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Study on Countermeasures for Innovative Development of Sugar Industry in Laibin City Based on the Background of Carbon Peak and Carbon Neutrality

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Abstract

As the "sweet business" and economic pillar of Laibin City, the sugar industry has ushered in a new development pattern under the background of "carbon peak" and "carbon neutral" strategies. This industry faces unprecedented policy support opportunities, technological innovation, industrial structure optimization, and higher requirements and challenges. This paper first analyzes the status quo of the global and Chinese sugar industry and meticulously analyzes the output, economic benefits, and growth space of sugar in Laibin. Secondly, this paper points out the core problems of insufficient low-carbon policy support, lack of green and low-carbon technical support, urgent industrial structure adjustment, etc. Finally, this paper formulates the innovation and development plan from the multi-dimensional aspects of increasing policy support, promoting green technological innovation, creating the green industrial cluster, etc., to provide a comprehensive development plan for upgrading and transforming the industry. Finally, this paper formulates innovative development plans from multiple dimensions, such as increasing policy support, promoting green technological innovation, and creating green industry clusters, to provide comprehensive strategic guidance for industrial upgrading and change to help it develop sustainably under the Carbon Peak and Carbon Neutrality background and to promote the optimization of the economic structure and sustainable development of Laibin.

Keywords

"carbon peak", "carbon neutral", sugar industry

1. Introduction

Today, the challenges posed by climate change have prompted the world to accelerate its transition to green development, with "peak carbon" and "carbon neutral" strategies emerging. Based on this background, all industries need to make every effort to find new ways to achieve the goal of green development and adapt to the transformation trend in the development process. The sugar industry, which carries the deep historical heritage of Laibin City, plays a crucial role in promoting regional economic development and securing jobs. Still, the high energy consumption and environmental pollution in the development of the traditional sugarcane industry are contrary to the goal of "dual carbon". Therefore, an in-depth exploration of the strategies for changing the sugar industry in Laibin City in the context of achieving the "Carbon Peak and Carbon Neutrality" goal is not only the key to ensuring the industry's continued survival and growth but also the core of promoting the optimization and upgrading of Laibin City's economic structure and sustainable development.

2. Organization Analysis of the domestic and international sucrose industry

2.1 Domestic Sugar Industry Analysis

In China's economic layout and livelihood, the pillar of the sugarcane industry plays a crucial role. In China's sugarcane planting industry, the Guangxi Zhuang Autonomous Region and the southern part of Yunnan Province have developed into a significant concentration of cultivated crops. From Table 1 of the national sugarcane cost-benefit situation, the main product output has fluctuated and declined recently, from 5553.45 kg/mu to 5189.55 kg/mu from 2017-2022. The combined output value and the principal product output value also show a downward trend, reflecting the market value fluctuation. The by-product yield value is low and unstable, e.g., only ¥18.45/mu in 2022. The total cost increases yearly, from ¥2,349.91/mu to ¥2,556.14/mu from 2017 to 2022, with production costs (including material and service costs, labour costs, etc.) accounting for a larger share. The net profit decreased significantly from 406.40 yuan/mu in 2017 to 46.87 yuan/mu in 2022, and the cost margin also reduced from 17.29% to 1.83%, indicating a significant decline in the profitability of the industry and a worrying planting efficiency. This is mainly due to the constraints of the scarcity of land resources and the repeated disruptions of natural phenomena such as typhoons, droughts, and floods, which have significantly jeopardized the quality of sugarcane seedlings during the growing period. In addition, sugarcane farmers are experiencing unprecedented difficulties in their planting careers due to the significant downsizing of the workforce within the agricultural industry.

