Analysis of the Current Status and Development Trend of the Blueberry Industry in Jilin Province

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Abstract: **As an important characteristic agricultural production area in my country, Jilin Province has developed rapidly in recent years and has become an important growth point of the regional agricultural economy. With the increasing demand for high-quality and healthy agricultural products in domestic and foreign markets, the blueberry industry has attracted widespread attention for its high added value and broad market prospects. However, the blueberry industry in Jilin Province still faces challenges such as frequent natural disasters and imperfect industrial chains during its development, and urgently needs to achieve industrial upgrading through scientific planning and innovative breakthroughs. Therefore, this article conducts an in-depth discussion on the development status and future trends of the blueberry industry in Jilin Province, and hopes to provide theoretical basis and practical reference for the high-quality development of the blueberry industry in Jilin Province, helping it to gain greater advantages in market competition and to serve as a regional economy Inject new momentum. Keywords: Jilin Province; Blueberry Industry; Current Situation Analysis**

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1. Introduction

Blueberries are a high-value-added fruit rich in antioxidants and nutrients, which have attracted much attention worldwide in recent years. According to statistics from the International Food and Agriculture Organization (FAO), global blueberry production has grown at an average annual rate of 6.5% in the past decade, and market demand has continued to expand. This trend is particularly prominent in my country. With the improvement of consumer health awareness and the upgrading of consumption structure, blueberries have gradually transformed from high-end fruits to popular consumer goods, and the market size has continued to expand. As one of the important blueberry producing areas in my country, Jilin Province has become a representative area for the development of the domestic blueberry industry due to its unique geographical environment and climatic conditions. From the perspective of industrial development background, the high value-added characteristics of the blueberry industry are highly consistent with the strategic goals of agricultural supply-side structural reform. According to the theory of comparative advantage, the development of regional agriculture should rely on its resource endowment and industrial foundation to form competitive characteristic industries [1]. As an important agricultural base in the northeastern region of my country, Jilin Province has unique ecological conditions and rich natural resources, which provides a solid foundation for the high-quality development of the blueberry industry. However, while the blueberry industry in Jilin Province is expanding rapidly, it also exposes problems such as imperfect industrial chain and insufficient risk resistance. These problems restrict the sustainable development of the industry. Therefore, this article conducts in-depth discussion on the current situation analysis and development trend of the blueberry industry in Jilin Province, and provides useful reference and reference for the high-quality development of characteristic agricultural industries.

2. Analysis of the Current Development Status of Blueberry Industry in Jilin Province

2.1 Basic Conditions of the Industry

The blueberry planting in Jilin Province is based on Yanbian Prefecture and Changbai Mountain as the core production areas. Thanks to the cool climate of 6.2℃ per year and the weakly acidic black soil resources (pH value is concentrated in 4.5-5.5), its natural conditions are perfectly suitable for the Beigaocong blueberries (Table 1). Growth needs. It is estimated that the suitable planting area in the province reaches 32,000 hectares, but the current development and utilization rate is less than 30%, and the potential for land intensiveness remains to be released. The geographical advantages adjacent to Russia and North Korea provide a physical basis for the construction of a cross-border cold chain system, but the coverage rate of the existing cold chain trunk line is less than 40% of the main production areas, which restricts the export efficiency of fresh fruits [2]

Table 1 Basic conditions of blueberry industry in Jilin Province

Serial number	index	Data/Description
1	Appropriate plant area	About 32,000 hectares (accounting for 1.8% of the province's arable land area)
2	Distribution of main roduction areas	Yanbian Prefecture (46%), Changbai Mountain (32%)
3	Effective accumulated temperature range	2200-2600℃·d(Suitable for Beigao cluster varieties)
4	Soil pH	4.5-5.5(Weak acidic black soil accounts for 68%)
5	Location and traffic conditions	6 border ports adjacent to Russia and North Korea, and 3 cold chain trunk lines

