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| RESEARCH ARTICLE

Exploration of the Application of Agricultural Intelligent Robots in the Qinghai-Tibet Plateau

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| ABSTRACT
In order to improve agricultural efficiency, reduce labor intensity, and improve the quality and yield of agricultural products on the Tibetan Plateau, this paper takes the application of traditional agricultural robots as an example and proposes the application of agricultural robots to agriculture on the Qinghai-Tibet Plateau based on the special breeding environment of the Qinghai-Tibet Plateau combined with the current situation of traditional agriculture. Through the application practice of robots in traditional agriculture, the possibility of the application of agricultural robots in the Qinghai-Tibet Plateau is pointed out, the working methods and advantages of robots in the Qinghai-Tibet Plateau are expounded, and the application of intelligent agricultural robots in the agriculture of the Qinghai-Tibet Plateau is discussed and analyzed. The results show that with the progress of science and technology, intelligent robots have gradually played an important role in various fields, and intelligent robots have broad application prospects in plateau agriculture. The application of agricultural robots in the Qinghai-Tibet Plateau should be aimed at the Qinghai-Tibet Plateau to make some adaptive research and development, intelligent upgrading and demonstration project promotion in order to promote the Qinghai-Tibet Plateau agricultural automation.

| KEYWORDS

Traditional agriculture, intelligent robots, Qinghai-Tibet Plateau, technology application.

| ARTICLE INFORMATION

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1. Introduction

The climate of the plateau area is usually relatively dry, the temperature difference between day and night is large, and its unique geographical environment and extreme and complex climatic conditions make the agricultural production of the plateau special. In addition, due to the limitations of natural conditions such as high altitude, low oxygen, cold, and drought, agricultural production in the plateau is facing great challenges. The Qinghai-Tibet Plateau is an inland plateau in Asia known as the "Roof of the World" and the highest plateau on Earth. The Tibetan Plateau has a significant impact on the global climate system and is considered to be one of the important factors in the formation of the Asian monsoon system. As an important ecological security barrier in China and even the world, the uniqueness and complexity of its agricultural development have attracted much attention. Traditional farming methods are labor-intensive, inefficient, and difficult to meet the development needs of modern agriculture on the plateau. In recent years, with the rapid development of intelligent robot technology, it has become possible to apply it to agriculture on the Qinghai-Tibet Plateau. It is of great significance to study the application of agricultural intelligent robots on the Qinghai-Tibet Plateau to improve agricultural production efficiency of the Qinghai-Tibet Plateau and ensure the ecological security of the Qinghai-Tibet Plateau. This paper will discuss the application of intelligent robots in agriculture in the Qinghai-Tibet Plateau in order to provide new ideas for agricultural modernization in the Qinghai-Tibet Plateau.

2. Current Situation and Challenges of Agriculture on the Tibetan Plateau

2.1. The Status quo of Traditional Agriculture

First of all, due to the special high altitude, strong sunshine and cold of the Qinghai-Tibet Plateau, agricultural production in the region faces many challenges, but agriculture on the Qinghai-Tibet Plateau still maintains a certain production capacity and characteristics (Ali, 2023). In terms of crop planting, the agricultural production of the Qinghai-Tibet Plateau is dominated by cold-tolerant and drought-tolerant crops, such as barley, wheat, peas, rape, etc., which have a certain adaptability to the harsh environment of the plateau. Secondly, the plateau has a small population due to the thin oxygen and complex topography, which also makes the artificial cultivation of traditional agriculture inefficient and difficult. Finally, due to the unique natural environment and complex climatic conditions of the plateau, many plants have thick leaves and low growth forms to reduce water evaporation and resist the effects of wind damage and frost.

