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A Comparative Study Of Sweet Corn Industry Development Between The United States And China

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Abstract:
This study systematically compared the development of the sweet corn industry in China and the United States. In the U.S., sweet corn planted area and yield decreased by 47.2% and 27.9% respectively from 2000 to 2023. Over 70% of sweet corn cultivated is allocated for processing, a figure that has been on the rise. The price of fresh sweet corn has surged by 119.2%. Since 2015, U.S. sweet corn exports have decreased by 18.5% in volume and 4.3% in value, while imports have increased by 63.5% in volume and 115.7% in value, almost tripling the amount in 2005. In contrast, China had a tenfold rise in yield and a threefold increase in planted area. The sweet corn planting zones have expanded nationwide, with the market predominantly driven by fresh consumption, as processed sweet corn constitutes less than 30%. In 2023, China's sweet corn exports were 13 times the volume and 33 times the value of 2005, while imports declined by 44.7% in volume and 43% in value. Recommendations for the U.S. include the enhancement of irrigation systems, transportation networks, and logistics infrastructure, as well as the reconfiguration of the industrial structure and layout, and the promotion of innovation in sweet corn product processing. For China, it is advisable to invest in the seed industry, adopt suitable machinery for mountainous regions, prioritize product innovation, strengthen the financial and insurance support, advance sweet corn processing technologies, and improve governmental oversight and statistical analysis.

Keywords: *China; Industry; Sweet Corn; the United States*

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I. Introduction

Sweet corn is an important crop that serves as staple food, vegetable, fruit, and animal feed. The United States is the first country in the world to cultivate and utilize sweet corn (Singh et al., 2014). For more than a century, the United States held the position of the world's leading producer of sweet corn. As of 2023, sweet corn, in conjunction with tomatoes and onions, constituted 54% of the total vegetable output in the United States. Although China began cultivating sweet corn in the 1980s, its growth has been remarkably swift. Currently, the area of sweet corn cultivation in China has exceeded 400,000 hectares, more than 2.5 times of the area in the United States (Gan et al., 2023; Liu et al., 2020).

Comparative analyses of the sweet corn industries in the United States and China can provide valuable insights for other countries involved in sweet corn production. At present, it is noteworthy that sweet corn is not accounted for in the official statistics of conventional vegetable crops in China. Consequently, research pertaining to China's sweet corn industry predominantly depends on field estimation data (Wang et al., 2014; Liu et al., 2016; Feng et al., 2020; Huang et al., 2020), which is often subject to mutual citation, outdated data (Li & Huang, 2021), or data misinterpretations (Huang et al., 2022; Li et al., 2020), and even misjudgments (Xue et al., Xu et al., 2020). The Institute of Agricultural Economy and Information, Guangdong Academy of Agricultural Sciences (IAEI-GDAAS) is a research institute dedicated to the study of the economic and informational aspects of the agricultural sector. Since 2008, IAEI-GDAAS has systematically monitored 24 major agricultural industries, including sweet corn production in Guangdong province, and has published annual reports (Luo et al., 2014; Gan et al., 2015; Liu et al., 2016; Gan et al., 2022; Gan et al., 2023).

II. Material And Methods

The present study utilizes official statistics from the U.S. Department of Agriculture (USDA), the UN Comtrade database, and extensive longitudinal data on China's sweet corn industry sourced from the IAEI-GDAAS to conduct a comparative analysis of the sweet corn sectors in the United States and China over the past 23 years. Furthermore, we conducted an analysis of the strengths and weaknesses in the sweet corn industries and

presented optimization recommendations for China and the United States.