2.2 Characteristics of Production System

The blueberry production system in Jilin Province shows significant "technology + organization" binary characteristics: on the one hand, the popularity of cold shed coverage and water-saving drip irrigation technologies reached 55% and 64% respectively, effectively alleviating the problems of winter frost damage and seasonal drought; On the other hand, the cooperative-led business model (accounting for 62%) integrates and distributes farmers through standardized production, but the loose interest linkage mechanism leads to limited technological diffusion efficiency. The variety structure is overly dependent on the Beigaocong series (78%), and the iteration speed of new cold-resistant varieties is less than 1/5 years per year, and homogeneous planting has exacerbated market risks [3]. In addition, the capacity utilization rate of deep processing enterprises is less than 50%, and terminal products are still mainly based on primary forms such as frozen fruit (65%), and the profit margin is directly affected by price fluctuations in the international market(Table 2).

Table 2 core characteristics of blueberry production system in Jilin Province

Dimension	Feature Description
Variety structure	North High Cluster Blueberry (78%), Half-high clump blueberries(22%)
Technical application	old shed coverage technology(55%), Drip irrigation penetration rate(64%)
Business model	Cooperative Leader (62%), Joint cooperation model between enterprises and farmers(23%)
Processing capability	23 processing enterprises, Deeply processed products account for only 35%
Certification coverage	Green food certification (48%), GAP certification(12%)

3. Key Influencing Factors in the Development of Blueberry Industry in Jilin Province

3.1 Positive Driving Factors

3.1.1 Technical research and development support

The technology R&D capabilities of the blueberry industry in Jilin Province are the core engine of its high-quality development. In recent years, the province has formed a "collaborative innovation network for industry, academia and research" based on the layout of universities and research institutions, especially in the selection and breeding of cold-resistant varieties, integration of facility agricultural technology, and green prevention and control of diseases and diseases. A scientific research platform represented by Yanbian University's Agricultural College focuses on the localization improvement of

Beigaocong blueberries and has successfully cultivated a new variety of "Changbai Blue" series. Its cold resistance and fruit sugar content have increased by 20% and 15% respectively compared with traditional varieties. %, significantly reduces winter coverage costs and market risks [4]. In addition, through the "Special Agricultural Science and Technology Special Project" policy, the government provides subsidies for the promotion and application of technologies such as intelligent greenhouse environmental regulation systems and drone plant protection, allowing small and medium-sized growers to upgrade their production models at a lower cost. For example, the Internet of Things monitoring system piloted and promoted by Wangqing County optimizes irrigation plans by collecting soil temperature and humidity data in real time, helping farmers save 30% of water per year and increase output by 12%. At the technical promotion level, the cooperative and the agricultural technology promotion station jointly carried out "field classrooms" to accelerate the diffusion of technology through the "demonstration park + farmers" model to form a sustainable technical service ecosystem.

3.1.2 The trend of high-end and diversification of the consumer market has provided huge growth space for the blueberry industry in Jilin Province. As the per capita disposable income of urban residents increases year by year, consumers' demand for high nutritional value and functional agricultural products has shifted from "price sensitivity" to "quality priority", promoting the transformation of blueberries from holiday gifts to daily diet. Jilin Province seized this opportunity and seized the market through geographical indication certification (such as the "Changbai Mountain Blueberry" regional brand) and differentiated marketing strategies [5]. Data from e-commerce platforms such as JD.com and Hema show that since 2022, the online sales of fresh blueberry fruit in Jilin Province have increased by 47% annually, of which the premium rate of organic certified products is as high as 35%-40%. At the same time, deep-processed products such as blueberry anthocyanin extracts, freeze-dried powders, etc. cater to the raw material needs of the health products and cosmetics industries. The annual sales of blueberry raw liquid masks developed by a biotechnology company in Changchun exceeded 80 million yuan, highlighting the industry Chain extension potential [6]. It is worth noting that the development of cross-border markets has further released the increase in demand, and the export volume to the Russian Far East through the Hunchun Port has increased by 28% for three consecutive years. The "overseas warehouse + cold chain direct transportation" model established by the free trade zone policy is compress logistics aging to 48 hours, significantly enhancing the competitiveness of the international market.