In terms of agricultural technology, with the development of science and technology, the agricultural production technology of the Qinghai-Tibet Plateau is also constantly improving. For example, through the construction of greenhouses, soil improvement, water-saving irrigation, and other technical means, the efficiency and output of agricultural production have improved. The agricultural development of the Qinghai-Tibet Plateau is not only related to the livelihood of local residents but also of great significance to maintaining the ecological balance of the plateau and promoting regional economic development. The state and local governments attach great importance to agricultural scientific research on the Qinghai-Tibet Plateau and support agricultural scientists in conducting in-depth research on plateau crops and animal husbandry by setting up special research projects to promote the development of plateau agriculture. However, due to the particularity of the Qinghai-Tibet Plateau, traditional agriculture has not been completely transformed into digital agriculture, and the agricultural development of the Qinghai-Tibet Plateau is still facing huge challenges. In the future, it is necessary to strengthen the innovation and transformation of agricultural science and technology, optimize the structure of the agricultural industry, and promote the development of agricultural modernization on the Qinghai-Tibet Plateau.

2.2 Challenges Faced by Traditional Agriculture

First, the shortage of agricultural resources, especially the shortage of water resources, has greatly restricted the agricultural development of the Qinghai-Tibet Plateau. The terrain is complex, the climate is harsh and other reasons. In addition, the permafrost in the plateau area is widely distributed, making it difficult to develop and utilize water resources, and the use of water for agriculture is greatly restricted. This has led to inefficient agricultural production and constrained development.

Second, the agricultural ecological environment of the plateau is fragile, and the contradiction between ecological protection and agricultural development is still prominent. Traditional agricultural production mode uses a large number of chemical fertilizers and pesticides, which pollute soil resources and water resources and cause damage to the ecological environment of the Qinghai-Tibet Plateau. At the same time, the traditional planting of crops is relatively simple, which is easy to cause pests and diseases and limits the growth and development of crops.

Third, due to the influence of factors such as remote geographical location and low level of economic development, the infrastructure construction of the Qinghai-Tibet Plateau is relatively lagging behind, the agricultural supporting facilities are not perfect, and the Qinghai-Tibet Plateau's agricultural science and technology innovation capacity is insufficient, and the conversion rate of agricultural scientific and technological achievements is low. All these have constrained the modernization process of its agriculture. The Qinghai-Tibet Plateau's agricultural management mode is dominated by the traditional small-scale peasant economy, and there is no high-scale and intensive development, which makes agricultural production efficiency low and farmers' income level low.

Fourth, social and economic factors: With the in-depth implementation of state policies, although the social and economic conditions of the Qinghai-Tibet Plateau have been markedly improved, there are still considerable differences in the level of development between different regions, and this has a direct impact on the speed and direction of agricultural modernization. Regions with a relatively high level of economic development are rich in capital, technology, and qualified personnel, and the process of agricultural modernization is relatively fast, while areas with relatively backward economies are limited by the shortage of resources and the loss of qualified personnel, and the process of agricultural modernization is relatively slow.

In conclusion, the challenges to agricultural development on the Tibetan Plateau are multifaceted (Zhao et al., 2023), and comprehensive measures need to be taken to solve them. At the same time, strengthening scientific and technological innovation and agricultural modernization is also an important way to promote the development of agriculture on the Qinghai-Tibet Plateau, so the application of intelligent agricultural robots in the Qinghai-Tibet Plateau is of great significance to the development of its agriculture, and the application of agricultural robots in the Qinghai-Tibet Plateau will help promote the modernization process of local agriculture (Zhang, 2023).

3. Exploration of Agricultural Robots

3.1 Practical Results of Agricultural Robots

Since the 90s of the 20th century, agricultural robots have also entered the ranks of China's robot technology research and development; many universities and research institutes have devoted themselves to research, big data analysis, image recognition and other items that have been continuously applied to agricultural robots, agricultural robots have begun to enter the Chinese market, and the research results have also been applied to first-line planting (Wang, 2023). Agricultural robots have begun to replace traditional labor, improving agricultural production efficiency, agricultural product quality and yield while reducing agricultural production costs and promoting agricultural modernization and sustainable development (Zhao, 2023). After entering the 21st century, agricultural robots have developed more intelligent systems with more powerful operation capabilities, greatly improved operation efficiency, and richer operation scenarios. Intelligent robots for planting, irrigation, picking and other purposes not only greatly reduce manpower but also play a considerable role in expanding production.