III. Results And Discussion

Comparison of Sweet Corn Industry Between the United States and China

Planted Area and Production

The planted area and production of sweet corn in the United States have experienced a notable decrease. Data from USDA indicate a gradual decline in the planted area, harvested area, and production of sweet corn in the United States since the beginning of the 21st century. In the year 2000, the planted area of sweet corn in the United States was 303,000 hectares, with a harvested area of 286,000 hectares and a production of 4.48 million tons. By 2010, these figures had diminished to a planted area of 250,000 hectares, a harvested area of 237,000 hectares, and a production level of 4.2 million tons. As of 2023, the planted area of sweet corn in the United States was has further decreased to approximately 167,000 hectares, with a harvested area of around 161,000 hectares and a production of 3.52 million tons. These statistics reflect declines of 44.9%, 45.3%, and 21.4%, respectively, when compared to the year 2000 (Fig. 1). Fortunately, there has been an increase in the unit production of sweet corn in the United States over the past two decades, rising from less than 15 tons to 21 tons per hectare, which represents a 39.2% increase. This enhancement in unit production has partially offset the overall reduction in sweet corn production within the United States.

Conversely, in China, there has been a substantial increase in both the area planted with sweet corn and its production output. Based on extensive longitudinal research and pertinent reports, it is evident that the planted area and production of sweet corn in China have significantly increased since the onset of the 21st century. In the year 2000, the area dedicated to sweet corn cultivation was merely 93,000 hectares, with a production volume of 556,000 tons. By 2005, both the area and production had nearly doubled, reaching 183,000 hectares and 1,063,800 tons respectively. In 2008, the area planted exceeded that of the United States, reaching 263,000 hectares, thereby making China as the leading nation in sweet corn cultivation globally. However, the unit production remained relatively low at 13 tons per hectare, which was 23.5% less than that of the United States. By 2013, China's sweet corn production had reached 4,861,000 tons, surpassing that of the United States and solidifying China's position as the world's foremost producer of sweet corn (Gan et al., 2015; Li & Huang, 2021). In the past decade, the expansion of China's sweet corn industry has experienced a deceleration. In 2018, the area dedicated to sweet corn cultivation was approximately 333,000 hectares (Li & Huang, 2021), which increased to over 400,000 hectares by 2020 (Liu et al., 2020). By 2021, the estimated cultivated area reached around 466,000 hectares (Gan et al., 2023), but this figure declined to approximately 404,000 hectares in 2022. Xue et al. (2023) posited an even more significant reduction, projecting the cultivated area to decline to 347,000 hectares, while anticipating a growth rate of approximately 2.5% in the forthcoming years. Additionally, since 2014, the yield per unit of sweet corn in China has exhibited relative stability at 15 tons per hectare. This yield represents a 1.6-fold increase compared to the year 2000, yet it remains 25% lower than the yield observed in the United States.