3.2 Development Restriction Bottlenecks

3.2.1 Natural disaster risk the high latitude characteristics of the main blueberry producing areas in Jilin Province cause them to frequently suffer from extreme climate events, becoming an important factor restricting industrial stability. First, the problem of overwintering frost damage caused by periodic cold waves is prominent. For example, Yanbian Prefecture encountered an extremely low temperature of -32℃ in early 2021, resulting in root frostbite caused by 53% of open-field blueberries planted, and direct economic losses exceeded 120 million yuan. Although cold shed technology can alleviate the impact of low temperatures, it is difficult for some farmers in mountainous areas to popularize it due to the high initial investment threshold (the cost of renovation of facilities per mu is about 20,000 yuan) [7]. Second, the risk of disease caused by heavy precipitation in summer is intensifying. The precipitation in Changbai Mountain area from July to August accounts for more than 70% of the total annual output. The incidence of anthrax and gray mold in rainy and high humidity environments increased by 25% compared with the previous year. Some orchards were forced to pick in advance to avoid the loss of rotten fruits, resulting in the quality of fruits has declined and the unit price has shrunk. In addition, the coverage rate of government-led agricultural insurance is insufficient (only 35% of the affected farmers), and the low matching of claims standards with actual losses has further weakened the farmers' risk resistance [8].

3.2.2 The shortcomings of the industrial chain

The weak links of the blueberry industry chain in Jilin Province are concentrated in the fields of back-end processing and circulation. First

of all, the shortage of cold chain logistics infrastructure has led to a high loss rate of fresh fruits. Although some regional cold chain distribution centers have been built in the main production areas, the coverage rate of cold storage below the county is less than 20%, and the problem of "chain breakage" in the transportation link is common. For example, some cooperatives in Tonghua City lack pre-cooling equipment and did not have to be picked within 3 hours after picking. The spoilage rate of treated fresh fruit is as high as 15%. Secondly, the technological innovation capabilities in the deep processing stage are lagging behind, and product homogeneity is serious. At present, processing enterprises in the province still mainly focus on primary products such as frozen fruits and jams. The development of high value-added products is limited by the excessive cost of extraction process (the cost of anthocyanin purification technology is about 1.8 times that of the international advanced level) [9]. In addition, the lack of brand building and market development capabilities has led to a large amount of high-quality raw materials flowing to deep processing enterprises in Liaoning, Shandong and other places, and the regional value chain has been in a low-end lock-in state of "raw material suppliers" for a long time. To break through the bottleneck, it is necessary to strengthen the construction of public technical service platforms, and guide leading enterprises and scientific research institutions to work together to solve key processes through industrial funds, and at the same time build a full-chain digital traceability system of "production-processing-sales" to improve brand premium capabilities.

4. Analysis of the Development Trend of the Blueberry Industry in Jilin Province

4.1 Macro Environment-Driven Direction

The strategic opportunities of the blueberry industry in Jilin Province are rooted in the interweaving of national policies and regional development dividends. Against the backdrop of global climate change and the reconstruction of international trade rules, the EU's carbon border regulation mechanism (CBAM)'s full-chain traceability requirements for agricultural products' carbon footprints have forced green transformation on the production side. Jilin Province needs to accelerate the replacement of high water consumption and high carbon emissions. The traditional planting model is adjusted through drip irrigation water-saving technology (the target irrigation water utilization coefficient has been increased to 0.68) and the annual growth rate of organic fertilizer application ratio of 5% to match the EU market entry threshold. At the same time, driven by the superposition of the domestic "rural revitalization" strategy and the "Implementation Plan for Comprehensive Revitalization of the Northeast" "14th Five-Year Plan", Jilin Province has included blueberries in the core support category of the "Changbaishan Characteristic Agricultural Industrial Belt" and has a special project for cold chain logistics infrastructure. Subsidies (such as the "Jilin Province Agricultural Products Circulation System Plan (2023-2027)" promised to invest more than 1.2 billion yuan per year), which will promote the commercialization and treatment rate of fresh fruits from 45% to 70%; taking advantage of the entry into force of the RCEP agreement, Hunchun Marine Economic Demonstration Zone Through the connection between the Japanese and Korean markets by "customs clearance integration" and "zero tariff" policies, the export scale of frozen fruits and anthocyanin extracts is expected to expand by 28% per year, and the proportion of the total blueberry output value of Jilin Province may exceed 40% by 2027. In addition, the legislation on black soil protection and the subsidy policy for farmland rotation forces low-value-added corn growers to turn to high-income economic crops such as blueberries, which will release the potential for transformation of about 500,000 mu of land and form a structural reshaping of the upstream supply end of the industrial chain.

