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Analysis of Changes and Causes in the Spatial Layout of Postpartum Drying Services for Grain in China

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Abstract: *This article analyzes the changes in the spatial layout of post harvest drying services for grain in China and their causes. After reviewing the current situation of drying service facilities in various regions, it has been clarified that factors such as uneven policy support, fluctuations in market demand, and differences in technology have an impact on the layout of drying services. Research has shown that the eastern region is relatively mature in terms of policy support and technological application, while some areas in the western and northeastern regions suffer from lagging facility construction and outdated technology, resulting in a regional imbalance in the spatial layout of drying services. To optimize the layout, it is necessary to strengthen policy guidance, enhance technology supply, and promote coordination and cooperation of resources between regions. The research in this article provides theoretical basis and practical guidance for improving the post harvest drying efficiency of grain and promoting agricultural modernization.*

Keywords: *Chinese grain; Postpartum drying service; spatial distribution*

1. Introduction

With the gradual advancement of China's agricultural modernization process, post harvest drying of grain has received increasing attention as a key link in improving grain quality, reducing losses, and enhancing storage and circulation efficiency. Drying services not only ensure the quality of food, but also provide effective protection for food security. In China, the regional differences in grain production and the continuous innovation of drying technology have led to significant changes in the spatial layout of post harvest drying services for grain. This change reflects not only the achievements of economic development and technological progress, but also closely related to policy orientation, market demand, and the evolution of the natural environmen[1] . This article aims to analyze the changes in the spatial layout of post harvest drying services for grain in China, explore the underlying causes, and reveal the roles played by different factors in layout optimization, in order to provide theoretical support and practical guidance for improving the efficiency and sustainable development of grain drying services.

Analysis of the Current Situation of Postpartum Drying Services for Grain in China

1.1 Coverage of Drying Services

There are significant differences in the coverage of post harvest drying services for grain in China, which are reflected in the construction and use of drying service facilities in different regions. In the eastern coastal areas and some economically developed central regions, drying facilities are relatively complete. Agricultural cooperatives, large-scale growers, and large agricultural enterprises mostly have modern drying facilities. However, in some regions where agricultural production is relatively scattered in the west and northeast, the popularity of drying services is low, and some farmers still rely on traditional drying methods or manual operations, resulting in uneven quality of grain drying. According to statistical data, the coverage rate of post harvest drying facilities for grain in the eastern region can reach over 70%, while the coverage rate in the western and northeastern regions is less than 50%. This difference not only affects the stability of grain quality, but also leads to higher grain loss rates in some areas, further exacerbating the imbalance of post harvest grain management.

1.2 Technical level gap

The gap in technological level is also a significant problem in the current situation of post harvest

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drying services for grain in China. In the field of technological applications, many regions currently mainly use traditional hot air drying technology, which has drawbacks such as uneven drying, high energy consumption, and difficulty in controlling grain quality. In comparison, some advanced regions have started to use more efficient and environmentally friendly technologies such as heat pump drying and microwave drying, which can better maintain the nutritional content and appearance quality of food, and have relatively low energy consumption. However, the speed of technological popularization significantly lags behind demand, especially in areas where farmers have lower levels of technical proficiency and often lack awareness and investment intentions towards new technologies[2]. According to relevant research, even in technologically advanced areas where some large-scale agricultural enterprises have adopted intelligent drying systems, the application rate of these new technologies is still extremely low for small and medium-sized farmers and low-income areas, resulting in uneven levels of overall postpartum drying service technology.

1.3 Uneven Market Demand

The market demand for post harvest drying services for grain will vary depending on the agricultural production structure and grain varieties in different regions. In some major production areas of our country, such as Shandong and Henan, there is a strong market demand for drying services, especially for high humidity grains such as rice and corn, which have been in high demand for a long time. Due to the short grain production cycle and concentrated harvesting season, a large number of drying equipment is often required to cope with the sudden harvest season. Compared to other regions, some low yield areas or areas mainly growing dry grain crops such as wheat and beans have relatively limited demand for drying services. Due to the differences in market demand, some areas have idle drying service facilities, while others face the problem of facility shortage and lack of drying services. In addition, with the transformation of modern agricultural production models and the extension of industrial chains, the market demand for drying services has become increasingly diversified, posing significant challenges to the adaptability and coverage of the existing service system.