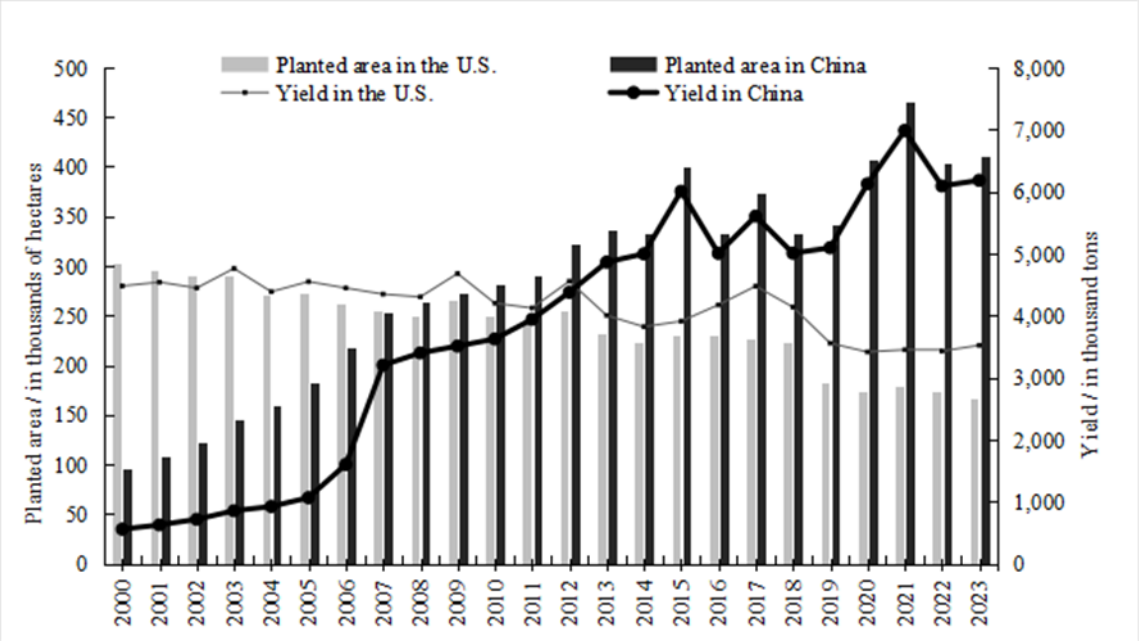

Figure 1. The planted area and production of sweet corn in the U.S. and China from 2000 to 2023 (Source: USDA and IAEI-GDAAS).

The Cultivation Regions

The planting regions of sweet corn in the United States tend to be concentrated. According to data from USDA, Minnesota emerges as the predominant area for sweet corn cultivation, representing approximately 26% of the total planting area. Following Minnesota, Washington accounts for 15-20%, while Wisconsin contributes 10-15%. Other states, including California, New York, Georgia, and Oregon, each maintain a planting area ranging from 5-7%, with Illinois comprising about 2-3%. The orientation of sweet corn cultivation varies by region. States such as Florida, California, Georgia, Pennsylvania, and Ohio primarily produce sweet corn for fresh consumption. In contrast, Minnesota, Washington, Wisconsin, and Oregon focus predominantly on sweet corn intended for processing. New York serves as a hybrid region, engaging in both fresh and processing production. Statistical analysis reveals a significant decline in the number of primary sweet corn production areas in the United States, decreasing from 26 in 2000 to merely 9 by 2023, with 17 states no longer classified among the main production areas. Prior to 2015, Pennsylvania and Ohio were notable contributors to fresh sweet corn production, each accounting for approximately 6-7% of the national output. However, their contributions have diminished over time, resulting in their exclusion from the current main production area statistics. Conversely, the share of leading states has increased. For example, Minnesota's share rose from 23% in 2016 to 27% in 2022, while Washington's share increased from 18% to 20%, Wisconsin's from 12% to 17%, and Florida's from 7% to 8%. These trends suggest a growing concentration within the sweet corn industry in the United States(Fig. 2).