4.2 Forecast of Technology Evolution Trends

Technology iteration will become the core driving force for solving the bottleneck of the blueberry industry in Jilin Province. On the production side, the "smart orchard" system based on low-power Internet of Things (NB-IoT) is accelerating penetration, and through the coordination of soil moisture sensors, micro weather stations and AI pest

identification algorithms, precise control of water and fertilizers can be achieved (test data shows that It can reduce the amount of fertilizer used by 30%) and disaster warning response time to shorten to within 2 hours. The "Blueberry Growth Digital Twin Platform" developed by Yanbian University and Alibaba Cloud has been connected to the 1,200 mu of demonstration base, with a model prediction accuracy of more than 90%, which can compress the average management cost per mu to 60% of the traditional model. In the field of variety research and development, the application of molecular marker assisted breeding technology (MAS) significantly shortens the breeding cycle of stress-resistant varieties. The "JLH-7" cold-resistant gene fragment screened from wild lingonberries by the Jilin Academy of Agricultural Sciences was successfully introduced into cultivation. After the variety, the wintering survival rate of -32℃ is achieved by more than 95%. Combined with the characteristics of early maturity (harvested 15 days ahead of traditional varieties), it can be launched at a staggered peak and seize the high-price window. The breakthrough in back-end processing technology is also critical. The "ultrasonic-enzymatic extraction process" developed by Jilin Agricultural University has increased the yield of anthocyanins to 4.2% (industry average of 3.5%), while the ultra-high pressure non-thermal sterilization technology (HPP) The shelf life of fresh juice will be extended to 120 days, providing technical support for the downward trend of e-commerce channels to third- and fourth-tier cities.

4.3 Analysis of Market Demand Potential

Consumption upgrades and population structure changes are reshaping the value map of blueberry products. Among young consumer groups, cross-border products of functional snacks and beauty products have become new growth poles - Tmall Supermarket data shows that blueberry chewable tablets, freeze-dried fruit yogurt blocks and other products increased by 217% year-on-year in 2023, and the proportion of OEM orders for anthocyanin + hyaluronic acid "oral beauty liquid in Jilin Province's extract processing enterprises soared from 5% to 22%. The silver-haired economy drives blueberries from "snack food" to "healthy and urgently needed products". The "China's Nutrition Blue Book on Middle-aged and Elderly" points out that 52% of patients with chronic diseases include anthocyanins in daily dietary supplements, driving blueberry capsules, compound probiotic preparations, etc. The sales volume of the products' hospital pharmacy channel increased by 35% year-on-year. It is worth noting that the sphere differentiation