2. Analysis of the Causes of Spatial Layout Issues in Postpartum Drying Services for Grain in China

2.1 Unequal policy guidance

The uneven spatial layout of post harvest drying services for grain in China is closely related to differences in policy guidance. The varying levels of support provided by local governments for the construction of grain drying facilities, financial subsidy policies implemented, and land use policies have a direct impact on the layout of drying services. For the eastern region, policies often focus on increasing the added value of grain production and promoting the development of modern agriculture. The government vigorously promotes the construction of drying service facilities and provides financial subsidies and technical support. This policy advantage has attracted numerous enterprises and cooperatives to invest in the construction of drying facilities. However, in some grain producing provinces such as the western or northeastern regions, policy support is relatively weak, resulting in slow progress in the construction of local drying facilities. In some rural areas, farmers have insufficient awareness of drying technology and lack economic incentives under policy guidance. Therefore, the implementation of policy differentiation has led to an uneven distribution of drying service facilities in different regions, which has an impact on the overall efficiency and quality of post harvest drying of grain.

2.2 Unstable market demand

The changes in the spatial layout of post harvest drying services for grain are closely related to the instability of market demand. The demand and demand structure for grain in different regions and years are fluctuating, which has a direct impact on the demand for drying services. In some areas where grain production is concentrated and large-scale, farmers and agricultural enterprises have relatively stable demand for drying services and are willing to invest in the construction of drying facilities. However, in regions with smaller grain production scales and higher levels of decentralization, individual farmers often lack sustained investment in drying facilities due to low economic benefits or significant demand fluctuations. The instability of market demand not only affects the construction process of drying service facilities, but also leads to low utilization rates of drying facilities in some areas, making it

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difficult to fully utilize their effectiveness[3]. Therefore, the volatility and imbalance of market demand have become one of the key factors affecting the spatial layout of post harvest drying services for grain in China.

2.3 Natural environmental constraints

The changes in the spatial layout of post harvest drying services for grain in China are also significantly constrained by natural environmental conditions. China has a vast territory and significant differences in climate conditions among different regions, which directly limits the layout of grain drying services. Taking the Northeast and Northwest regions as an example, due to the influence of seasonal precipitation and high humidity climate, traditional drying methods are difficult to effectively guarantee the quality of grain drying. Moreover, the investment required for large-scale construction of modern drying facilities in these regions does not match the local economic situation, resulting in a scarcity of drying service facilities in many places. In contrast, in some humid areas along the southeast coast, although the climate is suitable for drying, the heavy humidity and high temperature weather conditions still add difficulty to the drying process, which requires efficient drying facilities to ensure that grains are not affected by mold and quality loss. It can be seen that the complex and ever-changing natural environmental conditions pose different challenges to the development of post harvest drying services for grain in different regions, which in turn affects the overall spatial layout.

3. Optimization strategies for spatial layout changes of post harvest drying services for grain in China

3.1 Uneven Policy Support

The optimization of the spatial layout of post harvest drying services for grain in China is facing the problem of uneven policy support. In some developed regions, local governments often combine agricultural modernization policies and vigorously promote the construction of grain drying facilities through financial subsidies, tax reductions, and other means. These regions generally have more comprehensive agricultural development plans and support systems, which can effectively guarantee the construction and operation of drying facilities. For example, in Jiangsu, Zhejiang and other places, local governments have promoted the widespread popularization of grain drying technology and improved the efficiency and quality of drying services through policy encouragement and guidance. However, in some agricultural provinces in the central and western regions, especially in economically underdeveloped areas, the support provided by local governments for grain drying facilities is quite limited, mainly focusing on infrastructure construction rather than innovation and optimization of service facilities. Due to the uneven implementation of policies, there are differences in the layout of drying service spaces, which have an impact on grain quality and market supply chain efficiency. The fundamental reason for this problem lies in the government's cognitive bias towards grain drying facilities and the uneven implementation of relevant policies. To optimize this issue, more detailed regional differentiation policies need to be formulated to promote policy tilt in government financial subsidies, financial support, and technological innovation in the central and western regions, in order to promote balanced layout of drying service facilities between regions.

3.2 Matching degree between market demand and technology supply

In China, the optimization of spatial layout for post harvest grain drying services faces the problem of matching market demand with technological supply. Currently, in some regions, the post harvest drying services for grain are still dominated by low-cost and low efficiency traditional drying methods, with low technological levels that are difficult to meet the increasingly diverse market demands. With the development of grain production towards scale and intensification, the demand for modern drying continues to grow, and the requirements for technology are also increasing day by day[4].