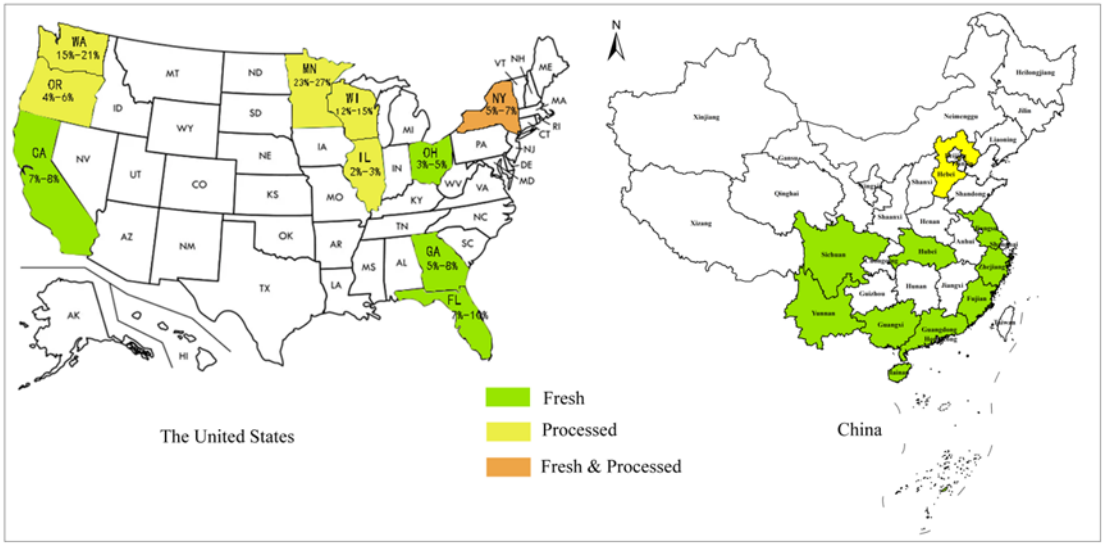

Figure 2. The planting regions of sweet corn in the U.S. and China (Source: USDA and IAEI-GDAAS)

The cultivation regions for sweet corn in China are experiencing significant expansion. Initially, sweet corn farming was concentrated in the southern provinces, particularly Guangdong, Guangxi, and Fujian. Historically, Guangdong province has been the predominant area for sweet corn cultivation, accounting for over fifty percent of the national total in both area and production during the first three decades of its cultivation. However, due to rapid economic growth in Guangdong, there has been a substantial increase in land and labor costs, which has adversely affected the economic viability for farmers. As a result, the sweet corn industry has begun to extend beyond Guangdong to adjacent provinces, including Yunnan, Hainan, Zhejiang, Jiangsu, and Sichuan. Furthermore, the processing sector for sweet corn in northern China has also seen swift development, with key processing regions located in Hebei, Inner Mongolia, and Heilongjiang provinces(Figs. 2). By 2022, the areas dedicated to sweet corn cultivation in these eight provinces exceeded 10,000 hectares each. Specifically, Guangdong reported 144,000 hectares, Yunnan 47,000 hectares, and Hainan 20,000 hectares of sweet corn cultivation(Xue et al., 2023). Looking forward, it is plausible that additional provinces may enter the sweet corn industry, resulting in further growth in the cultivation area dedicated to this crop.

Sweet Corn Processing

The proportion of sweet corn processing in the United States has exhibited an upward trend. The USDA classifies sweet corn data into two primary categories: fresh sweet corn and processed sweet corn. Fresh sweet corn pertains to sweet corn sold in the fresh market, whereas processed sweet corn is utilized in the production of frozen and canned sweet corn products. In the year 2000, the production of fresh sweet corn constituted 29% of the total sweet corn output, while processed sweet corn represented 71%. Within the processed category, frozen sweet corn accounted for 33%, and canned sweet corn comprised 38% of the total production. By 2015, these

proportions shifted to 36% for fresh sweet corn and 64% for processed sweet corn, with frozen sweet corn increasing to 37% and canned sweet corn decreasing to 27% of the total production. From 2016 onwards, there has been a slight decline in the share of fresh sweet corn and a corresponding increase in the share of processed sweet corn. By 2023, the distribution of sweet corn production in the United States was 25% for fresh sweet corn and 75% for processed sweet corn (Fig. 3). In contrast, according to our long-term tracking, the proportion of processed sweet corn in China remains relatively low, primarily due to traditional dietary practices that emphasize the use of fresh ingredients, resulting in limited attention to sweet corn processing. Relatively late, primarily in the Pearl River Delta region during the 1990s. In 2002, the national processing capacity for sweet corn was merely 30,000 tons, accounting for less than 10% of the total national production. At that time, there were also very few sweet corn varieties specifically bred for processing. However, over the past decade, the sweet corn processing industry in northern China has undergone significant growth, with national processing capacity increasing to over 500,000 tons (Xu et al., 2020). By 2022, the proportion of sweet corn processing in China had risen to 24% (Xue et al., 2023).

