough assisted in creating ridges and furrows for planting seeds and harvesting crops (such as potatoes and ground nuts), but the yield was still appallingly poor. To fit the kind of crop to be farmed, motorized tractor attachments and devices were designed. As an auxiliary device to the tractor, an extensive tube with several pores at the bottom and a seed bowl, for instance, made sure that numerous rows of seeds were sown in the field in a shorter amount of effort and time than with a manual technique. With its enhanced functions, this first technology can be scaled up to make it autonomous. At first, work will need to be done to personalize the use by surveying the location and its surrounding area and programming the best route according to the topography. Farmers who possess lead through with teach-in programming skills will be able to do routine activities with a certain amount of autonomy.

- **Automated Aerial Seeds Distribution Compared to Manual Sowing:**

Large open fields require a lot of labour and time to cover in order to manually sow seeds. Conventional seeding machines disperse the seeds and are quicker than the manual approach to cover large areas; nevertheless, they waste seeds when they fall outside of the ideal spot. The most basic type of sowing robot, created by V. Yedave et al., is capable of carrying out several duties, including covering the seeds, compact the soil, and planting the germinating material in rows at the necessary depth and spacing. However, there is additional unpredictability brought about by the uneven ground and soil conditions, which require attention. A large portion of the manual decision-making involved in seeding is eliminated when the ground is geomapped using sensors for soil properties. As a result, autonomous precision seeding robots that can regulate the topography, place-specific seeding depth, and spacing between seed plantings were created. As a result, the likelihood of a quality and reasonably priced crop is greatly increased from the moment of planting. Drones are used to fire sealed capsules holding fertilizer and nutrient-filled seed pods straight into the ground using pneumatic guns. In the future, an Internet of Things-enabled system that uses several automated precision seeding drones that are programmed to accurately plant an entire field may be imagined. Through digital networking, the farmer can see and keep an eye on the entire seeding process from a distance.

- **From Drone Imaging to Helicopter Viewing**

Helicopters or other aircraft equipped with cameras are used for routine aerial assessments of the property in order to obtain still images. However, the expense is still prohibitive. Infrared, ultraviolet, and hyperspectral imaging, in addition to normal photographic imaging, have made it possible to offset the need for conducting surveys during the day. It is feasible to record 3D videos with cameras that have night vision capabilities. Clarity in observing minute features in the field is enhanced by higher image resolution. In order to provide farmers with useful information on the condition of the soil, surroundings, distribution of water and absorption patterns, and crop health, "big data" is digitally processed. This process helps farmers make informed decisions about managing their land and crops

- **Plant breeding method in horticulture**

The secret to raising the quantity and calibre of horticulture crops is to breed new varieties. Based on key genes that have been found, novel breeding combines revolutionary information technology (such as AI and big data) with new-generation biotechnology and multi-omics. First, the foundation for using novel breeding is the number of significant genes discovered by genomics [i.e., by map-based genetic engineering, quantitative trait locus (QTL) and genome-wide association analysis (GWAS)] along with genetically engineered organism techniques. The examination of the whole genome and pangenome of T2T (telomere to telomere) is one of these representative markers. Watermelon's genomics function and genetic improvement will be significantly improved by the accurate identification of genetic variety provided by a T2T gap-free genome based saturating mutation library. Additionally, new technologies speed up the process of breeding (i.e., identifying genes and analysis) artificial intelligence, and big data. Plant phenotyping speeds up the collection of massive data related to horticulture by utilizing cutting-edge technologies as its basis. Phenotyping has advanced quickly in the last ten years, and its applications in breeding, the assessment of plant materials, and the discovery of particular genes have all increased. As a plant develops, its phenotypic is influenced by both genetic and environmental variables.

Benefits of Utilizing AI and Robotics in Crop Protection:-

The cultivation and safeguarding of crops have undergone a radical transformation with the introduction of technology such as robotics and artificial intelligence (AI) across these fields. It is important to understand that automated systems and artificial intelligence (AI) may support entire crop protection strategies.

- **Resilience and climate adaption:**

Significant obstacles to agricultural output are presented by climate change. Robotics and AI have important roles to play in risk mitigation and adaptation related to climate change. Large-scale meteorological data can be processed by sophisticated algorithms, which assists farmers in choosing crops, planting dates, and water use. Robots fitted with environmental sensors are able to track pest outbreaks, soil moisture content, and weather patterns, giving agricultural managers access to real-time information. Farmers may minimize crop losses and make timely adjustments by anticipating weather patterns with AI-driven climate modelling.

- **Mange the Nutrition Utilizations:**

Achieving the ideal crop nutrition is essential for quality and production. By analyzing the composition of the soil, crop nutrient demands, and growth patterns, artificial intelligence and robotics can enhance fertilizer management. With the use of intelligent systems, one can precisely apply nutrients or other supplements by keeping an eye on nutrient excesses or shortfalls. Robotics can also automate processes like nutrient supply, weeding, and precise seeding, which reduces waste and increases resource efficiency. Robotics and artificial intelligence help to promote sustainable agriculture by lowering environmental impact by customizing nutrition tactics to meet the demands of individual crops.

- **Cultural Activities and Labour Optimization:**

Varieties of cultural practices are included in agriculture and are necessary for the productive production of crops. Artificial intelligence (AI) and robotics may automate and simplify a variety of processes, minimizing labor-intensive work and maximizing the use of available resources. For instance, robotic systems are more accurate and efficient at time-consuming tasks like pruning, sorting, and harvesting. Farmers may concentrate on higher-value duties like crop planning, disease control, and market analysis by automating monotonous processes. The combination of robotics and AI increases productivity while also improving farmers' quality of life, which attracts more people to the agricultural industry.