Table 1: National cost-benefit of sugarcane

Item	Unit	2017	2018	2019	2020	2021	2022
Per acre							
Main Product Output	kg	5553.45	5752. 58	5256. 68	5430. 61	5534. 59	5189. 55
Total output	yuan	2756. 31	2774. 85	2559. 60	2690. 48	2777. 95	2603. 01
Value of main products	yuan	2732. 26	2750. 55	2538. 46	2665. 72	2752. 14	2584. 56
Value of by-products	yuan	24. 05	24. 30	21. 14	24. 76	25.81	18. 45
Total cost	yuan	2349. 91	2443. 54	2379. 12	2425. 98	2512. 06	2556. 14
Production costs	yuan	2050. 31	2127. 55	2055. 31	2066. 73	2171. 24	2216. 72
Material and service costs	yuan	841. 66	873.36	846. 34	894. 69	917. 85	987.13
Labor cost	yuan	1208. 65	1254. 19	1208. 97	1172.04	1253. 39	1229.59
Discount for domestic labor	yuan	625. 99	658. 90	645. 95	625. 52	651.21	668. 91
Hired labor costs	yuan	582. 66	595. 29	563. 02	546. 52	602. 18	560. 68
Land cost	yuan	299. 60	315.99	323. 81	359. 25	340. 82	339.42
Rental of land in circulation	yuan	31.31	35. 10	42. 80	48. 46	46. 89	45.65
Discounted rent for self-camping	yuan	268. 29	280. 89	281.01	310. 79	293.93	293. 77
Net profit	yuan	406. 40	331.31	180. 48	264. 50	265. 89	46. 87
Cash cost	yuan	1455. 63	1503. 75	1452. 16	1489. 67	1566. 92	1593.46
Cash proceeds	yuan	1300. 68	1271. 10	1107.44	1200. 81	1211.03	1009. 55
Cost margin	%	17. 29	13. 56	7. 59	10. 90	10. 58	1.83

Source: National Compendium of Cost and Benefit Information on Agricultural Products 2023.

Sugar factories in China are scattered all over the country, but the technical strength of each enterprise shows a significant gradient difference. Many domestic sugar enterprises have inherited the classic sugar production technology when refining cane stalks. This technology requires a lot of energy and does not satisfy the resource utilization rate. At the same time, it has a more significant negative effect on the natural environment.

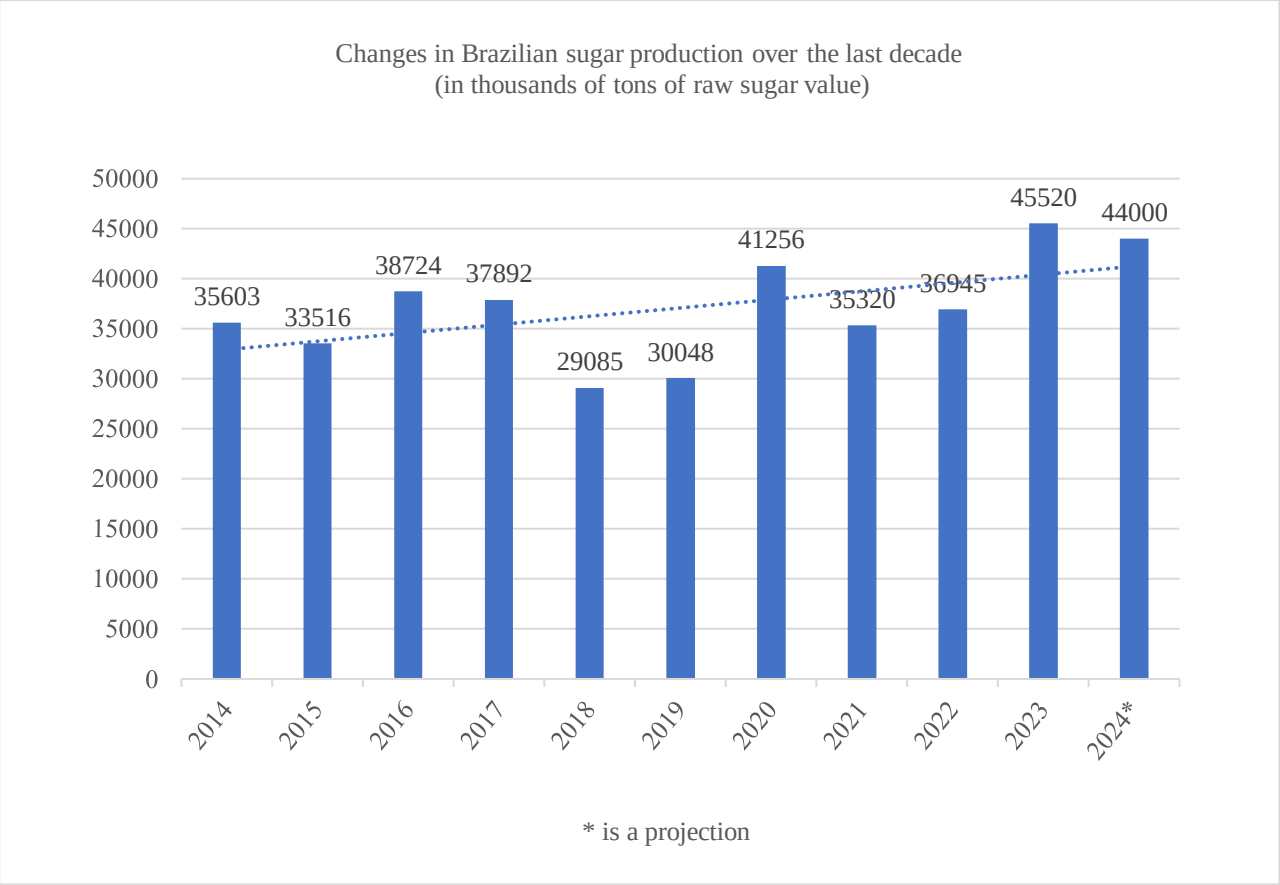
Conventional sugar production processes consume a lot of energy, have a low utilization of resources and have significant negative consequences for the natural environment. In the context of the traditional sugar process, the energy consumption in executing the dewatering and sugar production processes is alarmingly high. In addition, the speed of sugar extraction is in urgent need of a leap forward. Inadequate disposal of the waste and by-products of the sugar industry has seriously disturbed the ecological balance of nature. To realize the ambitious blueprint of zero carbon emission and carbon reduction, the sugar manufacturing community in the country is boldly experimenting and following a gradual path of green change. Cutting-edge technological equipment has been adopted by specific organizations that have cleverly integrated highly efficient, energy-saving thermal energy conversion processes with intelligent automated dessert manufacturing processes.