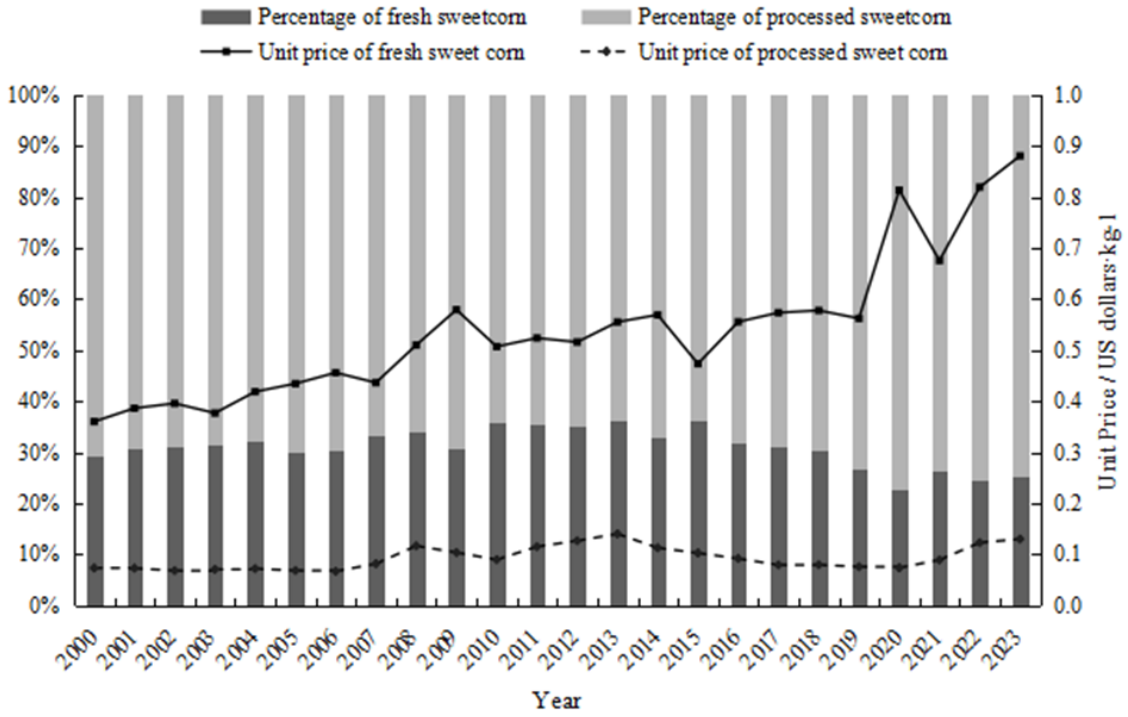

Figure 3. The plant structure and unit price of sweet corn in different years in the United States (Source: USDA)

The Market

The price of fresh sweet corn in the United States significantly exceeds that of processed sweet corn. Between 2000 to 2023, the price of processed sweet corn fluctuated between $0.07 and $0.13 per kilogram, whereas the price of fresh sweet corn escalated from $0.36 per kilogram to $0.88 per kilogram, reflecting an increase of 145%. Notably, in recent years, there has been a pronounced surge, with the price in 2023 exhibiting a 57% rise compared to 2019. This disparity in pricing is substantial, with fresh sweet corn priced up to ten times higher than processed sweet corn (Fig. 3). In 2023, the total value of sweet corn production in the United States approached $1 billion, with the value of sweet corn designated for fresh consumption being double that of sweet corn intended for processing. Conversely, the price of fresh sweet corn in China has remained relatively stable. Market tracking data indicates that the price of fresh sweet corn in China generally ranges from $0.36 to $0.86 per kilogram, while processed sweet corn is typically priced between $0.21 and $0.29 per kilogram. Prices for sweet corn tend to be slightly elevated during the winter months, ranging from approximately $0.64 to $0.86 per kilogram. In contrast, during the summer peak season, when sweet corn is abundantly available, prices are comparatively lower, ranging from about $0.36 to $0.64 per kilogram. Regionally, high-quality fresh sweet corn commands higher prices in the developed southern regions of China, whereas northern regions, which primarily focus on processing, generally exhibit lower prices. Based on production and pricing data, it is estimated that the total production value of sweet corn in China for 2023 was approximately $3 billion, with the majority of this value derived from the sales of fresh sweet corn.

