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The Impact of Intelligent Agricultural Machinery Sharing Model on Production Costs of Smallholder Economy: A Case Study of Houshan Village Cooperative in Kaiping City

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Abstract: *With the acceleration of agricultural modernization and rural revitalization, the production dilemma of smallholders has become increasingly prominent. As an innovative application of the sharing economy in the agricultural field, the intelligent agricultural machinery sharing model has become an important way to reduce the production costs of smallholders and improve the level of mechanization. Taking Houshan Village Cooperative in Baihe Town, Kaiping City, Guangdong Province as a typical case, this study finds through case analysis that the model converts fixed costs into variable costs through "asset-light operation", optimizes resource allocation relying on intelligent platforms, and lowers the participation threshold with the support of policy subsidies, thus significantly reducing the costs of machinery purchase, operation and maintenance, and operation for smallholders. The research shows that intelligent agricultural machinery sharing not only directly reduces the explicit expenditures in the production cost structure, but also indirectly optimizes implicit costs by expanding the service area of a single machine to improve operation efficiency and reduce resource waste. Finally, optimization paths are proposed from three aspects: improvement of technology and skills, rational allocation of resources, and precision of policies, providing theoretical support and practical reference for the organic connection between smallholders and modern agriculture.*

Keywords: *Intelligent Agricultural Machinery Sharing; Smallholder Economy; Production Cost; Sharing Model*

1. Introduction

Driven by both rural revitalization and agricultural modernization, the core contradictions faced by smallholders have become increasingly prominent,high costs of agricultural machinery purchase and low utilization efficiency caused by decentralized operation have seriously restricted their competitiveness.[1] The emergence of the sharing economy model has provided a new idea to solve this problem. Relying on technologies such as the Internet of Things and Beidou Navigation, the intelligent agricultural machinery sharing model integrates idle agricultural machinery resources and realizes efficient allocation through online reservations and intelligent scheduling, becoming a key innovation to reduce the production costs of smallholders. As a model of agricultural socialized services in Guangdong Province, the "Cooperative + Supply and Marketing Cooperative + Farmer" sharing practice of Houshan Village Cooperative in Kaiping City has achieved remarkable results, benefiting more than 15,000 smallholder households.[2] Taking it as a sample, this study deeply analyzes the impact mechanism of the intelligent agricultural machinery sharing model on the production costs of smallholders, in order to provide empirical basis for the promotion of inclusive agricultural services.[3]

2. Definition and Theoretical Basis of Intelligent Agricultural Machinery Sharing Model

2.1 Definition of the Sharing Model

Intelligent agricultural machinery sharing is an asset-light operation model that realizes the cross-

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temporal and cross-spatial allocation of agricultural machinery through forms such as leasing and mutual assistance, with a digital platform as the hub. The agricultural machinery sharing model is a new type of agricultural service model and also a mode of agricultural machinery use based on the concept of the sharing economy. It aims to improve the utilization efficiency of agricultural machinery and reduce the use cost for farmers by sharing resources. Especially during the peak agricultural production seasons such as spring plowing and autumn harvest, it can effectively solve the problem of shortage of agricultural machinery resources.The operation mechanism of agricultural machinery sharing is analogous to that of shared bicycles.Moreover, some shared agricultural machinery is equipped with a remote monitoring and positioning system, which can realize real-time monitoring and checking of the operation status, driving route, and usage time of the "shared agricultural machinery". At the same time, detailed diagrams and videos of operation steps are set up at the placement locations to guide farmers in operation, and special personnel are assigned to be responsible for equipment installation, commissioning, maintenance, and other work.[4] Essentially, the intelligent agricultural machinery sharing model, through the new organizational form of a digital platform, significantly reduces the transaction costs in the agricultural machinery service market, thereby activating potential market demand and optimizing resource allocation.