3.3 Regional Economic Differences

The regional economic differences in China have a profound impact on the spatial layout of post harvest drying services for grain, especially in terms of the level of economic development and agricultural production models in different regions. For some economically developed regions, farmers have higher incomes and relatively larger agricultural production scales, so the demand for drying

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services presents a relatively stable and intensive trend. In such areas, large-scale agricultural enterprises and cooperatives can be introduced through market-oriented means to invest in the construction of drying facilities, thereby promoting the modernization and efficiency of facilities. However, in the central and western regions, especially in some poverty-stricken areas, agricultural production is still in the stage of family operation, with a relatively low degree of scale, and the demand for drying services after grain production fluctuates greatly. In these regions, the marketization level of post harvest drying of grain is relatively low, and many farmers still rely on natural drying or small-scale drying equipment. This inefficient drying mode not only affects the quality of grain, but also exacerbates production costs. The regional economic differences have led to significant differences in the spatial layout of drying service facilities between the north and south, as well as between urban and rural areas. Therefore, optimizing spatial layout requires full consideration of regional economic characteristics, promoting underdeveloped areas to leverage policy support, capital investment, and other means to enhance agricultural scale and the construction of drying service facilities, in order to reduce the negative impact of regional economic disparities on grain drying services.

3.4 Facility Site Selection and Resource Utilization Efficiency

The location selection of post harvest drying service facilities for grain is directly related to the efficiency of resource utilization and the coverage effect of services, and is one of the key links in optimizing spatial layout. Currently, the site selection decisions for grain drying facilities in some regions of China rely more on administrative planning or empirical judgment, lacking scientific basis. This model often leads to unreasonable distribution of facilities, resulting in resource waste and affecting the overall efficiency of services. In some major grain producing areas, the excessive concentration of drying facilities has resulted in local resource congestion. For example, in some high-yield areas during the concentrated harvest season of grain, drying facilities are prone to overload operation, resulting in prolonged grain retention time and even a decline in the quality of some grains. At the same time, in some peripheral areas or grain sub production areas, the layout of drying facilities often appears sparse or even absent, causing farmers in these areas to have to transport grain over long distances to the main production areas for drying treatment. This not only increases transportation costs, but also intensifies the pressure on the grain flow link. To solve the problem of facility site selection, modern technology and scientific methods need to be introduced into layout planning. For example, Geographic Information Systems (GIS) can provide scientific basis for the site selection of drying facilities through comprehensive analysis of multidimensional data such as land use data, grain yield distribution, road networks, and meteorological conditions. Through simulation analysis, precise layout of facilities can be achieved, which can cover both major grain producing areas and radiate to secondary producing areas and peripheral areas, thereby improving the popularity and fairness of services. In addition, the efficient utilization of resources requires a reasonable allocation of facility scale in site selection planning. In large-scale production areas, priority can be given to building intensive large-scale drying centers, utilizing advanced automation equipment and energy recovery systems to achieve efficient operation; In areas with smaller production scales, flexible layout of mobile or modular drying facilities can be chosen to meet seasonal demand changes. This diversified layout pattern can achieve optimal allocation of resources based on regional characteristics, avoiding resource waste caused by a single layout pattern. In the future, in the process of optimizing facility site selection and resource utilization efficiency, attention should also be paid to the construction of regional coordination mechanisms. By establishing a cross administrative drying service network, the shortcomings in facility layout can be effectively compensated for. For example, for grain producing areas adjacent to provinces, the model of cross regional joint construction of large-scale drying centers can be explored to avoid duplicate investment and share service resources. In addition, regional collaboration mechanisms can optimize the operation mode of facilities by cross regional allocation of equipment and manpower, maximizing the efficiency of facility utilization, and reducing idleness or redundancy.

4. Future Development Direction of China's Grain Postpartum Drying Service Space Layout

4.1 Dynamic balance between regional demand and service supply

The spatial layout of post harvest drying services for grain needs to comprehensively consider the dynamic matching between regional grain planting structure and service supply capacity. Currently, the grain planting structure in different regions varies significantly due to climate conditions, cultivation

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habits, and economic development levels, which directly affects the demand and timeliness of grain drying services. However, there is a significant imbalance in supply and demand matching, with high concentration of drying facilities in some major grain producing areas and insufficient service coverage in marginal agricultural areas. This supply-demand imbalance not only affects the quality of food, but also increases logistics and time costs. The implementation of dynamic balance requires big data analysis as the basis, which can accurately predict the peak harvest period and climate conditions in various regions, and guide the flexible allocation of facilities. For example, in areas with high grain production, a mobile drying service system can be established to alleviate local pressure through cross regional allocation of equipment and personnel. At the same time, in areas with lower levels of economic development, the government can promote infrastructure construction through policy support to ensure the coverage and fairness of grain drying services. By combining Geographic Information Systems (GIS), optimize the location selection of service outlets and adjust the facility layout to a multi center distribution to improve overall service efficiency. Dynamic balance also requires flexibility for long-term development. In the future, attention should be paid to establishing a dynamic monitoring mechanism for regional drying service demand, and optimizing the service network in real time based on adjustments in planting structure, climate change, and population mobility trends to reduce service lag.

