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Mathematical Modeling of Demand and Supply: Analyzing Corn Market Equilibrium

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Abstract:

This article offers a comprehensive analysis of the current state and future development trends of the corn industry, with a specific focus on its significance within China's agricultural sector. As one of the country's most important grain crops, corn plays a crucial role in various sectors including animal feed, human food, and as a key raw material in industrial applications. Over recent years, the corn market in China has witnessed substantial fluctuations in both supply and demand, driven by a combination of factors such as extreme weather events, shifts in trade policies, and other external influences. The Chinese government has responded to these challenges by implementing a range of measures aimed at bolstering the industry, including policy directives, financial incentives, and enhanced regulatory oversight. Additionally, the promotion of technological innovation has been identified as a critical component in improving efficiency and productivity within the sector. Looking forward, the corn industry is poised for more stable and sustainable growth, driven by deeper integration within the industry and increased international collaboration. These developments are expected to solidify the industry's role not only within China but also in the global agricultural economy, ensuring its continued contribution to both national food security and economic development.

Keywords: Demand, Supply, Fuction, Equilibrium, Model

1. Introduction

This article delves into the current situation, development trends, and response strategies of the corn industry. Corn, as the largest grain crop in China, ranks among the top in both production and consumption in the world, and occupies an important strategic position in food security. With the advancement of technology and changes in market demand, the corn industry is gradually developing towards high efficiency and modernization. The article analyzes the changing trends of corn planting area, unit yield, total yield, and consumption structure, and predicts the supply and demand pattern of the future corn market. At the same time, in response to the challenges faced by the current corn industry, such as price fluctuations and intensified market competition, strategies have been proposed to strengthen scientific research and innovation, optimize planting structures, and expand the field of deep processing. This article aims to provide reference and inspiration for the sustainable development of the corn industry.

China Agricultural Industry Model, the corn planting area will reach 44.2265 million hectares in 2024, an increase from previous years. This is mainly due to the strong willingness of farmers to plant corn and the government's support policies for the corn industry. With the increase of planting area and the improvement of unit yield, the total corn yield also shows a steady increasing trend. It is expected that the unit yield of corn will reach 6607.06 kilograms per hectare in 2024, with a total yield of 292.2071 million tons. This is mainly due to technological progress, optimization of planting patterns, and the implementation of actions to increase corn yield.

The demand for corn consumption is relatively stable, but the structure has changed. It is expected that the total consumption of corn in 2024 (excluding inventory changes) will be 317.8463 million tons [1-5], a year-on-year increase of 0.6%. Among them, consumption for food and animal feed has slightly decreased, while industrial consumption has increased. This is mainly due to factors such as overcapacity in pig production, poor industry profits, and overcapacity reduction, which have led to a decrease in feed consumption, while the demand for corn by deep processing enterprises has increased.

In terms of imports, although China's corn imports have increased in recent years, it is expected that the domestic corn supply will be sufficient by 2024, and the gap between production and demand will be narrowed, resulting in a decrease in imports. However, due to the low price of

corn in the international market [5-10], corn imports may remain high in the coming years. It is expected that the net import volume of corn in 2024 will be 25.6392 million tons, a decrease of 5.46% compared to 2023.

In terms of exports, China has a certain export advantage in fresh corn, with export volume far exceeding import volume. The main export commodity is "sweet corn made or preserved by non-vinegar methods", mainly exported to European countries such as Germany.

The price of corn market is influenced by various factors, including supply and demand, import and export situation, policy adjustments, and weather changes. The current corn market prices are stabilizing, but price fluctuations are still possible due to the global economic situation and international trade environment. In the long run, the corn price cycle roughly follows a 3–4-year cycle, generally following the price law of rising, fluctuating, and falling. It is expected that the transition to the downward phase will come to an end in the first half of 2024, and a new cycle may begin in the second half.

2. Models

In recent years, with the advancement of agricultural technology, the improvement of production efficiency, and policy incentives such as reduced land transfer costs and producer subsidies, the supply of corn has usually shown an increasing trend.

2.1 Supply function

If the supply quantity is Q_s and the price is P, the supply curve can be expressed as Q_s=f (P), where f is an increasing function indicating that the supply quantity increases when the price rises.

Influence factor: Changes in production costs, such as fertilizer fees, seed fees, labor costs, etc., will directly affect the position of the supply curve. Policy factors such as government subsidies, taxes, trade policies, etc. can also affect supply.

2.2 Demand function

The demand for corn mainly comes from various aspects such as feed, food processing, and industrial raw materials. In recent years, with population growth, improved living standards, and the development of animal husbandry and industry, the overall demand for corn has shown an increasing trend, but it may also be affected by economic fluctuations, policy adjustments, and other factors.

If the demand quantity is Q_D and the price is P, the demand curve can be expressed as Q_D =g (P), where g is a decreasing function indicating an increase in demand when the price decreases.

Influence factor: Consumer income: An increase in income typically leads to an increase in demand for food and industrial raw materials [7]. Alternative prices: Changes in the prices of substitutes such as wheat and soybeans can affect the demand for corn. Consumer preferences: Dietary habits and cultural differences can also affect the demand for corn.