2.2 Theoretical Basis

2.2.1 Transaction Cost Theory

As the core and most direct theoretical basis, transaction cost theory perfectly explains why the sharing model can generate economic benefits. This theory holds that there are costs in any market transaction. Through digital integration, the intelligent sharing platform efficiently matches the scattered supply of agricultural machinery and the demand of farmers, greatly reducing the search and information acquisition costs for both parties. The sharing model can provide transparent information such as historical operation prices, service evaluations, and machine model standards through the platform, offering reliable reference for pricing negotiations between the two parties, simplifying the decision-making process, and reducing the cost of bargaining. The platform can also effectively supervise the agricultural machinery operation process through GPS trajectory tracking, remote monitoring of operation area, electronic payment, and a credit evaluation system, ensuring service quality and the smooth execution of contracts, and reducing potential dispute risks and enforcement costs.

2.2.2 Resource-Based View and Resource Bricolage Theory

From the perspective of the resource-based view and resource bricolage theory, we can see the impact of the intelligent agricultural machinery sharing model on the production costs of the smallholder economy. By integrating the idle agricultural machinery resources scattered among various owners, the intelligent sharing platform forms a large-scale "virtual agricultural machinery resource pool" that can be called at any time, realizing the transformation from personal ownership and inefficient utilization to social sharing and efficient utilization.The platform assembles the originally idle and non-strategic resources into strategic resources with strong service capabilities. This platform is not only a simple information intermediary, but also an *optimized dispatcher* of resources. Based on data such as agricultural conditions, geographical location, and operation type, it intelligently matches the optimal agricultural machinery with farmland, maximizing the operation efficiency and output of each agricultural machine, realizing the optimal allocation of agricultural equipment resources at the social level, endowing these resources with new value, and jointly forming a competitive advantage that individual farmers cannot match.

3. Process of the Impact of Intelligent Agricultural Machinery Sharing Model on the Production Costs of Smallholder Economy

Combined with the characteristics of its smallholder economy dominated by rice cultivation, Houshan Village has formed a characteristic cost impact process of "collective leasing - precise cost reduction - implicit cost optimization", which is specifically manifested as follows:

Firstly, Houshan Village carries out resource integration. The village has formed a village collective-led agricultural machinery leasing cooperation. By leveraging the agricultural machinery resources of Baihe Town, it leases agricultural machinery to Kaiping Supply and Marketing Agricultural Service, forming a tripartite model of "village collective providing equipment, supply and marketing cooperative providing services, and farmers paying fees". Under this model, not only do farmers avoid the

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disadvantage in bargaining when leasing individually, but the village collective also obtains an annual rental income of 40,000 yuan, which is used for the maintenance and renewal of agricultural machinery.[5]

Secondly, there is precise operation and resource conservation. The shared intelligent agricultural machinery is equipped with advanced sensors and intelligent control systems. Taking the intelligent fertilizer applicator as an example, it can accurately control the amount of fertilizer applied according to the soil fertility data fed back by soil sensors. In the farmland operation in Houshan Village, compared with traditional manual fertilization or fertilization by ordinary agricultural machinery, the intelligent fertilizer applicator can reduce the amount of chemical fertilizer used by 20-30%, lowering the chemical fertilizer purchase cost for smallholders. Similarly, the variable pesticide application technology of intelligent plant protection UAVs can accurately apply pesticides according to the pest and disease situation of crops, reducing the amount of pesticides used and thus lowering the pesticide cost.

Finally, the reduction of production costs of the smallholder economy is achieved through the optimization of implicit costs. The sharing model improves production efficiency to indirectly reduce costs. Through the centralized scheduling of the agricultural assistance service center of the supply and marketing cooperative, the problem of "difficulty in hiring agricultural machinery" is solved, avoiding delays in sowing or harvesting due to the shortage of agricultural machinery, reducing the loss of farming time, and decreasing the per-mu yield loss by 10-15%. Moreover, the management cost is reduced. Farmers do not need to learn agricultural machinery operation and maintenance skills; instead, they can place orders via mobile phones or make reservations at village-level service points, saving time and learning costs.

