Region - Educational Research and Reviews, 2024, Volume6, Issue11
DOI: 10.32629/rerr.v6i11.3143
ISSN Online: 2661-4634
ISSN Print: 2661-4626

From the perspective of smart agriculture: exploring the new path of construction and operation management of modern agricultural park

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Abstract: Modern agricultural park is an important carrier to realize agricultural modernization, and the rise of smart agriculture has injected new vitality into the construction and operation management of the park. Combined with cutting-edge technologies such as Internet of Things, big data and artificial intelligence, modern parks are gradually transforming from traditional agriculture to precision, low carbon and high efficiency. Based on the perspective of smart agriculture, this paper puts forward a number of innovative strategies for the construction and operation management of modern agricultural parks, such as "sensing terminal+data hub" to improve digital infrastructure, "regional characteristics+brand matrix" to enhance the value chain of agricultural products, and "e-commerce ecology+precise supply and demand" to optimize the market expansion mechanism, so as to provide theoretical support and operational guidance for the practice of smart agricultural parks.

Key words: smart agriculture; construction of modern agricultural parks; operational guidance

1 Introduction

The "Fourteenth Five-Year Plan" for national agricultural green development clearly puts forward that it is necessary to promote agricultural modernization with smart agriculture as the starting point and realize the deep integration of information technology and agriculture. Smart agriculture is a modern agricultural model with Internet of Things, big data, artificial intelligence and other technologies as the core, which runs through agricultural production, management and circulation, and has obvious advantages in optimizing resource allocation and improving production efficiency. Under the guidance of rural revitalization strategy, modern agricultural parks have become a model of deep integration of "agriculture+technology". From the digital upgrading of infrastructure to the efficient integration of industrial chain, and then to the systematic optimization of management mechanism, modern agricultural parks are reshaping the operation mode of traditional agriculture, which has high discussion value.

2 The construction of the park-accurate design and efficient landing under the wisdom empowerment

2.1 "Sensing terminal+data hub": the layout of digital infrastructure construction

In the view of smart agriculture, the sensing terminal is usually composed of environmental sensors (such as

temperature and humidity, light intensity, soil water content sensors) and equipment monitoring module, which is used to collect dynamic data of planting areas in real time. The data hub is supported by cloud computing, big data analysis and artificial intelligence algorithms, and is responsible for data storage, processing, analysis and feedback. The deployment scheme of sensing terminal should focus on the needs of the park, and design the distribution density and sensor types in combination with the specific crop growth characteristics and plot conditions. For example, in the fruit tree planting area, soil moisture tension sensors can be used in the park at intervals of 20 meters to monitor the moisture around the root system in real time. In the field crop area, it is necessary to combine weather station equipment to obtain data such as wind speed and rainfall to predict the changing trend of regional microclimate. The data transmission of such sensors usually adopts LoRa (long distance wireless) or NB-IoT (narrow band Internet of Things) technology, and uploads the data to the management system in a low power consumption and high stability way.

At the same time, the park needs to establish a high-performance cloud computing platform, integrate environmental data uploaded by sensing terminals with big data technology, and combine historical planting data with regional agricultural databases to form a dynamic growth model. Taking Shouguang National Modern Agricultural Industrial Park in Shandong Province as an example, about 15,000 Internet of Things sensors were deployed in the park, which realized the multi-dimensional parameter collection of more than 300 greenhouses and realized the automatic linkage of irrigation and fertilization. The irrigation water consumption per mu decreased by about 40%, the fertilizer consumption decreased by 25%-30%, and the crop yield increased by 15% on average. The data hub should also integrate artificial intelligence algorithms to predict the best time of key planting nodes (such as sowing, irrigation and harvesting). Based on deep learning technology, the data center can identify the early symptoms of pests and diseases, automatically generate prevention and control schemes, and link drones for precise spraying to avoid drug waste and environmental pollution. In terms of application integration, the data center needs to be deeply connected with the mechanical equipment and external service platforms in the park. Through API interface or special protocol, the data center can directly control automatic irrigation system, plant protection drone and picking robot, and realize closed-loop management from analysis to execution [1].

