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Labor Supply Issues and Solutions in Potato Production Process: Case Study of Chongqing Region

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Abstract: This research delves into the prevalent labor shortage issue in potato production within the Chongqing region, analyzing its multifaceted impacts on the agricultural supply chain. Despite being a crucial crop in China, the southwestern terrain's complexity, an aging population, and labor scarcity pose challenges to large-scale potato cultivation mechanization. While some regions have introduced mechanization, the mechanization rate remains low. Labor shortages disrupt product and information flows, from planting to harvesting, resulting in reduced yields, diminished production efficiency, and compromised product quality. Proposed solutions involve optimizing cultivation practices, investing in machinery tailored for mountainous areas, streamlining processes, and establishing a stable labor force. However, challenges like high agricultural machinery costs and labor quality persist. The study concludes by urging further research covering technical innovations and supply chain analysis to provide specific solutions for potato production labor shortages, promoting agricultural modernization and sustainable development. In summary, this study offers valuable insights into labor challenges in potato production, facilitating future research and practical implementation.

Keywords: potato, agricultural supply chain, labor shortage

1. Introduction

As the backbone of the country's economic and social development, agriculture's stable system of production, supply and demand directly impacts its people's prosperity and quality of life [1]. However, as urbanization continues, population mobility in rural areas has gradually intensified, leading to a labor shortage [2, 4]. This phenomenon has a knock-on effect on the agricultural supply chain, affecting agricultural products' production, distribution and final supply [4, 5]. For this reason, there is an urgent need to find practical and effective solutions to alleviate the labor shortage problem and guarantee the stability and security of the supply of agricultural products.

Focusing on potato cultivation in Chongqing, this study aims to analyze in depth the impact of the labor supply problem on the supply chain of agricultural products. This study will explore the intricate interactions between different factors in this multifaceted and complex geographical context. Through a detailed study of the potato supply chain, this study will gain a deeper understanding of the current situation of the agricultural labor force in Chongqing and the flow of agricultural products and information through the supply chain.

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Based on revealing the impact of labor shortage on the potato supply chain in various aspects, this study will propose a series of targeted strategies to optimize the operation of the agricultural supply chain. By integrating advanced scientific and technological tools and management concepts, this study aims to effectively respond to the challenges posed by labor shortages to achieve sustainable development and stable operation of the agricultural supply chain. This study will reveal the urgency and complexity of the current agricultural labor supply and provide useful reference and guidance for optimizing and developing agricultural supply chains. Through these efforts, this study is expected to find practical solutions to the problem of agricultural labor shortage in rural areas, thus promoting the stable and sustainable growth of agricultural supply chains.

2. Current Status Overview

Potatoes are a critical staple food and economic crop in China. However, in the southwestern region, which serves as a primary cultivation hub, the terrain, though favorable for agricultural production due to its suitable water and thermal conditions, predominantly comprises hilly and mountainous landscapes. The basic mode of cultivation relies heavily on manual labor. Nonetheless, the region confronts the dual challenges of an aging population and labor scarcity, rendering large-scale mechanized production, as possible in flat terrains, unfeasible. Consequently, small-scale machinery emerges as the preferred means of cultivation. Notably, areas such as the Daba Mountains and Wuling Mountains in Chongqing have made considerable progress in comprehensively mechanizing potato cultivation and harvesting. Yield measurements reveal that production reaches an impressive 2585.5 kg per, accompanied by a cost-effectiveness increase of over 1000 RMB per. The benefits of mechanization, such as heightened production efficiency, lowered labor costs, and enhanced product quality, are evident. However, Chongqing's potato cultivation and harvesting mechanization rate remains relatively low, at just 31%. The exorbitant costs associated with small-scale machinery and the necessity for tailored designs to suit diverse terrains significantly elevate the intricacies and costs of cultivation. Consequently, labor shortages remain a pivotal constraint in local potato production. The ramifications of labor shortages are felt across both product flow and information flow within the supply chain.

3. Problem Analysis

3.1. Impact of Labor Shortages on Product Flow in the Supply Chain

The product flow in the Chongqing potato supply chain presents three key stages: planting and cultivation, harvesting and processing, and transport and marketing. However, labor shortages have a direct and far-reaching impact on both the planting-cultivation and harvesting-processing stages.