2.3 Supply-demand equilibrium analysis

In the analysis of supply-demand equilibrium, the equilibrium point is where the supply and demand curves intersect, signifying that at this price level, the supply equals demand, and the market is in equilibrium. When there is a shift in either supply or demand, the equilibrium price adjusts accordingly. For instance, if the supply increases, causing the supply curve to shift rightward while demand remains unchanged, the equilibrium price will decrease, and vice versa. To conduct a more precise analysis of the supply and demand curves, we can utilize a mathematical model. Here, the supply function is represented as QS=aP+b (a linear function where a>0), and the demand function as QD=c-dP (a linear function where d>0). The equilibrium price (P*) and equilibrium quantity (Q*) can be determined by solving the system of equations where QS equals QD.

3. Discussion

3.1 Suggestion for Supply

Firstly, improve the production capacity of corn. Encourage farmers to increase their corn planting area through policy guidance and voluntary participation in areas suitable for corn cultivation. At the same time, strengthen land consolidation and improvement, improve land utilization and output rates; Implement the corn yield improvement project, improve the level of corn yield by promoting high-yield and high-quality varieties, optimizing planting modes, and strengthening field management. For example, the integrated technology of "5335" for high-yield corn planting and the "one increase, three improvements, and one prevention" technology model for corn can be promoted, selecting high-yielding varieties that are resistant to density and stress, and reasonably increasing planting density. Secondly, optimize the supply structure. Reasonably adjust the corn planting structure based on market demand and regional resource endowment. In areas with high demand for feed, increase the planting area of corn appropriately; Develop specialized corn cultivation in areas with high demand for deep processing; In addition to domestic corn, we can also actively utilize international market resources to expand the source countries and channels of corn imports. At the same time, encourage the development of corn substitute production, such as sorghum,

barley, etc., to alleviate the domestic supply-demand contradiction of corn.

Thirdly, strengthen market regulation. Establish a sound monitoring and early warning system for the corn market, timely collect, organize, and analyze supply and demand information in the corn market, and provide scientific basis for government decision-making; Establish a sound system for regulating corn reserves, regulate market supply and demand through reserve throughput, and stabilize market prices. Release reserve corn during times of tight corn supply to increase market supply; Purchase reserve corn when there is an oversupply of corn to reduce market pressure.

3.2 Suggestion for Demand

Firstly, accurately grasp market demand. Regularly conduct in-depth research and analysis on the corn market, including changes in domestic and international market demand trends, consumption structures, competitive situations, etc., in order to accurately grasp market dynamics and demand changes, establish and improve market information monitoring and warning mechanisms, timely collect, organize and analyze relevant information, and provide scientific basis for decision-making. This helps companies anticipate market changes in advance and adjust production and business strategies in a timely manner. Secondly, optimize the product structure and layout. Adjust and optimize the structure of corn products according to changes in market demand and increase the supply of specialized and high value-added products. For example, developing diversified products such as feed corn, industrial corn, and edible corn to meet the needs of different fields; Optimize the layout of corn production based on market demand and resource endowment in various regions. In areas with high demand for feed, increase the planting area of feed corn appropriately; Develop industrial corn production in areas with high demand for deep processing. Thirdly, promote consumption upgrading and market expansion. Strengthen quality control and standardized management in the corn production process to improve product quality and safety. Enhance consumers' awareness and trust in corn products through brand building and marketing promotion; While ensuring domestic market demand, actively exploring international markets and increasing the export volume of corn products. By participating in international exhibitions and establishing overseas sales channels, we aim to enhance the international competitiveness of our corn products.

3.3 Suggestion for Government

The government will stabilize the corn market price through measures such as collecting and storing grain reserves and releasing them to prevent significant price fluctuations from having adverse effects on farmers and consumers; Strengthen the supervision of the corn market, crack down on illegal activities such as hoarding and price gouging, and maintain market order and a fair competitive environment. Establish a sound market information release mechanism, timely release supply and demand information, price information, etc. in the corn market, and provide decision-making references for farmers and enterprises; The government will increase investment in corn research and support the development and promotion of new varieties, technologies, and processes. Improve the yield, quality, and stress resistance of corn through technological innovation; Organize experts and technical personnel to conduct technical training and guidance services in the fields, helping farmers solve practical problems encountered in production.

4. Conclusion

This study conducted an in-depth analysis of the current situation and development trends of the corn industry, and concluded that corn, as the largest crop in China, plays a core role in ensuring national food security through its production, consumption, and trade. Through policy support, technological innovation, and industrial chain optimization, the yield and total output of corn have steadily increased. However, it is still necessary to pay attention to the impact of market fluctuations and international trade situations on the corn industry. In the future, we should continue to strengthen the research and promotion of new corn varieties, promote industrial integration and development, increase the added value of corn products, and strengthen international cooperation to expand the sources of corn imports, ensuring the stability and safety of corn supply. In summary, the sustained and healthy development of the corn industry is of great significance for ensuring national food security.

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