Correlation between Potato Industry Benefits and Climate in Ulanqab City

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Abstract Ulanqab City is known as the "potato capital of China", and the potato industry is a pillar characteristic industry that supports local rural revitalization and drives agricultural economic growth. Climate resources are the core natural elements that determine the growth, development, yield accumulation, and quality formation of potatoes. The temporal and spatial variations of temperature, sunlight, precipitation, and extreme weather directly affect potato yield, commodity quality, and overall market returns. In this paper, the potato industry in Ulanqab City is taken as the research object. Combining regional climate characteristics and potato growth habits, the inherent relationship between various climate factors and industrial benefits is systematically analyzed, the existing problems in industrial development under existing climate conditions are sorted out, and the development strategies that are suitable for climate characteristics are proposed, providing reference for the potato industry in Ulanqab City to achieve stable production and income increasing, high-quality and sustainable development.

Key words Ulanqab City; Potato industry; Climatic factors; Industrial benefits; Correlation analysis

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Potatoes have multiple attributes of grain, vegetable, and economic crop, and are the core characteristic crop in northern dryland agricultural areas to ensure stable production and drive farmers' income growth. Ulanqab City is located in the golden potato planting belt, belonging to the mid temperate continental monsoon climate, with a cold plateau climate and sandy soil. The locally produced potatoes have sufficient dry matter, high starch content, low incidence of pests and diseases, and excellent commodity appearance. With its unique natural conditions, Ulanqab City has become a core base for potato cultivation, processing, and distribution in China. For many years, the development of the entire potato industry chain has driven stable income growth for local farmers and provided stable support for regional agricultural economy. However, with the intensification of global climate change, the precipitation pattern in the northern region has changed, the frequency of extreme weather such as periodic drought, short-term rainstorm, hail and so on has increased year by year, and the regional climate stability has declined significantly. Abnormal fluctuations in meteorological factors can disrupt the growth rhythm of potatoes throughout their entire growth period, causing fluctuations in annual yield, a decrease in the proportion of high-quality commercial potatoes, and an increase in field management costs, and directly lowering the overall economic benefits of the industry[1]. In this paper, combining the climate characteristics of Ulanqab City and the current development status of the potato industry, the inherent correlation between climate factors and the benefits of the potato industry is deeply analyzed, the problems existing in the development of the potato industry in Ulanqab City are systematically explored, and the development strategies to promote the improvement of potato industry quality and efficiency based on climate advantages are proposed, in order to provide theoretical basis and practical reference for the improvement of potato industry benefits in Ulanqab City.

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1 Climate characteristics and development status of potato industry in Ulanqab City

1.1 Regional core climate characteristics Ulanqab City is located in the central plateau of Inner Mongolia, with cool summers, abundant sunshine resources, large temperature differences between day and night, and prominent characteristics of rain and heat during the same period. The climate conditions are highly suitable for the growth habits of potatoes, which prefer cold and cool weather, light, and avoid high temperatures[2]. The climate advantage for regional development of potato industry is very prominent. The temperature during the growing season is mild and moderate, which can effectively suppress the growth of pests and diseases, reduce pesticide application, and meet the needs of green planting development. Adequate sunshine duration and high light intensity throughout the year can fully meet the photosynthesis needs of potatoes, which is beneficial for the accumulation of dry matter and starch. The significant temperature difference between day and night in autumn can significantly reduce plant nutrient consumption and further improve potato quality. At the same time, the regional climate gap is also prominent, with relatively low annual precipitation and extremely uneven spatial and temporal distribution of precipitation. Spring and summer droughts occur year-round, and it belongs to typical rain-fed agricultural areas. The shortage of natural water resources is the core factor restricting

the growth of potatoes. In addition, extreme weather conditions such as spring and autumn frost, local hail, and short-term heavy rainfall occur frequently, further increasing the natural risks of large-scale potato cultivation.