In mountainous areas, the limitations of manual cultivation methods have resulted in relatively low yields and correspondingly low benefits. Although the government has introduced small-scale mechanized production, challenges such as high costs and lack of expertise constrain the pace of fully addressing the labor shortage. In this context, potato production remains far less efficient than in other regions, with planting and harvesting processes taking longer, leading to a decline in overall productivity. It is worth noting that labor shortages also continue to affect the harvesting and transport phases of the potato, ultimately affecting the overall efficiency of the supply chain.

In addition, labor shortages trigger a range of inefficient practices at the harvesting and processing stages, seriously affecting the quality of processed potato products. According to the literature, processing companies and farm workshops produce only 10 percent of the region's total output, highlighting the potentially huge growth potential. Thus, labor shortages not only constrain the efficiency and quality of production in the supply chain but also limit the development of the potato industry in terms of value-added growth.

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Labor shortages in the Chongqing potato supply chain have far-reaching implications for the key stages of planting, harvesting and processing. To solve this problem, targeted strategies are needed to improve the current labor shortage situation, enhance supply chain efficiency and product quality, and thus achieve sustainable development of the potato supply chain.

3.2. Impact of Labor Shortages on Information Flow in the Supply Chain

In the Chongqing potato supply chain, the process of information flow is divided into three key stages: production planning and decision-making, exchange of information on supply and demand in the market, and transport and inventory management of agricultural products. However, labor shortages have triggered a series of non-negligible impacts in these stages, posing significant challenges to the coordination and operation of the supply chain.

First, labor shortage directly hinders the seamless transfer of information, especially in the production planning and decision-making stages. Due to the need for more human resources, the execution of production plans is delayed, affecting the normal operation of downstream segments. Such instability and delays may lead to impaired coordination in the supply chain and even disruption in the production process due to lagged transmission of information.

Secondly, a labor shortage similarly constrains the market supply and demand information exchange stage. Lack of sufficient human resources can lead to a lag in the transmission of information, making it impossible to promptly reflect the actual demand and supply situation in the market. This makes it difficult for decision-makers to make corresponding adjustments based on accurate market conditions, which may result in information disconnection and waste of resources in the supply chain.

Finally, a labor shortage also affects agricultural products' transport and inventory management stage. Due to the need for more human resources, harvesting, transporting, and inventory management of agricultural products may take time, which affects the speed of product distribution and inventory control. This can lead to breaks in the supply chain, affecting the products' overall efficiency and timeliness.

In addition to the issues directly affecting supply chain coordination, labor shortages raise several challenges at the decision-maker level. The lack of accurate information support makes it difficult for policymakers to accurately assess the supply and demand situation in the market and make decisions based on the actual situation. This can lead to inaccurate decisions, leading to overproduction or supply shortages. The labor shortage problem in the Chongqing potato supply chain has several implications for the transfer of information flow. To achieve coordination and operation of the supply chain, the labor shortage problem needs to be addressed to ensure that information can be transferred seamlessly and decision-makers can make decisions based on accurate market conditions, thus facilitating the efficient operation of the supply chain and the timely delivery of products.

4. Solutions to Labor Supply Issues

Solutions are proposed from two angles: product flow and information flow within the potato supply chain.

4.1. Optimizing Product Flow in the Potato Supply Chain

Enhancing planting and cultivation stages can optimize the product flow. Selecting appropriate raw materials for cultivation is crucial to increase overall profits and reduce subsequent losses. Specific potato varieties tailored to cultivation goals should be chosen. Research indicates that the current potato cultivation in Chongqing needs more specialized and targeted varieties. A variety selection based on growth periods, tuber characteristics, and actual yields should be implemented, with room

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for innovation by introducing new or locally adapted varieties. Mitigating cold damage risk during the fall harvest, with investment in disease-resistant varieties, demands substantial funding and research efforts to ensure sustainable and efficient production [6].

Investment in machinery suited to various stages of Chongqing's potato production, especially for mountainous areas, plays a vital role in mechanizing cultivation and harvesting. This reduces reliance on manual labor and enhances production efficiency [7]. Despite the high initial costs, government support and financial aid are crucial. Given Chongqing's diverse, high-quality potato varieties, farmers can collaborate with processing companies to secure relatively affordable potato raw materials in exchange for support to invest in advanced agricultural machinery. This alleviates labor shortage impacts on product flow and establishes stable sales channels, ensuring production security and farmer income.