Imports and Exports

The United States has experienced a decline in sweet corn exports alongside an increase in imports. Data from UN Comtrade indicates that the volume of processed sweet corn exports from the United States has gradually decreased in recent years. In 2023, the total export volume was recorded at 104,071 tons, with an export value of $167.9 million, reflecting decreases of 43.0% and 20.7%, respectively, when compared to 2017. Within this export volume, canned sweet corn constituted 49,800 tons, valued at $83.46 million, while frozen sweet corn accounted for 54,300 tons, with an export value of $84.42 million. The primary destinations for these exports included Japan, Korea, and Mexico. Concurrently, in 2023, the United States imported 74,106 tons of canned and frozen sweet corn products from various countries, amounting to an import value of $90.87 million. The principal sources of these imports were Thailand, Canada, and Mainland China. The import volume and total import value exhibited increases of 55.9% and 78.9%, respectively, compared to 2015 (Fig. 4).

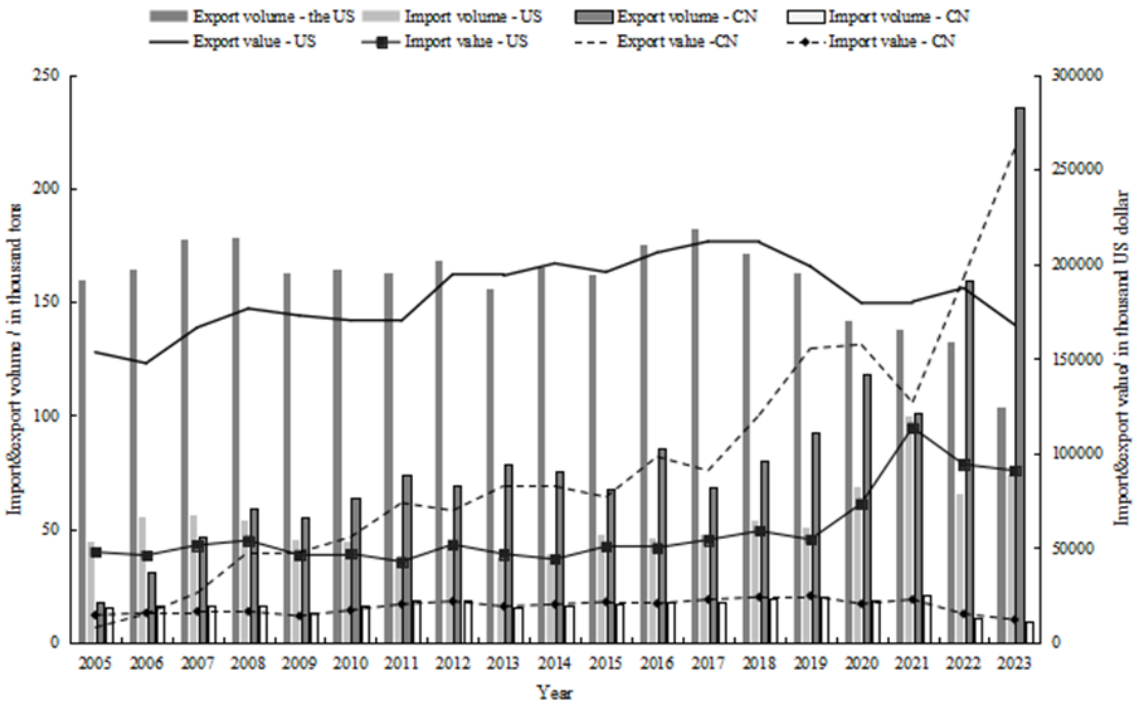

Figure 4. The import and export of sweet corn from 2005 to 2023 in the United States and China (Source:UN Comtrade)