1.2 Current status of potato industry development The potato planting scale in Ulanqab City consistently ranks first in Inner Mongolia Autonomous Region and among the top in China. After years of cultivation and development, a complete industrial chain system that integrates large-scale planting, standardized production, refined processing, and branded sales has been established in local area. The industrial format continues to iterate and upgrade, completely breaking away from the traditional mode of single export of fresh potatoes, and extending to diversified formats such as seed potato breeding, warehousing cold chain, starch processing, deep processing of leisure food, and e-commerce export. The added value of the industrial chain continues to increase, and its role in absorbing employment and driving farmers' income growth is significant. Relying on its unique climate and soil advantages, the geographical indication brand influence of Ulanqab potatoes continues to expand, and its products are marketed in major markets across China. In the context of climate change, the shortcomings of industrial development continue to be highlighted: climate fluctuations cause a decrease in annual yield stability, meteorological disasters such as drought and frost lead to reduced production, abnormal and rotten potato chunks, concentrated outbreaks of pests and diseases, and the proportion of high-quality commodity potatoes fluctuates year by year; the continuous rise in agricultural inputs, labor, and storage costs has led to a reduction in the income of some growers, and the climate risks faced by the industry in stabilizing production and increasing income continue to increase[3].

2 Correlation analysis of climate factors and potato industry benefits in Ulanqab City

2.1 Temperature Temperature is the basic condition for the growth and development of potatoes. The optimal temperature range for potato tuber enlargement is 15 – 22 ℃, which is highly compatible with the summer climate in Ulanqab City and is the core foundation for high-quality and high-yield potatoes in the local area. A suitable temperature can ensure that potatoes sprout neatly, grow vigorously, and have well-developed roots, providing sufficient nutrients for tuber expansion. The significant temperature difference between day and night in autumn is the key to improving the quality of potato tubers: suitable temperature during the day promotes organic matter synthesis, while low temperature at night weakens plant respiration, reduces nutrient loss, and significantly increases the starch and dry matter contents of potato tubers, raising product market premiums, and directly improving industrial quality and efficiency. However, abnormal temperatures can cause significant loss of benefits. During the continuous high temperature in summer, potato stems and leaves may become excessively long, providing a large amount of nutrients for branch and leaf growth, inhibiting tuber enlargement, resulting in smaller potato chunks and a decrease in total yield. At the same time, high temperature and high humidity environments can easily induce late blight and aphid infestation, increasing the cost of pesticide control and field manual management. Late frost in spring and early frost in autumn can directly damage seedlings and mature plants, causing premature aging of plants and cessation of tuber development. In severe cases, it can lead to widespread production reduction and have a devastating impact on industrial yield and efficiency.

2.2 Sunshine Abundant sunlight is the most prominent climatic advantage of the potato industry in Ulanqab. Potatoes are light loving crops that rely on sufficient light for photosynthesis throughout their entire growth period. During the local potato growing season, the proportion of sunny days is more, and light intensity is high. Adequate sunlight can sustainably promote the accumulation of nutrients such as carbohydrates and starch, effectively reducing the output of hollow and deformed potatoes and significantly increasing the proportion of high-quality commodity potatoes. At the same time, sufficient sunlight can decline air and soil humidity in the field, inhibit the reproduction of mold and pathogenic bacteria, reduce the probability of disease and pest occurrence from the source, decrease investment in planting prevention and control, and simultaneously achieve triple benefits of yield improvement, quality optimization, and cost reduction. In only a few years of low light and heavy rain, there may be weak plant growth, insufficient nutrient accumulation, and a slight decline in yield. Overall, sunlight resources have always played a stable and positive role in promoting the local potato industry.