Water-saving irrigation and fertilizer application programs have been adopted in sugarcane cultivation to reduce energy consumption (Khoodaruth, 2016; Li et al., 2024).

2.2 Foreign Sugar Industry Analysis

The development of the sugar industry around the world takes many forms. Brazil is the world's largest sugar producer and is highly competitive in the industry. Based on a large area, Brazil has refined sugarcane operation using modern agricultural science and technology, such as genetic breeding, combined with modern agricultural science and technology, such as satellite remote sensing and GIS, to improve the yields and quality of sugarcane. As can be seen from Table 2, Brazil's sugar production in the past ten years has fluctuated to some extent. Still, the overall scale is enormous and maintains a high level in most years, such as the production of more than 40,000 kilotons (raw sugar value) in 2020, 2023 and 2024, which is due to its advanced planting technology and management mode, which enables it to stably supply a large amount of sugar and occupy an essential position in the global sugar market. In the sugar industry, Brazilian enterprises are characterized by large-scale and advanced technology, and their advanced sugar production process and energy cycle system, such as the energy cycle, can effectively reduce carbon emissions.

Figure 1: Changes in Brazilian sugar production over the last decade



Source: China Sugar Association

Australia's sugar industry is unique in rationalizing water resources and proper waste disposal. Using bagasse meal as the primary raw material, the sugar industry in Australia has concentrated on exploring ways to transform it into building material and has tried to turn the eliminated wine residue into ecological organic fertilizer while at the same time developing in-depth bio-fertilizer products based on bagasse meal, forming a unique development model that has improved the utilization rate of resources and reduced the impact of wastes on the environment.

However, given various constraints, such as the degree of economic upgrading and the pace of technological innovation, a large number of developing countries have encountered many obstacles in

expanding the area of sugarcane cultivation. In the formative years, the lack of high-quality seeds and sophisticated planting techniques has resulted in generally low productivity. In the modern industrial manufacturing era, longstanding energy-consuming and environmentally polluting operations are challenged by a need for waste treatment capacity. This problem is becoming more apparent in the face of the demands of a “Carbon Peak and Carbon Neutrality” strategy, which calls for increased research and development of science, technology and innovation, as well as the application of these technologies in the production process.Australia's sugar industry is unique in rationalizing water resources and proper waste disposal. Using bagasse meal as the primary raw material, the sugar industry in Australia has concentrated on exploring ways to transform it into building material and has tried to turn the eliminated wine residue into ecological organic fertilizer while at the same time developing in-depth bio-fertilizer products based on bagasse meal, forming a unique development model that has improved the utilization rate of resources and reduced the impact of wastes on the environment.