Streamlining processes and standardizing operations can improve potato transportation and processing efficiency. With favorable water and thermal conditions in Chongqing, an innate advantage for cultivation exists. However, the fragmented potato industry chain hinders economies of scale in deep processing. To address this, local governments could offer favorable policies to attract leading potato processing enterprises, encouraging small businesses to join. This optimization reduces storage and transportation costs, minimizing losses while maximizing profits through cooperative efforts [8].

Establishing a stable labor force while enhancing labor quality and quantity in the region is critical. The western regions, including Chongqing, suffer from poor education and unfavorable ecological conditions, leading to a talent drain. Infrastructure development, rural environment improvement, and agricultural policies should be implemented to retain and attract local labor to combat this. Simultaneously, introducing skilled foreign labor through favorable policies can enhance labor quantity and quality. Skills training and vocational education tailored to different categories can elevate the overall quality of the workforce, thereby improving potato production efficiency [9].

4.2. Optimizing Information Flow in the Potato Supply Chain

Strengthening information technology training for farmers and practitioners is essential to enhance information acquisition and processing abilities. Given the low educational level of many farmers, government intervention should encourage village committees to lead the way in teaching network technology. Regular assessment of farmers' learning progress will ensure proficient application in agricultural production. The training content should align with practical operations and adapt to technological advancements in agricultural machinery, fostering improved information acquisition and processing capabilities.

Implementing information technology and establishing a platform for information sharing enhances accuracy and efficiency in information transmission. This necessitates substantial investment and research efforts, with government departments in the region periodically updating and maintaining the platform. Content could encompass distinctive potato characteristics and recommend appropriate machinery for local terrain, temperature, and humidity during cultivation and harvesting. Regular updates on potato growth conditions and virus status should be communicated to farmers, minimizing losses [10].

Creating a mechanism for information sharing among farmers, production enterprises, and markets enhances the accuracy and timeliness of market demand and supply information. This facilitates more accurate calculations and decisions regarding production and investment costs at different stages. The supply chain managers can benefit from this mechanism to regulate the entire potato supply chain and allocate production resources more rationally according to market demand, preventing potato oversupply or shortage scenarios. This ensures reduced losses for farmers and businesses, achieving maximum profitability.

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5. Conclusion

Product and information flow within the potato supply chain play pivotal roles in potato production, and labor shortages negatively affect both. Optimizing these flows and implementing viable solutions alleviate labor shortage challenges, enhance potato production efficiency and quality, and foster supply chain optimization and sustainable development. This process requires collaboration among governments, businesses, and farmers to establish a more stable and efficient potato supply chain, realizing agricultural modernization and sustainable development. This study offers solutions from the perspectives of product flow and information flow. Optimizing product flow, prioritizing appropriate potato varieties, investing in machinery for mountainous areas, and improving processes and standards can increase yield and efficiency.

Furthermore, collaboration between farmers and processing companies with government support can reduce mechanical investment costs while fostering a mutually beneficial relationship. In terms of information flow, training farmers and practitioners in information technology and establishing information-sharing platforms improve information acquisition and processing capabilities. Facilitating information exchange among farmers, production enterprises, and markets ensures more accurate decision-making, effective resource allocation, and minimizing losses.

In conclusion, labor shortage issues significantly impact Chongqing's potato industry supply chain. These issues can be mitigated by comprehensively optimizing product and information flows, ultimately enhancing supply chain efficiency and creating an environment conducive to sustainable potato industry development. It's essential to note that this study's focus on Chongqing's potato supply chain's labor shortage impact on product and information flows might not encapsulate the country's entirety or other influencing factors. Future research could expand to cover other regions and explore labor shortage challenges in various geographical contexts. Moreover, a more in-depth analysis could investigate the influence of technological innovation on potato cultivation and the integration of new agricultural intelligent technologies to enhance supply chains. Simultaneously, research could delve into a comprehensive analysis of policy, economic, and social factors' combined influence on supply chains, facilitating the development of more holistic solutions.

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