In contrast, China has witnessed an increase in sweet corn exports and a decrease in imports. According to UN Comtrade data, the quantity of processed sweet corn exports from China has shown a consistent upward trend in recent years. In 2023, the total export volume reached 235,851 tons, with a total value of $260.74 million, marking the highest level recorded to date. This represents increases of 249.5% and 239.1%, respectively, compared to 2015, which corresponds to 13 times and 33 times the amounts recorded in 2005. The main export destinations for Chinese sweet corn include Germany, the Netherlands, Spain, the Republic of Korea, and the United States. In the same year, China imported 9,415 tons of processed sweet corn products from various countries, including Thailand, the United States, New Zealand, and Vietnam, with an import value of $12.10 million. Both the import volume and value reached their lowest historical levels, declining by 44.7% and 43%, respectively, compared to 2015 (Fig. 4).

IV. The Strengths And Weaknesses Of The Sweet Corn Industry In The U.S. And China

The Strengths and Weaknesses of the Sweet Corn Industry in the U.S.

The sweet corn industry in the United States benefits from several key advantages, including a diverse range of varieties, advanced technological practices, scaled land, systematic standards and comprehensive financial support. Firstly, boasts a cultivation history of over 200 years in sweet corn, positioning it as a pioneer and global leader in research, development, and seed supply within this sector (Dhaliwal & William, 2022). Secondly, data from the USDA and China's Ministry of Agriculture indicate that the average farm size in the United States is approximately 169 hectares, which is more than five times larger than the average farm size in China. This larger scale facilitates the mechanization of planting processes. Official statistics reveal that the mechanization rate in U.S. agriculture exceeds 95%, whereas China's comprehensive mechanization rate was only

72% in 2021. Thirdly, the combination of scale and mechanization has fostered the standardization of sweet corn production in the United States, thereby mitigating technical risks associated with cultivation. The USDA's annual statistical bulletins provide essential guidance for farmers in developing production plans, which helps to minimize market risks associated with indiscriminate planting. Collectively, these factors have contributed to the robust development of the agricultural insurance system in the United States, thereby ensuring more secure returns and promoting the healthy growth of the sweet corn industry.

The sweet corn industry in the United States faces several disadvantages, primarily stemming from long transportation distances, extreme weather conditions, and insufficient irrigation infrastructure. In comparison to China, the transportation time and costs associated with moving fresh sweet corn from production areas to major consumer markets are relatively high, which poses a challenge to the growth of the fresh sweet corn sector. Additionally, inadequate irrigation facilities in certain regions, coupled with the adverse effects of extreme weather in recent years, have significantly contributed to the reduction of sweet corn cultivation areas in specific production zones (Dhaliwal & Williams II, 2022, 2023).

The Strengths and Weaknesses of the Sweet Corn Industry in China

The advantages and disadvantages of China's sweet corn industry are largely antithetical to those of the United States. China's sweet corn industry benefits from several key factors, including a vast consumer market, a robust transportation infrastructure, and proactive government support. Firstly, with a population of approximately 1.4 billion, China possesses a substantial consumer base that offers significant potential for the expansion of its sweet corn sector. Secondly, the country boasts a well-developed transportation and logistics network, which facilitates the timely delivery of sweet corn from production areas to consumer markets, often within a single day. This efficiency is particularly advantageous for the fresh sweet corn market, especially when contrasted with the United States, where the extensive geographical span of 4,500 kilometers complicates rapid transportation. Thirdly, given that sweet corn serves dual purposes as both food and animal feed, the Chinese government prioritizes food security and has enacted a series of supportive policies that foster the swift advancement of the sweet corn industry.