5. The Path to High-Quality Development of Blueberry Industry in Jilin Province

5.1 Strengthen Collaborative Innovation Across the Entire Chain

Reconstruct the value of the industrial chain through integrated "R&D-planting-processing-circulation". The upstream promotes the linkage between industry, academia and research, and relies on Jilin Agricultural University and other institutions to establish a blueberry gene editing laboratory to target the cultivation of new varieties with cold resistance (with a tolerance of -30℃) and high anthocyanin content (≥4.5mg/g) to shorten the breeding cycle to 3 Within the year; Zhonghe will promote a green planting traceability system based on blockchain, and provide a subsidy of 200 yuan per mu to bases with an organic fertilizer replacement rate of more than 60%, and a supporting carbon footprint accounting toolkit will achieve 80% of the core production areas to obtain GLOBALG by 2027. AP authentication. The processing end will build a deep processing demonstration park, introduce supercritical CO_2 extraction technology to improve the purification efficiency of anthocyanins (target purity 98%), and develop high-value-added products such as blueberry fermentation stock solution. The downstream upgrades the cold chain logistics network, and reduces the post-harvest loss rate from 18% to within 8% through the combination of "backbone cold storage + mobile pre-freezer" and uses the Hunchun cross-border e-commerce comprehensive pilot zone to achieve a 48-hour direct access to Japanese and Korean consumer terminals.

5.2 Market Breakthrough Strategy

Implement precise market penetration of

"circle-by-scene + cross-scene". Domestic channels focus on breaking through the sinking market: cooperate with Pinduoduo and Meituan Youxuan to launch "9.9 yuan tasting package" to reach county consumers through community group buying, and simultaneously launch low-temperature freeze-dried fresh locks in high-end supermarkets such as Hema and Ole' Product (shelf life of 12 months), additional antioxidant test report has a premium of 30%. The international market implements a hierarchical pricing strategy, exporting more than 95% purity anthocyanin raw materials to Japan (unit price ≥800 USD/kg), exporting frozen fruits (-40℃ quench specification) to Southeast Asia to seize the baking raw materials market, and jointly pilot the "export of blueberries" in customs. Fresh fruit vacuum pre-cooling fast clearance mode. The brand side creates a regional public brand of "Changbai Mountain Blue" and builds a dual endorsement system of "organic certification + functional patents". Authorizes enterprises to use "HiBlue" (Hi-Link blockchain traceability logo) to increase premium space, and jointly launch "Blueberry" with Douyin. Picking AI Live" has been exposed more than 5 million times per day.

5.3 Optimization of Risk Prevention and Control Mechanism

Build a "four-dimensional joint prevention" risk control system: 1) Promote the transformation of facilities at the planting end, and subsidize the cost of the greenhouse at a 30% cost (up to 500,000 yuan/project), and support policy-based agricultural insurance covers frost damage and hail disasters (reimbursement rate reaches 85%), pilot "climate output options" to hedge disaster losses; 2) The processing end implements the "guaranteed price + secondary share" of order agriculture (if it is agreed to guarantee the minimum price of 5 yuan/jin, the processing profit exceeds 15% will be returned to farmers), reducing the impact of market fluctuations; 3) Establish a blueberry price index monitoring platform on the market side, use big data to warn of overcapacity, and dynamically regulate the export tax rebate rate (±3%) to balance domestic and foreign sales; 4) 20 million yuan was invested on the technology side to establish a "smart production safety fund" to prevent IoT equipment Data leakage risk requires 5G edge computing nodes to be equipped with a national secret SM4 encryption chip to ensure that production data is sovereignty and controllable.

6. Conclusion

Through a systematic study of the blueberry industry in Jilin Province, this paper reveals its development characteristics and core challenges at this stage. At present, the blueberry industry in Jilin Province has initially formed a basic chain of planting, processing and sales based on regional resources and policy dividends. However, due to the lagging technology research and development, insufficient industrial chain coordination and single market expansion, the industrial potential has not been fully released. The future development trend highlights three major directions: First, the policy-driven green transformation is in line with standards, and the variety is stress resistance and processing added value through technological innovation; Second, the segmentation of market demand forces industries to differentiate, promote fresh food and functions The third is the intelligent upgrade of the risk prevention and control system, and enhance the resilience of the industrial chain through technological embedding and institutional linkage. The research advocates the construction of a highly efficient and sustainable modern industrial model through multi-dimensional coordination of "technical innovation + market adaptation + institutional guarantee", providing theoretical support and practical reference for Jilin Province's blueberry industry to participate in international competition and achieve high-quality development.

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