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3. Laibin Sugar Industry Analysis

3.1 Analysis of Production Value and Output

3.1.1 Value of Production

As a leading industrial enterprise in the Guangxi Zhuang Autonomous Region, the Laibin Sugar Industry shoulders the arduous mission of driving the regional economy to flourish. A wide range of industrial segments, such as the planting of sugarcane and the sugar production process, are covered, and its effectiveness in promoting the development of urban and rural economies is apparent at a glance. As can be seen from Table 2, by utilizing existing contracted arable land for sugarcane cultivation, transferring large-scale sugarcane cultivation and subsidizing the “eucalyptus retreating from sugarcane”, sugarcane farmers have achieved significant growth in economic benefits; at the same time, the business activities of the sugar industry have driven the substantial increase in industrial output, which in turn has led to the development of a thriving logistics and packaging industry.

Table 2: Economic benefits of sugarcane cultivation

Item	Unit	Rates
Mass utilization of existing contracted arable land for sugarcane cultivation	Yuan/acre	1040~2120
Transfer of large-scale cultivation of sugar cane	Yuan/acre	390~1120
“Eucalyptus out, cane in” subsidy	Yuan/acre	1930~2200

Source: Laibin Sugar Industry Bureau.

Even though Laibin is uniquely positioned to grow its output, the roller coaster ride of yield fluctuations is still prominent. Weather conditions are critical to sugar production, with severe drought conditions causing cane fields to suffer from severe water shortages, which not only reduces sugar content but also causes significant wilting of the plants, as well as waterlogging problems caused by excess water, which can lead to tilting and even rotting of the cane plants, all of which significantly affect the efficiency of sugar harvesting. The volatility of the world sugar market substantially affects the company's motivation and enthusiasm to cultivate sugar. When sugar prices hit a low point, companies cut back on the amount of raw materials they buy, resulting in a drop in production, a critical point that should not be underestimated. In the context of the ambitious plan to achieve “peak carbon” and “carbon neutrality”, the technological reforms and machinery upgrades implemented by the company will undoubtedly contribute to a significant increase in production efficiency (Amjady, 2001; Zhang, 2021).

3.1.2 Production Analysis

The sugar cane industry in Laibin City has a significant potential for development. It is located in the south subtropical monsoon zone, with abundant light, heat and rain, rich soil, and better development potential. As can be seen from Table 3, the planted area in Laibin City accounts for 86.08% of the designated area of the city's sugarcane production protection zone and 43.75% of the existing cultivated land, which provides a solid foundation for the sugarcane yield and shows that Laibin City has more significant development potential in sugarcane cultivation, and is expected further to expand the scale of cultivation in the future, increase the sugarcane yield, and promote the development of the cane and sugar industry (Cao et al., 2021; Xu & Jiang, 2021).

Table 3: Area under sugarcane cultivation and its related share in Laibin, 2023

Citywide sugarcane planting area	1772000acres
Accounting for the designated area of the city's sugarcane production protection zone(2058600acres)	86.08%
Percentage of the city's existing arable land(4050500acres)	43.75%

Source: Laibin Sugar Industry Bureau.

3.2 Development Capacity Analysis

From planting acquisition to sugar production, deep processing and other aspects, Laibin City has established a relatively perfect sugarcane production industry chain; from Table 5, the number of sugarcane farmers reached 132,000 households, involving a large number of sugarcane farmers, accounting for 51% of the resident agricultural population, the output of sugarcane into the factory reached 8.53 million tons, the direct income of sugarcane farmers was RMB 4.41 billion yuan, the average per capita income was RMB 8,480 yuan, accounting for 30.10% of the city's per capita disposable income of the rural population, indicating the critical role of the cane industry in driving employment and increasing the income of farmers. The per capita income was RMB 8,480 yuan, accounting for 30.10% of the city's per capita disposable income of rural residents, indicating that the sugarcane industry plays a vital role in driving employment and increasing farmers' income.

Table 4: Status of the sugar industry since 2019

Item	Data
Number of sugarcane farmers in the city	132000
Number of sugar cane farmers involved	520000
Percentage of resident agricultural population	51%
Incoming sugar cane production	8530000 ton
Direct income of sugar cane farmers	44.1billions
Per capita income of sugar cane farmers	8480yuan
Per capita disposable income of the city's rural residents	30.10%

Source: Laibin Sugar Industry Bureau.