4. Analysis of Cost Reduction and Efficiency Improvement of the Sharing Model in the Houshan Village Case

Kaiping City has actively explored new paths for the development of the new rural collective economy. By leveraging the agricultural machinery resources of Baihe Town, Houshan Village Committee leases agricultural machinery to Kaiping Supply and Marketing Youhe Agricultural Technology Service Co., Ltd., and jointly carries out agricultural machinery operation services. This promotes the integrated development of supply and marketing cooperatives and rural collective economic organizations, guides smallholders to connect with the large market, solves the problems of "who will farm the land and how to farm it well", realizes industrial revitalization, and promotes farmers' income increase.[6]

4.1 Direct Effect of Cost Reduction

The direct effect of the agricultural machinery sharing model in Houshan Village, Kaiping City in terms of cost reduction is mainly reflected in the following two aspects:

Firstly, the machinery operation cost for farmers is reduced. Through agricultural machinery sharing, farmers do not need to purchase expensive agricultural machinery equipment by themselves, which reduces the costs of machinery purchase, maintenance, operation, and so on. This model solves the problems of farmers' difficulty in farming, difficulty in hiring agricultural machinery, and difficulty in preventing and controlling plant diseases and insect pests. At the same time, it also reduces the resource waste caused by the idleness of agricultural machinery, directly lowering the agricultural production and operation costs for farmers.[7]

Secondly, the village collective resources are activated and the income is increased. Houshan Village Committee leases agricultural machinery to Kaiping Supply and Marketing Youhe Agricultural Technology Service Co., Ltd., directly increasing the annual collective economic income of the village by 40,000 yuan. This effectively activates the village collective's agricultural machinery resources, enables the idle agricultural machinery resources to generate economic value, avoids the loss caused by idle resources, and realizes the direct effect of cost reduction and income increase for the village collective in the utilization of agricultural machinery resources.

The agricultural machinery sharing model in Houshan Village, Kaiping City realizes the maximization of the direct effect of cost reduction through the "farmer-village collective" two-end linkage. For farmers, the unified agricultural machinery operation service integrates links such as farming, transportation, and plant protection, avoiding the huge investment and idle waste of agricultural machinery purchase by individual farmers, and directly reducing production expenditures. For the village collective, the idle agricultural machinery is transformed from "consumable assets" to "profitable

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resources", which not only reduces the idle maintenance cost, but also obtains stable income through leasing. Essentially, through the intensive sharing of resources, this model breaks the dual dilemma of "high cost for individual farmers and idle collective resources" in agricultural production, provides a replicable practical sample for agricultural cost control and resource activation under the background of rural revitalization, and truly realizes the two-way empowerment of "cost reduction" and "income increase".

4.2 Indirect Benefit of Efficiency Improvement

Firstly, there is efficiency improvement through large-scale operation. From the original scattered land, the cooperative now actively integrates scattered plots into a state conducive to mechanized operation. After integration, the daily operation area of agricultural machinery has significantly increased from 15 mu(1 hectare=15 mu) to 40 mu, greatly improving the utilization efficiency of agricultural machinery and enabling it to complete more operations per unit time. At the same time, the annual income of a single machine has increased by 3 times. This is because large-scale operation allows fixed costs to be allocated over a larger operation area, thereby reducing the cost per unit output and improving economic benefits.[8] In addition, large-scale operation is conducive to the unified implementation of advanced planting technologies and management models, improving the quality and yield of agricultural products, and enhancing market competitiveness.

Secondly, cost saving through precision agriculture. The application of precision agriculture technology has achieved remarkable results in reducing production costs. The variable pesticide application technology of UAVs plays an important role. It can accurately control the amount of pesticide applied according to the actual pest and disease situation and growth needs of crops. Compared with traditional pesticide application methods, the amount of pesticide used is reduced by 30%. This not only directly reduces the pesticide purchase cost, but also reduces the pollution of pesticides to the ecological environment, protects the agricultural ecological environment, and conforms to the concept of sustainable development. At the same time, precision fertilization is carried out in combination with soil sensors. Through real-time monitoring and analysis of soil fertility, fertilizers can be accurately applied according to the actual needs of different plots, avoiding cost waste and yield loss caused by over-fertilization or insufficient fertilization in the past. The per-mu chemical fertilizer cost has decreased by 50 yuan, which not only saves production costs, but also helps maintain the healthy fertility of the soil and ensures the long-term stable growth of crops.[9]

Thirdly, income increase through industrial chain extension. The "agricultural land cloud sharing" e-commerce model vigorously promoted by the cooperative has opened up a new way for the extension of the agricultural industrial chain and income increase. The "agricultural land cloud sharing" e-commerce model directly builds a bridge between farmers and consumers, reduces intermediate links, and lowers circulation costs. The form of order agriculture allows agricultural product production to be carried out accurately according to market demand, making it more planned and effectively reducing the risk of unsalable products caused by market fluctuations. In addition, this model has also driven the development of related industries such as packaging, logistics, and agricultural product processing, creating more employment opportunities and economic growth points, and realizing the overall improvement of the value of the agricultural industrial chain.