2.2 "Regional characteristics+brand matrix": innovation strategy of agricultural product value chain

Regional characteristics are the core entry point of brand building in modern agricultural parks and the cornerstone of brand incubation. Combined with the unique local natural resources and agricultural culture, the park can accurately develop characteristic agricultural products, thus forming a differentiated competitive advantage in the market. On the one hand, the park should fully tap the geographical indication resources of the region, such as using the climatic advantages of high altitude areas to develop alpine tea; or combining with specific soil components to create high-quality agricultural products like selenium-enriched rice. On the other hand, through the empowerment of science and technology, the park needs to improve the quality stability and production controllability of products. Taking the white tea industry in Anji, Zhejiang Province as an example, through soil improvement technology and standardized planting mode, the yield and quality of tea were simultaneously improved, and a high-end tea brand recognized by domestic and foreign markets was successfully built. In addition, the park needs to deeply integrate regional characteristics with cultural communication, and with the help of short video platforms, live e-commerce and other emerging forms of communication, take regional stories and production scenes as the starting point to shape consumers' deep impression on the brand. On this basis, the park should establish a quality traceability system for featured products, and show consumers the whole process data from the field to the dining table through digital technology to further enhance market trust [2].

With the single product brand as the core, the park should build a multi-level brand structure to form a linkage

development system of regional brands, corporate brands and single product brands (as shown below). Single product brands should accurately locate the high-end market, with highlighting scarcity and quality as the core. For example, organic fruits can create a high-end brand image through green certification and traceability. At the same time, regional brands need to integrate multiple brand resources and expand their brand influence in the form of "industrial alliance". In terms of industrial extension, the park can cooperate with deep processing enterprises to transform primary agricultural products into high value-added commodities such as fruit puree and quick-frozen fruits and vegetables, thus realizing the vertical extension of the industrial chain. In order to ensure the promotion effect of brand matrix, the park needs to formulate a unified brand communication strategy and combine online and offline multi-channel marketing to ensure the consistency and penetration of brand information. In addition, the park should also set up a smart agriculture experience center to bring consumers closer to the brand and increase brand stickiness in the interactive form of "field picking+processing experience". For example, by holding agricultural festivals, open visit days and other activities, consumers can intuitively feel the production story behind the brand, and form a strong emotional resonance; it can also expand the income source of the park by combining agriculture with tourism, and play a multiplier effect in the promotion of the brand matrix [3].

2.3 "E-commerce ecology+accurate supply and demand": the optimization mechanism of the park market expansion

The park should give priority to the cooperation with mainstream e-commerce platforms (such as Taobao and JD.COM), and set up "flagship stores of agricultural parks" on these high-flow platforms to focus on promoting featured agricultural products. The product layout of flagship store should emphasize "traceability mark+quality assurance", display the whole process production data, certification mark and planting environment and other information, and strengthen consumers' trust in product quality. At the same time, with the help of regional e-commerce platforms (such as daily fresh e-commerce), we can achieve deep penetration in specific areas and meet regional consumer demand. For the high-end market, the park can combine social e-commerce (such as WeChat applet) to create a private domain traffic pool, launch customized agricultural product packages or pre-sale models, and combine accurate push and community interaction to achieve accurate reach. In addition, the park should also use the data analysis tools of the e-commerce platform to regularly monitor the online sales conversion rate, consumer click preferences and hot-selling categories, optimize the product category layout and inventory plan in time, and ensure the refined management of resource input. In terms of digital marketing, the park should focus on developing content e-commerce mode, and use short video platforms (such as Tik Tok and Aauto Quicker) to show the growth process and processing scenes of agricultural products, so as to narrow the distance between consumers and producers. Especially in the festival schedule, the park can jointly launch activities such as limited-time snapping, live spike and so on, with the help of interactive activities to enhance users' sense of participation and quickly realize the transformation of product sales [4].

In addition, the accurate matching mechanism between supply and demand is the core function of smart e-commerce ecology, which is directly related to the resource allocation and operational efficiency of the park. The park needs to rely on the consumer big data analysis platform to deeply explore the market hot demand, purchase frequency and price sensitivity. For example, when big data analysis shows that the demand for specific fruits in a certain place has surged, the park can adjust the planting plan or allocate existing stocks to quickly respond to market demand and avoid sales losses caused by insufficient supply. For seasonal agricultural products, the park needs to analyze the historical sales data and consumption trends in advance, arrange the production cycle reasonably, and reduce the risk of inventory backlog. Therefore, the park should establish a regional cold chain distribution center and adopt the mode of "direct supply from the place of origin+direct terminal" to ensure the rapid transportation of fresh agricultural products under the best temperature

control conditions. At the same time, the park needs to improve the integrated process of "order-production-distribution", and the intelligent dispatching system can adjust the transportation route in real time to reduce the transportation cost and optimize the distribution speed. In the construction of "farmland to table" efficient supply chain ecology, the park needs to use the scientific and technological advantages of e-commerce ecology to open up the market structure in a short period of time with efficient operation, and at the same time form a competitive advantage with data-driven long-term planning to realize all-round upgrading of agricultural product market expansion.