In the first 5G agricultural park in Fujian, China, the Israeli demonstration farm, 5G agricultural robots are used for data collection and real-world intelligent inspection. His "feet" can rotate and move 360 degrees, supporting him to walk around at will, automatically detouring, and at the same time supporting automatic inspection, fixed-point collection, automatic return, and automatic charging. "Ears" and "eyes" are four high-definition cameras, "overhead" are various sensors such as wind speed, carbon dioxide, photosynthetic radiation, etc., and "mouth" is temperature and humidity sensors.

Yanmar SMASH of Japan is a mobile agricultural "high-tech smart solution" for monitoring, analyzing, and managing crops. The whole system adopts the latest information and communication technology to intelligently monitor and inspect plants and soil, then analyze the collected information and data, and provide clear, feasible and scientific information to support the intelligent management of crops. SMASH can autonomously move, monitor crops, detect and treat diseases, saving a lot of time in agricultural operations and greatly improving production efficiency.

Ecorobotix weeding robot of Switzerland, a weeding robot developed by ecoRobotix in Switzerland, is a major innovation in weeding technology. The Ecorobotix weeding robot identifies weeds one by one, inspects crop growth, and sprays pesticides for specific conditions. Powered by solar panels, the EcoRobotix weeding robot uses GPS navigation to identify planting areas and visual sensors to sense the land ahead and distinguish between crops and weeds. When weeds are found, the two arms underneath the robot can precisely spray a small amount of herbicide, which can effectively protect beneficial insects such as bees and prevent the spray from drifting. According to the head of EcoRobotix, one of its teams was able to reduce the amount of herbicide used by a factor of 20 compared to conventional spraying systems. This effectively avoids the overuse or waste of herbicides, eliminates residues in crops, and is also conducive to ecological protection.

The development of agricultural robots is not only reflected in the many aspects of technology application but also in the development of intelligent agriculture, regenerative agriculture, biological agriculture and the comprehensive application of digital technology, which indicates the inevitability of the development and promotion of agricultural science and technology. The abundant practical results of agricultural robots also make it possible to popularize and apply agricultural robots to the Qinghai-Tibet Plateau to improve the current situation of agriculture on the Qinghai-Tibet Plateau and promote its agricultural digital development.

3.2 Exploration of the Application of Agricultural Robots in the Qinghai-Tibet Plateau

3.2.1 How Agricultural Robots Work

Agricultural operations can be broadly divided into sowing, cloud monitoring, data collection, harvesting and other operations.

The use of intelligent agricultural robots to replace traditional manual sowing and harvesting operations can improve the efficiency of agricultural operations, reduce the cost of agricultural production, and solve the problem of lack of human resources on the Qinghai-Tibet Plateau. In addition, in harsh environments where manual work is difficult to carry out, agricultural robots can replace the staff to complete the work quickly, ensuring work efficiency and avoiding danger to the staff.

The application of intelligent machine system in monitoring is very significant, through the perception of crop appearance, combined with environmental perception sensors, intelligent control, etc., to build an intelligent monitoring platform on the cloud platform, real-time detection of plant growth status, through different detection information every year It is not difficult to scientifically predict the planting and yield of the next year, so as to put forward guiding suggestions for planting operations in the agricultural area of the Qinghai-Tibet Plateau. However, the Qinghai-Tibet Plateau is sparsely populated, dry, and has special geographical and climatic conditions, making it difficult to predict the growth trend of crops through traditional manual judgment and realize precision agriculture. The use of an intelligent agricultural machine system can fill this gap through the external performance of crops to judge the condition of all aspects and achieve intelligent planting and scientific maintenance.