2.3 Precipitation Precipitation is the biggest shortcoming that restricts the quality and efficiency enhancement of the potato industry in Ulanqab. Most of the local planting plots rely on natural precipitation for irrigation, and the insufficient total amount of water resources and imbalanced spatial and temporal distribution of precipitation are the main factors restricting stable industrial production. The branching and tuber expansion stages of potatoes are critical stages for water demand. Moderate precipitation can match the growth needs of plants, ensuring rapid tuber expansion and achieving stable and high yields. The climate characteristics of local rain and heat during the same period can provide temporary water support during the vigorous growth period of potatoes, laying a solid foundation for stable industrial production. The normalization of drought disasters seriously restricts industrial efficiency: there is a lack of precipitation during the spring sowing and seedling emergence periods, insufficient soil moisture, low seedling emergencerate, weak seedling growth, and insufficient seedlings and ridges in the field; summer is prone to drought, and during the critical period of tuber enlargement, water supply is insufficient, resulting in a significant increase in the proportion of small potatoes and a substantial decrease in yield per mu. In addition, short-term heavy rainfall and rainstorm are likely to cause ponding and soil hardening in the field, and induce rotten roots and tu-

bers. The scab disease and late blight break out, a large number of potato pieces are rotted and scrapped, and the costs of drying and storage management and protection are rising synchronously. It is the primary climatic factor that cause the fluctuation of annual industrial income.

3 Existing problems in the development of potato industry in Ulanqab from a climate perspective

3.1 Shortage of precipitation resources and weak ability to resist drought and stabilize production The climate shortcoming of insufficient natural precipitation and uneven spatial and temporal distribution in the region is prominent. Currently, there are still large areas of dryland planting areas that are not equipped with complete water-saving irrigation facilities, and production relies entirely on natural precipitation, making it difficult to resist normalized drought. The annual yield fluctuates greatly. At the same time, the promotion and coverage of drought resistant varieties and water-saving planting technologies that are suitable for local arid climates are insufficient, and the overall climate resilience of the industry is weak.

3.2 Imperfect construction of meteorological disaster prevention and control system Local extreme weather has sudden and uncertain characteristics, but the adaptation of agricultural meteorological services to industrial disaster prevention systems is insufficient. Refined meteorological warning information is difficult to reach grassroots farmers, and most farmers still rely on traditional experience to carry out planting, unable to scientifically predict disasters in advance, and the implementation of pre protective measures is lacking. At the same time, the implementation of supporting technologies such as post disaster pest control, field restoration, and yield reduction remediation lags behind, and the losses caused by meteorological disasters further expand.

3.3 Low level of refined planting management The current potato planting management model is solidified, and dynamic adjustment mechanism based on annual climate prediction has not been established. The sowing, fertilization, and field management time are fixed, which cannot adapt to the fluctuations in annual temperature, precipitation, and light. In years with suitable climate conditions, production capacity has not been fully released, and losses have significantly increased in years with adverse weather conditions, making it difficult to ensure the stability of industrial income.

4 Development strategies for improving the quality and efficiency of potato industry based on climate advantages

4.1 Improving water-saving infrastructure and addressing the shortcomings of precipitation constraints Focusing on the core limiting factor of drought, it should continuously improve the supporting facilities of agricultural water conservancy, and expand the coverage of efficient water-saving technologies such as undermulch drip irrigation, micro irrigation, and sprinkler irrigation, achieving precise artificial water replenishment during the key growth period of potatoes, and breaking free from natural precipitation constraints. It should optimize the layout of planting space, compress the bare planting area in arid core areas, and construct water-saving farmland with high standards; potato varieties that are drought resistant, tolerant to poverty, and suitable for local climate should be vigorously selected and promoted, in order to enhance the industry's drought resistance from the source of the varieties[4].

4.2 Building a refined meteorological service system and strengthening comprehensive disaster prevention and control A special meteorological service mechanism covering the whole growth period of potatoes should be built. For the critical stages of seedling emergence, branching, tuber expansion and mature harvesting, it should release detailed early warning information of frost, drought and rainstorm so as to realize the advance prediction and pre prevention and control of disasters. It should open up grassroots information dissemination channels, promote targeted practical techniques for disaster prevention and management, and guide farmers to carry out operations such as film mulching for soil moisture preservation, anti freezing and seedling protection, post rain drainage, and pest and disease prevention. Standardized post disaster remediation processes should be established, and precise field restoration and pest control should be carried out, to minimize losses caused by meteorological disasters.