However, at the same time, the development of the sugar industry has encountered some problems. Regarding scientific and technological innovation, China must catch up to the world's advanced level. The use of fine agricultural technology in sugarcane planting is relatively small, while the popularization of intelligent irrigation and precise fertilization systems could be better, resulting in severe soil erosion. The traditional sugar industry process is still process-oriented, and the promotion of green and low-carbon technologies is relatively backward, with high energy consumption and environmental pollution. Regarding market competition, Laibin faces competition from sugarcane producers in other regions, both at home and abroad. Domestic sugarcane from Brazil and Australia has robust, cost-effective and quality advantages, while sugarcane production in the different areas of the country is also improving, posing a particular challenge to the market share of Guangxi's sugar industry (Wan, 2019).

4. Constraints on the Innovative Development of the Sugar Industry in Laibin City

4.1 Insufficient Carbon Peak and Carbon Neutrality Policy Support

4.1.1 Poor Policy Relevance and Adaptation

The Carbon Peak and Carbon Neutrality strategy facing sugarcane production in Laibin City needs more specificity. There are differences in carbon emission characteristics and reduction potentials at various stages of the sugarcane production process, and most of the current relevant policies are general and need to reflect the specificities of the sugarcane industry fully. Moreover, there are no clear standards and technologies for measuring carbon emissions in China's sugarcane production process, making it difficult for enterprises to accurately measure their carbon emissions and formulate efficient emission reduction measures.

4.1.2 Financial Support Faces Difficulties

In pursuing the goal of “Carbon Peak and Carbon Neutrality”, the sugar industry in Laibin City is encountering a severe test of capital. At this stage, the government's support for specific sugar production funding needs to be increased, making it difficult for enterprises to overcome the financial constraints on technological innovation, facility upgrading and environmental research. Considering key factors such as industry risk ratings and collateral value assessment, banks have shown a significant supply shortage in allocating green credit to the sugar production industry.

4.1.3 Weaknesses in Policy Implementation and Regulation

Some grass-roots units have made several operational errors in implementing energy conservation and emission reduction tasks because of their need for more mastery of tactics and implementation. Given the shortage of specialized technical personnel and inadequate infrastructure, enterprises face the challenge of precise management in controlling carbon emissions, failing effective deterrents to penalize non-compliant enterprises rooted in the deficiencies in the regulatory process and ineffective punitive measures. Individual organizations are only concerned about small profits, ignoring the critical strategic plan to achieve “carbon peak” and “carbon neutrality”, and the current management structure makes it challenging to impose real constraints on them (Wang, 2017).

4.2 Lack of Green and Low-carbon Production Technologies

4.2.1 Dilemmas in the Sugarcane Growing Segment

Sugarcane cultivation linkage has a significant gap in its promotion in China. Agricultural water use efficiency in China is only 30-40%, mainly relying on heavy water diffusion and furrow irrigation, which causes enormous water loss, and there is a big gap compared with precise drip and micro-sprinkler irrigation. Traditional fertilizer application methods rely on conventional experience, resulting in excess or shortage of fertilizers and higher production costs. However, they may also cause soil pollution, eutrophication of water bodies, and greenhouse gas emissions. In agricultural production, over-reliance on chemicals has resulted in severe ecological pollution while at the same time creating a higher level of resistance to pests, thus reducing the efficiency of pest control (Li et al., 2016).

4.2.2 Sugar segment faces technical bottlenecks

The sugar cane industry is essential to China's strategy to achieve “Carbon Peak and Carbon Neutrality”, but it faces many technological bottlenecks. Traditional sugar production technology is characterized by high carbon dioxide emissions and high production costs due to its high energy consumption, high consumption of water in the cooking process and high reliance on fossil energy. The comprehensive utilization rate of wastes such as bagasse and waste mash could be higher. At present, bagasse is mainly used in fields such as papermaking and simple power generation, and most of it has yet to be subjected to high-value resourcing. There are serious environmental problems with the disposal of organic matter in wastewater, and the current treatment process is not practical for recycling and reusing organic matter (Shihuang, 2019; Sun & Shen, 2016).