The intelligent management system can monitor environmental factors such as land, water source, and light in real time. The environment of the Qinghai-Tibet Plateau is changeable; the difference between day and night is large; this system can allow operators and operators to receive real-time monitoring data and then send relevant instructions to the robot at any time through network ports such as computers and the agricultural robot can efficiently complete the relevant operations after receiving the instructions, so as to realize the growth of crops to be remotely monitored and adjust the growth environment of crops in time. At the same time, the robot, through scanning and detection, with the indicators of crop health as the standard, can reasonably water and fertilize, adjust the growth environment of crops, and achieve the goal of intelligent management in order to achieve an automated and intelligent planting mode, reasonable allocation of manpower, material resources and other resources, reduce unnecessary costs.

3.2.2 Advantages of Agricultural Robots

Agricultural planting robots use advanced sensors and navigation technology to achieve precision agriculture. In the planting process, agricultural robots can accurately control the sowing depth and fertilizer amount according to the soil moisture, nutrients and other parameters of the Qinghai-Tibet Plateau, which improves the survival rate of seeds and the yield of crops. In the spraying process, agricultural robots can accurately control the amount and scope of spraying according to the situation of pests and diseases (Chen et al., 2022) so as to avoid the waste of drug resources and protect the ecological environment of the Qinghai-Tibet Plateau.

Agricultural robots such as unmanned tractors and plant protection drones can realize automatic operation through sensors and artificial intelligence technology, improve work efficiency, reduce labor costs, and promote agricultural automation on the vast and sparsely populated plateau. At the same time, a large amount of data can be collected in the agricultural production process to help farmers make decisions and analyze and optimize the production process. Through data analysis, farmers can better understand the impact of soil conditions, climate change and other factors on crop growth, adjust planting strategies in a targeted manner, formulate more effective planting and maintenance strategies, and improve the stability and sustainability of agricultural production, thereby improving the quality and yield of agricultural products (Mai, 2024).

Intelligent inspection agricultural robots can adapt to a variety of complex environments (Wei et al., 2019), and in the complex terrain environment on the plateau, agricultural robots can move flexibly to complete various tasks. Under adverse environmental conditions such as drought, floods, pests and diseases on the Qinghai-Tibet Plateau, agricultural robots can also protect crops from damage to the greatest extent and improve their stress resistance and adaptability through precise control and intelligent management.

Agricultural robots can operate continuously for a long time and be remotely controlled, which improves agricultural production efficiency. Traditional agricultural machinery requires manual operation and limited working hours, while intelligent agricultural robots can achieve 24-hour uninterrupted operation. In the busy season or the harvest and other critical moments, the role of agricultural robots is more prominent and can greatly shorten the agricultural production cycle. In general, agricultural robots have many advantages in the development of modern agriculture on the Qinghai-Tibet Plateau. Agricultural robots can adapt to the topographical environment of the plateau, improve the shortcomings of human resources shortage and low efficiency due to the vast and sparsely populated population, and solve the problem of water shortage restricting agricultural development. These advantages make agricultural robots an important trend in the development of modern agriculture on the Qinghai-Tibet Plateau (Wan, 2014).

4. Conclusion

Affected by factors such as special climate and complex environment, it is difficult to change the environment for the development of traditional agriculture on the Qinghai-Tibet Plateau, and the economy is still dominated by traditional small farmers, and most areas still rely on manual labor to complete a series of agricultural operations such as planting, maintenance, and harvesting, so the work efficiency is low, and the income of laborers is not high. Moreover, in the process of cultivation and conservation, it is inevitable that the plateau ecology will be damaged to a certain extent because it is not scientific. In the future, with the continuous reform and innovation of science and technology, the application prospects of intelligent agricultural robots in agriculture on the Qinghai-Tibet Plateau will become more and more broad. Its application can effectively improve the agricultural efficiency of the Qinghai-Tibet Plateau, reduce labor intensity, and improve the quality and yield of agricultural products. Through continuous technological innovation and policy support, it is believed that the application of intelligent robots in special areas such as the Qinghai-Tibet Plateau will continue to promote and achieve greater achievements, injecting new vitality into the sustainable development and modernization of agriculture on the Qinghai-Tibet Plateau.

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