4.3 Promoting climate adaptive and refined field management It should abandon traditional experiential and fixed planting models, and establish a refined management system of "climate prediction + dynamic management". Based on the prediction of annual climate trends, it should flexibly adjust the sowing, irrigation, and fertilization cycles; seize the suitable time for temperature and light to strengthen seedlings and promote production, strengthen protection and control in sensitive periods with large climate fluctuations and high incidence of disasters, and achieve the goal of seeking benefits and avoiding harm, stabilizing the overall income of the industry.

5 Conclusions

The moderate temperature, abundant sunshine, and large temperature difference between day and night are the core advantages of the high-quality development of the potato industry in Ulanqab City, continuously helping to improve potato quality and brand value. However, the shortage of natural precipitation, the imbalance of temporal and spatial distribution, and the frequent occurrence of extreme disasters such as drought, frost, rainstorm are the core bottlenecks restricting the stability of industrial production and income. The annual fluctuations in climate factors directly determine the yield, quality, and overall economic benefits of the potato industry. In the context of climate change, in order for the potato industry in Ulanqab to continue consolidating its core com-

petitive advantage as the "potato capital of China", it is necessary to improve water-saving facilities, establish meteorological disaster prevention systems, select excellent varieties, and improve field management to fill the gaps in climate. This will enable the construction of a modern potato industry system that is adapted to climate characteristics, promote stable and increased income in regional characteristic agriculture, and assist in rural revitalization and high-quality sustainable development of agricultural economy.

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(From page 87)

photovoltaics, and replace and eliminate inefficient coal-fired equipment in batches. It should fully tap the coastal mudflat space of Huanghua Port, make overall arrangements for new energy projects of wind and light, steadily improve the scale of regional clean energy supply, continue to optimize the local energy structure, and alleviate the pressure of carbon reduction brought by heavy chemical industry.

3.2.2 Revitalizing saline-alkali land resources along the Grand Canal, and expanding urban and rural green spaces. It should systemically promote the construction of ecological corridors along the Grand Canal, continuously add waterfront forest protection and artificial wetlands, implement land transfer and seedling support policies for village collectives participating in afforestation, synchronously lay out ecological tourism sites along the Grand Canal, and simultaneously release ecological and cultural tourism benefits. Based on the local research platform for saline alkali land, it should promote the large-scale planting of saline-alkali tolerant wheat, provide free high-quality seeds and standardized field technical services to planting subjects, cultivate local leading enterprises in grain processing, and extend the characteristic industrial chain of saline alkali planting. It should simultaneously promote the green spaces transformation of idle urban land and corners of rivers, plan supporting ecological isolation zones for various chemical industrial parks, steadily expand the green space of the entire area, and narrow the development gap of the four major systems.

3.2.3 Encouraging public supervision, and improving supporting mechanisms for green development. It should establish an integrated online and offline environmental supervision channel, implement an incentive mechanism for reporting environmental issues, regularly publicize the progress of CCUS, canal greening, and saline alkali land renovation projects to the public, regularly carry out grassroots environmental protection science popularization propaganda, and consolidate the bottom-up supervision power of the masses. Local financial institutions should be guided to optimize credit allocation, new energy, green agriculture in saline alkali land, and low-carbon technological transformation in chemical industry should be listed as key support areas, and credit supply should be moderately tightened for high energy consuming foreign trade enterprises. It should incorporate development indicators related to carbon reduction and green expansion into the annual assessments of various districts, counties, and parks, stabilize financial investment in environmental protection and green technology research and development, link Beijing and Tianjin scientific research resources to carry out low-carbon and saline alkali improvement technology research and development, promote the landing of green technologies adapted to local industries, and form a multi-party collaborative governance system.

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