4.3 Insufficient Optimization of Enterprise Industrial Structure

4.3.1 Mismatch Between Enterprise Size and Synergy

Sugar enterprises in Laibin City are mainly small and medium-sized enterprises (SMEs) that operate on a smaller scale. In this case, small and medium-sized enterprises have no bargaining power in purchasing raw materials, thus generating higher production costs. Regarding scientific and technological research and development, it is difficult to carry out large-scale research and introduce high-level green and low-carbon science and technology due to funding and workforce constraints. There needs to be more collaboration and cooperation among enterprises regarding raw material procurement, production planning and marketing. There is no advantage of industrial accumulation and a lack of effective exchanges and cooperation in raw material procurement, production planning and marketing, resulting in wasted resources and disordered competition. For example, enterprises raised each other's prices in the process of purchasing cane sugar, and there was malicious competition in the sales process, which caused losses in the industry.

4.3.2 Low Value Added in the Industry Chain

The sugar industry in Laibin City is based on the ancient technology of sugar production as a pillar. Still, more attention must be paid to the extension of the industrial chain and value enhancement. Sugar products have many problems in the deep processing of the sugar industry in Laibin. They are relatively homogeneous, mainly focusing on producing essential products such as primitive sugar quality and white granulated sugar, with the technical content at a low level and relatively limited room for growth. In developing high-value-added speciality sugars and unique sugar products, the sugar industry in Laibin City has invested significantly less money. For example, there needs to be sufficient investment in the research and development of specialty functional sugar, high-end candy and other products, which makes it challenging to launch products with high value-added and market competitiveness. In the deepening of global economic integration, the sugar industry in Laibin is also facing challenges. On the one hand, many high-tech enterprises continue to innovate in the field of food deep processing, its advanced technology and diversified products on the traditional sugar industry in Laibin City constitute competitive pressure; on the other hand, Laibin City, the sugar industry's lack of scientific and technological content of the problem is becoming more and more prominent, and urgently need to solve the thorny issue of low value-added products to enhance the competitiveness in the market (Li & Yang, 2015).

5. Innovation Paths in the Sugar Industry of Laibin City in the Context of Carbon Peak and Carbon Neutrality

5.1 Strengthening Government Support

5.1.1 Developing Stronger Policies and Subsidy Mechanisms

The sugar industry in Laibin should implement the “Carbon Peak and Carbon Neutrality” strategy in a targeted manner. A special subsidy fund will be set up for green and low-carbon development enterprises. For example, sugar cane farmers who use new energy and water-saving facilities can be subsidized according to the amount of the purchase cost, and sugar mills can be subsidized for the purchase of low-carbon advanced equipment and the improvement of process technology. In addition, tax incentives should be improved. Enterprises that take the initiative to fulfil the “Carbon Peak and Carbon Neutrality” strategy should be given tax reductions to purchase environmental protection equipment and research and develop green technologies. Tax rebates should be given to enterprises that manufacture low-carbon sugar to encourage them to take the initiative to devote themselves to the “Carbon Peak and Carbon Neutrality” strategy. “Carbon Peak and Carbon Neutrality” process.

5.1.2 Optimize Policy Implementation and Regulatory Processes

A well-established process for implementing and monitoring the Carbon Peak and Carbon Neutrality strategy. Rationalizing the various functions further and enhancing internal collaboration and cooperation is necessary. Specific carbon emission monitoring, accounting and assessment methods are proposed on this basis. For example, a carbon emission information monitoring system for enterprises will be constructed, requiring them to upload relevant information at regular intervals and have it verified by a third-party

organization. Strengthen the supervision of the implementation process of the "Carbon Peak and Carbon Neutrality" policy. In addition to economic sanctions for enterprises that fail to meet the standards, the "Carbon Peak and Carbon Neutrality" policy can also be ensured by suspending production and rectifying means. Carbon Peak and Carbon Neutrality". At the same time, it is necessary to establish a perfect policy feedback system so that enterprises can analyze the difficulties and problems they face in real-time and make corresponding adjustments and optimization.