5. Challenges and Countermeasures of the Intelligent Agricultural Machinery Sharing Model of Houshan Village Cooperative in Kaiping City

Although the Houshan Village model has achieved remarkable results, it still needs to address challenges. Based on the actual situation of Houshan Village and in accordance with the sustainable development proposed by the state to build a sustainable sharing ecosystem, the following problems are identified and corresponding optimization paths and policy recommendations are put forward.

(1)The elderly have difficulty operating intelligent equipment, and the penetration rate of the cost-effective equipment such as solar pest monitoring instruments is low, resulting in insufficient technological inclusiveness in Houshan Village. Measures can be taken to promote technology popularization, develop aging-friendly operation interfaces, and promote modular agricultural machinery. In terms of optimization paths, it is possible to strengthen skill training, improve infrastructure construction, reduce use costs, establish an intelligent scheduling system, and strengthen safety guarantees. In terms of policies, increase capital subsidy efforts, provide financial support, improve laws and regulations, and establish an evaluation and supervision mechanism.

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(2) The annual maintenance cost of precision agricultural machinery exceeds 10,000 yuan, the equipment maintenance cost is high, and the cooperative lacks special fund support. Policies can be made more precise by increasing capital support, improving agricultural machinery subsidy policies, including sharing platforms in the agricultural machinery subsidy list, establishing a special guarantee fund for smart agriculture, and setting up a regional maintenance fund. In terms of mechanism innovation, we should explore the use of "blockchain + insurance" to resolve equipment damage disputes. Additionally, farmers can be encouraged to invest in agricultural machinery in the form of shares and receive dividends based on usage, thereby enhancing their sense of participation.. For optimization paths, it is essential to establish a standardized maintenance system, adopt intelligent maintenance technology, build a professional maintenance team, optimize the maintenance process, and strengthen parts management. Furthermore, the government should provide capital subsidies, introduce tax preferential policies, establish a maintenance insurance mechanism, support industry-university-research cooperation, and improve the agricultural machinery scrapping and renewal policy.

(3) Farmers are worried that farming data will be misused by commercial platforms, leading to data security risks. Optimization measures can be implemented to build a hierarchical defense system, strengthen data encryption and desensitization, improve access control and permission management, establish a security monitoring and emergency mechanism, and increase investment in hardware equipment security. The state can also issue laws and regulations to establish data security standards, provide capital support, and strengthen supervision to promote talent training, which plays an important role in addressing this risk.

(4) There is an imbalance in the utilization efficiency of agricultural machinery in Houshan Village. During the busy agricultural season, there may be a shortage of agricultural machinery, while during the slack season, the idleness rate is high, resulting in resource waste. A dynamic adjustment system can be established to predict peak demand through big data and allocate agricultural machinery across regions, such as cooperating with surrounding villages and towns, launching preferential activities during the slack season, and encouraging farmers to carry out non-seasonal operations such as farmland consolidation and straw treatment.[10]

6. Conclusion

This study confirms that through technological empowerment, organizational innovation, and policy coordination, the intelligent agricultural machinery sharing model has a significant impact on the production costs of smallholders. At the explicit level, asset-light operation and subsidy policies directly reduce equipment investment; at the implicit level, large-scale and precise operation reduces resource dissipation and indirectly improves total factor productivity. The practice of Houshan Village in Kaiping City shows that this model can reduce the per-mu production cost of smallholders by 20-30%. The intelligent agricultural machinery sharing model has achieved cost reduction and efficiency improvement, providing a referenceable practical path for promoting agricultural modernization and rural revitalization.

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