The challenges facing China's sweet corn industry include a nascent seed industry, outdated planting and processing technologies, fragmented land ownership, and an incomplete system of standards and financial insurance. Firstly, the industry has a relatively brief history of less than 50 years (Gan et al., 2015; Li & Huang, 2021), which, combined with a lack of core germplasm resources and a disconnect between breeding and seed production, has resulted in limited competitiveness and a high degree of reliance on foreign seed sources. Our research indicates that over 90% of sweet corn seeds in southern China are imported from the United States, Thailand, or Taiwan (Gan et al., 2023). Secondly, the fragmentation of agricultural land in China necessitates a heavy reliance on manual labor for sweet corn cultivation, leading to low levels of mechanization and standardization. This situation places the Chinese sweet corn industry at a disadvantage in terms of production costs and pricing in the global market. Thirdly, the insurance market for sweet corn remains underdeveloped, contributing to elevated industry risks and challenges in securing financing and loans. Lastly, the absence of systematic periodic monitoring and comprehensive statistical data within China's sweet corn industry hampers effective production guidance and scientific research initiatives.

V. Recommendations For The Advancement Of The Sweet Corn Industry In The United States And China

Recommendations for the Advancement of the Sweet Corn Industry in the United States

The sweet corn industry in the United States is currently at a pivotal juncture. To ensure its continued stability and growth, several strategic measures must be implemented. First, it is imperative to enhance the irrigation infrastructure in regions reliant on rainfed agriculture and those employing a combination of irrigation methods, such as Illinois, Wisconsin, and parts of Minnesota. Second, there has been a notable decline in the consumption of canned sweet corn in the United States, with a growing preference for fresh sweet corn (Roman et al., 2017). To address this shift in consumer demand, it is essential for the United States to improve its domestic transportation and logistics infrastructure or to modify the planting structure and geographic distribution of sweet corn to minimize transportation time and costs associated with fresh sweet corn. Finally, the predominance of canned and frozen sweet corn products in the U.S. market has contributed to a degree of consumer taste fatigue. Therefore, it is crucial to innovate and develop new processed sweet corn products to offer consumers a broader range of choices, thereby stabilizing or potentially increasing the market for processed sweet corn.

Recommendations for the Advancement of the Sweet Corn Industry in China

China is currently in a developmental phase regarding its sweet corn industry. With the backing of a substantial market and a well-established transportation and logistics framework, fresh sweet corn is expected to remain a focal point in the future. However, as living standards improve, there will be an escalating demand for

products that offer enhanced taste and multifunctionality. It is essential to increase investment in sweet corn breeding to cultivate varieties that are widely adaptable, bi-colored, and multifunctional (Xiao et al., 2020; Liao et al., 2023; Yang & Chen, 2022; Yang et al., 2021; Gong et al., 2019). Concurrently, it is important to support and strengthen seed enterprises to enhance the market supply of local high-quality varieties, establish well-known sweet corn brands, and improve market competitiveness. Additionally, promoting land consolidation and enhancing production service capabilities will facilitate large-scale operations. Research and development efforts should focus on machinery suitable for hilly terrains to elevate the levels of mechanization and standardization within China's sweet corn industry. Furthermore, there has been a significant demand for international processed sweet corn products in recent years. It is advisable to continuously diversify product offerings and enhance processing technologies and equipment to increase market share in international markets. Lastly, it is recommended to incorporate fresh sweet corn into regular crop statistics and to publish annual data in China to support planting planning and scientific research initiatives.

VI. Conclusions

During the past decades, the sweet corn in the United States has experienced a 47.2% decrease in planted area, 27.9% decrease in yield, 18.5% decline in export and 63.5% increase in import volume. In contrast, China has seen a threefold increase in planting area and a tenfold increase in yield. China's sweet corn exports were 13 times higher in volume and 33 times higher in value compared to 2005, but the imports decreased by 44.7% in volume and 43% in value. The main factors related to this change may involve irrigation, transportation, logistics infrastructure, industrial structure and layout, product innovation, financial and insurance market.

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