5.1.3 Enhancing Financial Support

In sugarcane production in Laibin City, the banking sector should be actively guided to strengthen the support of loans to realize the goal of "Carbon Peak and Carbon Neutrality". Banks should be guided to actively develop green credit businesses according to the actual situation of sugarcane production. For example, sugarcane producers can receive special credit, including relaxed credit terms, extensions, and preferential interest rates. Explore the establishment of a "Sugarcane Green Development" fund to bring in various types of capital to provide diversified financing for enterprises to realize the goal of "Carbon Peak and Carbon Neutrality". At the same time, through financial subsidies and risk compensation, reduce banks' credit risks in sugarcane production and promote green loans for sugarcane producers (Li & Feng, 2021; Lu, 2021).

5.2 Actively Promote Green Technology Innovation in Sugar Production

5.2.1 Technological Innovation Strategies for Sugar Cane Planting Segments

(1) Promotion of Precision Irrigation Technology

Precision drip irrigation technology, such as drip irrigation and micro-sprinkler irrigation, is widely used in irrigation systems to improve the utilization rate of irrigation water. Intelligent irrigation equipment can be constructed in sugarcane planting areas to realize real-time monitoring of soil moisture, temperature and growth cycle, laying the foundation for popularising and applying precision irrigation technology. Research shows that in the process of sugarcane planting, adopting drip irrigation technology can reduce soil erosion, soil erosion, and soil erosion. In addition, it can be matched with rainwater collection, storage and other equipment to achieve the effective utilization of water resources.

(2) Application of Precision Fertilization Technology

Applying advanced agricultural technologies such as GIS, GPS and RS, we precisely monitor and analyze soil nutrients and fertilize sugarcane. On this basis, build a water and fertilizer management system suitable for each fertility period of sugarcane to realize precise fertilization and accurate calculation of fertilization timing during each fertility period of sugarcane, reduce the use of chemical fertilizers and environmental pollution, and ensure high yields and quality of sugarcane under the premise of realizing the effective use of chemical fertilizers. Vigorously develop organic fertilizers and biochemical fertilizers, reduce the use of chemical fertilizers, and reduce carbon dioxide emissions.

(3) Green Pest Management Technology Implementation

It is necessary to deepen the research, innovation and practice in plant pests. The introduction of natural enemies of pests, such as parasitic wasps and predatory mites, will enable us to achieve precise control of harmful insect populations. To improve ecological protection, we must popularize green pesticide types, such as the Field Guardian, which is made from plant extracts, and the Miracle Substance, which microbiological generals forge. This revolutionary pesticide aims to phase out obsolete synthetic chemicals. For example, using natural insecticidal ingredients from plants, such as neem and picloram, enables efficient suppression of pests such as the cane borer. With the help of cutting-edge Internet of Things (IoT) technology, an early warning system has been set up to monitor pests in the cane fields, which can keep an eye on the dynamics of the pests and, based on the real-time feedback, a targeted repellent strategy has been developed.

5.2.2 Sugar Chain Technology Innovation Path

(1) R&D and Introduction of Energy Efficient Sugar Production Process

It is recommended that sugar factories actively research and develop new, energy-saving technologies for sugar production. Promote sugar factories to adopt membrane separation, ion exchange, and other technologies for efficient sugar separation under low-temperature and high-pressure conditions, as well as reduce the energy

consumption of traditional technologies in heating and evaporating sugar. Promote sugar factories to research and develop high-efficiency evaporation devices, such as multi-effect evaporation and heat pumps, to realize efficient water use and reduce energy consumption in cane sugar production. And optimize the sugar cooking process to enhance its automation, reduce energy consumption and errors caused by manual work, and enhance production.

(2) Enhanced Waste Resource Utilization Technology

Strengthen research and development on the recycling and reuse of bagasse. On this basis, explore new methods for the high value of bagasse, its application in the construction and furniture industries, or its conversion into biofuel (such as ethanol, biodiesel, etc.) through bioengineering. For the remaining sludge, use the new anaerobic fermentation process and membrane separation process to effectively utilize the organic substances in the sludge to prepare biogas, biofertilizers, etc., to achieve the sustainable development of the sugarcane sugar industry.