3 Operations management--the path of refinement and synergy under smart governance

3.1 "Intelligent decision+multi-party cooperation": innovative framework for collaborative governance of parks

The intelligent decision-making system takes big data algorithm and AI technology as the core, and gathers the dynamic data such as meteorology, soil and equipment operation status uploaded by the sensing terminal in real time to generate accurate and operable governance schemes. The park should take the knowledge map as the framework and build an "innovation ecosystem with knowledge-driven as the core". This knowledge map can relate a single data to the complex relationship between production, environment and market demand, and can also dynamically optimize the data through deep learning model. In addition, the intelligent decision-making platform should have remote control function, and managers can complete real-time adjustment by using mobile terminal or desktop terminal, triggering the operation of automatic irrigation or fertilization equipment, and greatly improving governance efficiency. In order to ensure that the system can continuously adapt to the changing environment, it is necessary to introduce self-learning module and rely on data accumulation optimization algorithm to make intelligent decision-making more forward-looking in the face of complex agricultural scenes.

On the basis of intelligent decision-making, the park needs to establish a four-in-one collaborative framework of "government+enterprise+scientific research+farmers", and clarify the responsibilities and division of labor of all parties (as shown below). For example, the government is responsible for formulating relevant policies, and needs to provide special funds to support the construction of data centers, sensor networks and hardware equipment; scientific research institutions undertake the development of core algorithms and technical landing tasks to ensure that the intelligent platform has cutting-edge technical support; the responsibility of the enterprise lies in providing equipment maintenance, market expansion and logistics supply chain management; farmers concentrate on production execution and operate intelligent equipment and agricultural machinery according to standardized processes. In order to ensure the transparent and efficient cooperation process, the park needs to build an agricultural credit system based on blockchain. The system records the key data of multi-party cooperation in an unalterable distributed ledger, which can track the whole process from the government funds allocation, to the actual conversion rate of scientific research results, and then to the performance score of enterprises and farmers.

3.2 "Green operation+recycling": low-carbon agricultural operation and management mode

The "14th Five-Year National Agricultural Green Development Plan" clearly stated that promoting agricultural green development should focus on energy conservation, emission reduction and recycling, and create a low-carbon and efficient production system. The park needs to give priority to the introduction of precision irrigation and precision fertilization technology, and use the Internet of Things sensors to monitor soil moisture, nutrient status and crop growth indicators in real time to realize the on-demand supply of irrigation and fertilization. Precision technology can effectively reduce the overuse of chemical fertilizers and water resources, avoid environmental pollution caused by excess nutrients, and improve the resource utilization efficiency. In addition, the park needs to build a water and fertilizer integration and waste recycling system to organically combine resource consumption with production activities. For example, in the process of crop

planting, the intelligent sensor network and rainwater collection system are used to store rainwater in high-efficiency utilization devices for irrigation replenishment or facility cleaning; the waste produced by livestock and poultry breeding can be converted into biogas through anaerobic fermentation device, which can be used for the energy of the park facilities, and the fermentation residue can be made into organic fertilizer and returned to the planting link, forming a closed-loop resource circulation chain. In addition, the park can install solar photovoltaic panels to provide clean energy support for sensing terminals and low-power equipment, further reducing the proportion of traditional energy use and reducing the total carbon emissions. In the process of implementation, the park also needs to develop a perfect resource scheduling and monitoring mechanism to track the waste utilization rate and energy consumption efficiency in real time to ensure the efficient operation of the resource recycling system.

On the basis of green production, the park needs to systematically promote the certification of agricultural products, and establish a standardized production system according to the *Measures for the Administration of Green Food Labels* and the *Measures for the Administration of Organic Product Certification*, covering planting, processing, packaging and other links to ensure that products meet the certification standards of green food and organic products. In the certification process, it is necessary to introduce a third-party quality inspection agency to conduct a comprehensive evaluation of soil, water quality and pesticide residues, and record key data in the production process in combination with blockchain technology, so as to realize the traceability of the whole production process and provide strong technical support for the certification application. At the same time, it should rely on the park to build a green supply chain, optimize the whole process operation mode from farmland to market, attract the attention of high-end consumers and the international market, and provide practical guarantee for the park to achieve a win-win situation of economic and ecological benefits. Based on the comprehensive promotion of green technology and recycling system, the park can realize the optimal management of low-carbon agriculture from production to market.

4 Conclusion

Smart agriculture provides a new perspective and path for the construction and operation management of modern agricultural parks. From information infrastructure construction to brand value chain remodeling, and to collaborative governance and green operation, smart agricultural technology runs through the whole life cycle of park development. In the future, with the continuous iteration and popularization of smart agricultural technology, modern agricultural parks will further achieve accurate, efficient and sustainable development, providing strong support for China's agricultural modernization process.

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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