4.2 Exploration of the Path to Intelligent Upgrade of Drying Services

With the deepening of agricultural modernization, the intelligence of grain drying services has become an important direction for future development. Currently, many traditional drying facilities are facing problems of technological aging, high energy consumption, and low efficiency, which not only increase operating costs but also limit the improvement of service capabilities. The intelligent upgrade can not only alleviate the above problems, but also optimize the overall layout of services through technological innovation. The core of intelligent upgrading is the deep integration of drying equipment and digital technology. For example, by introducing IoT technology, real-time monitoring and remote control of devices can be achieved, reducing errors caused by manual intervention. In addition, the optimization of drying processes based on artificial intelligence algorithms can provide precise temperature and humidity control solutions for different grain varieties and moisture contents, avoiding the deterioration of grain quality. In the future, intelligent upgrades can also establish a full process traceability system for grain drying services through blockchain technology, ensuring grain quality and service transparency. At the spatial layout level, intelligent technology will greatly enhance the possibility of resource collaboration between regions. Through the cloud data platform, the drying service demand and facility usage status of various regions can be shared in real-time, allowing for dynamic adjustment of equipment deployment plans. This intelligent network can not only reduce service redundancy, but also improve resource utilization efficiency in edge areas, laying the foundation for comprehensively optimizing the layout of drying service space.

4.3 Exploration of Multi functional Comprehensive Service Center

The development trend of post harvest drying services for grain is not only about improving the number of facilities and service efficiency, but also needs to be extended towards multifunctionality. In many major grain producing areas, a single drying service model is difficult to meet the diverse needs of farmers, and comprehensive service centers centered on drying services are becoming a new development direction. The comprehensive service center provides one-stop services for farmers by integrating functions such as drying, warehousing, transportation, and agricultural technology promotion. The advantage of this model is that it can not only significantly shorten the post harvest processing time of grain, but also reduce logistics costs. For example, after the grain is dried, it directly enters the intelligent storage system in the center, reducing transportation losses. At the same time, agricultural technology service personnel can provide planting technology guidance to farmers through the central platform, forming an integrated chain of planting, harvesting, and processing. The layout of this comprehensive service center needs to be fully combined with the actual conditions of the region. For example, major grain producing areas with convenient transportation can prioritize the layout of large comprehensive centers, while remote areas are suitable for building small regional service nodes, forming a small-scale networked layout with large centers as the core. In the future, comprehensive service centers can collaborate with agricultural cooperatives and leading enterprises through financial support and policy guidance, becoming an important carrier for rural economic revitalization.

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4.4 Application of Green and Low Carbon Technology in Drying Services

The post harvest drying service for grain not only achieves efficiency improvement, but also faces problems of high energy consumption and environmental pollution. The application of green and low-carbon technologies can not only reduce the environmental burden of the drying process, but also optimize the cost structure of services through energy conservation and consumption reduction, providing support for the sustainable development of the post harvest food service system. At present, the application of new energy technology in drying services has begun to take shape. For example, using solar energy to assist grain drying equipment can effectively reduce the proportion of traditional fuel usage. Combining air source heat pump technology can significantly reduce energy consumption while ensuring drying efficiency. In addition, the introduction of waste heat recovery technology can recycle the thermal energy during the drying process, improving the overall energy utilization efficiency. The promotion of green technology requires policy guidance and market support. In some pilot areas, the government promotes the popularization of green drying equipment through subsidy policies and encourages enterprises to incorporate green technologies into their service systems at the policy level. In the future, the popularization of green and low-carbon technologies will not only promote the ecological transformation of drying services, but also provide a unified green development framework for the spatial layout of grain drying services nationwide through the formulation and promotion of technical standards.

5. Conclusions

In short, the spatial layout of post harvest drying services for grain in China is facing many challenges such as uneven policy support, fluctuating market demand, and shortage of technology supply. The demand for differentiated development between regions has led to significant differences in the construction level and efficiency of drying facilities in different regions. Optimizing this layout not only requires local governments to enhance policy support and promote technological and financial guidance in the central and western regions, but also to adapt to market changes, improve technological levels, and meet diversified needs. The modernization process of grain drying services can be accelerated through the collaborative cooperation of the government, enterprises, and research institutions, thereby achieving a more efficient and sustainable grain storage and circulation system, laying a solid foundation for the high-quality development of Chinese agriculture.

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