5.3 Building a Green Sugar Industry Cluster

5.3.1 Optimizing Corporate Structure for Synergistic Development

(1) Promoting Mergers, Reorganization and Integration of Enterprises

In the sugarcane production enterprises in Laibin City, Guangxi, the mergers and acquisitions of enterprises should be actively guided and supported to realize the effective utilization of resources in a market-oriented way so that the production and operation of enterprises can be maximized. Small-scale and small and medium-sized enterprises with operational difficulties should be merged and reorganized to complement each other's advantages. Large enterprises can utilize their resources in terms of technology, capital, and market to help small and medium-sized enterprises transform and upgrade, thereby enhancing their operational efficiency and competitiveness. For example, to form a large-scale enterprise group, to improve the comprehensive strength of scientific and technological research and development, market expansion, and to cope with significant problems such as Carbon Peak and Carbon Neutrality, as well as to protect the interests of employees and the stability of the local economy in mergers and acquisitions, and so on.

(2) Strengthening Inter-firm Synergies and Cooperation Mechanisms

Build a collaboration system for sugarcane sugar enterprises and promote collaboration in all industrial chain links. Collaborate in areas such as raw material procurement, technology sharing and marketing. Establish a sugar industry federation or industry association to guide enterprises in centralized purchasing of raw materials such as sugarcane and improve negotiation leverage and stability. Establish a technology exchange platform among enterprises to realize the sharing of knowledge on energy conservation, environmental protection and environmental protection, and jointly conduct related technical training and research and development in terms of marketing; joint industry efforts should be adopted to realize joint development of both domestic and international markets with a unified corporate image and marketing strategy to prevent vicious competition and enhance the overall efficiency of the industry. For example, joint participation in various grain exhibitions will highlight the characteristics of the Laibin saccharification industry and the idea of green development.

5.3.2 Extend the Industry Chain to Enhance Added Value

(1) Expanding the Field of Deep Processing of Sugar Products

Strengthening the deep processing of table sugar, enriching product categories and enhancing comprehensive value. In-depth research has been conducted on functional sugars such as oligosaccharides and prebiotic sugars. Through collaboration with scientific research institutes, we have carried out scientific and technological innovation and developed new technologies to improve the quality and yield of functional table sugar. For example, oligosaccharides' conversion rate and purity are increased through enzymatic methods. Based on the development of unique candy products, candies, pastries, and beverages, they are designed according to local characteristics. Adding local cultural factors to the packaging of the products can enhance the cultural heritage and charm of the products to be able to cater to the needs of customers for speciality foods, thus enhancing the market competitiveness of sucrose products.

(2) Promoting Industrial Integration

Promote the in-depth integration of sugarcane with other related industries to cultivate new economic growth points. Strengthen the integration with the food industry by supplying high-quality sugar sources and personalized sugar products to major food companies to meet the requirements of major industries for sugar. Develop low-sugar and high-fibre beverages with beverage companies and specially flavoured bakery beverages with bakeries. Expand cooperation with the pharmaceutical industry to develop medicinal excipients and medicinal preparations based on the characteristics of sugarcane, e.g., using sucrose as a medicinal sweetener, filler or coating. Explore ways to combine sugarcane sugar production with the cosmetic and biochemical chemical industries to develop sucrose-based skin care products that utilize its moisturizing function or use sucrose as a raw material to prepare biologically biodegradable substances. Through the integration of the industry, enhance the value-added of sugarcane, achieve the sharing and collaboration of resources, and promote the innovative development of China's sugarcane under the Carbon Peak and Carbon Neutrality strategy.

6. Conclusion

Through a comprehensive and in-depth analysis of the sugar industry in Laibin City in the context of Carbon Peak and Carbon Neutrality, this paper presents its current development status, including fluctuations and changes in production value and output, the advantages of the industry chain's development power, and the challenges of scientific and technological innovation and market competition, and also digs into critical issues such as insufficient policy support and lack of green and low-carbon production technology, as well as inadequate optimization of enterprise industrial structure, etc., in the process of achieving the goals of Carbon Peak and Carbon Neutrality. At the same time, the critical problems of insufficient policy support, lack of green and low-carbon production technology, and inadequate optimization of enterprise industrial structure in achieving the Carbon Peak and Carbon Neutrality goals are also deeply explored. Based on this, we propose innovative paths covering government support, technological innovation, and industrial cluster building. In the future, with the advancement of Carbon Peak and Carbon Neutrality, the industry is expected to break through the technology and optimize the structure through continuous innovation, form industrial clusters, enhance the comprehensive benefits, inject new impetus into the local economy, achieve a win-win situation for both the industry and the environment, and play an essential role in the green development of the global sugar industry.

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Conflicts of Interest

The authors declare no conflict of interest.

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