Research on Optimization Strategy for Agricultural Products Supply Chains Against the Backdrop of E-commerce Environment

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Abstract: In recent years, with the rapid development of the Internet in China, e-commerce platforms have become an important way for people to conduct transactions, among which the e-commerce platforms for agricultural products are the most popular. At present, domestic and foreign researchers have carried out in-depth research into the supply chains of agricultural products on e-commerce platforms, but there are still many problems to be solved. This paper compares the profitability of two-stage, three-stage, and four-stage supply chains by establishing a model. In addition, based on the current development of China's e-commerce platforms, this paper analyzes the problems existing in the e-commerce platforms for agricultural products, and then proposes possible optimization strategies.

1. Introduction

In recent years, with the continuous development and popularization of the Internet, many retail models have been transformed from traditional physical stores to e-commerce platforms. E-commerce platforms utilizes advanced big data and cloud technology to provide enterprises and merchants with an important site to coordinate and integrate information flow, material flow and capital flow to achieve order, relevance and efficiency. These platforms can help enterprises to effectively carry out business activities at a low cost. Therefore, many industries have shifted their sales centers from traditional brick-and-mortar stores to e-commerce platforms, and agricultural products are no exception. Currently, agricultural e-commerce has become a brand-new sales model for agricultural products in China, which not only facilitates the transaction process, but also increases the income of farmers, thus being of great significance to rural revitalization.

By mathematical modeling, this paper analyzes the advantages of agricultural e-commerce platforms and attempts to find out the most suitable way for China's agricultural development. Meanwhile, based on the current situation of China's e-commerce development, it studies the problems in the supply chains of agricultural logistics and finally proposes possible optimization strategies.

2. Literature Review

2.1 Foreign Studies of Agricultural E-commerce

Foreign scholars have made great progress in the studies of e-commerce platforms. As for the concept of e-commerce platforms, in the early years [1] Malone (1987) proposed that an e-commerce platform used electronic technology to provide trading places on virtual networks. [1] Bakos (1998) held that the e-commerce platform was an intermediary organization that provided relevant market information for buyers and sellers to improve transaction efficiency. Wilson (2001) proposed the introduction of e-commerce platforms in the agricultural products market, which can help integrate agricultural products on broader platforms, thereby lowering the transaction cost of produce, reducing circulation and increasing the profits for producers.

In addition, foreign scholars have also carried out research into various aspects of agricultural e-commerce and their related fields. For example, Bath (2000) conducted in-depth research on logistics of agricultural products, who applied the relevant theories of agricultural product logistics in the field of international trade and expanded the application space of theories related to agricultural product logistics. [1] Gourdin (2001) studied e-commerce logistics, and he believes that good logistics plays an important role in e-commerce enterprises. In other words, e-commerce enterprises should attach great importance to logistics and distribution, otherwise they will be in the unfavorable position.

2.2 Domestic Studies of Agricultural E-commerce

Domestic research on e-commerce platforms started later. As for the definition of e-commerce platform, Yi Famin (2010) proposed that an e-commerce platform was a kind of platform used to gather different enterprises to carry out business activities in the virtual space of the Internet. Li Zhiguo (2017) held that the e-commerce platform was an Internet platform organization using a combination of information and network technologies to enable enterprises, customers and other stakeholders to obtain excess profits in the transaction process.

Domestic scholars have also carried out lots of research on agricultural e-commerce platforms. For instance, Wang Qun (2015) believes that an agricultural e-commerce platform is an online electronic trading platform for bulk agricultural products, and each participant is to conduct agricultural purchase and sales activities on the platform after becoming a platform trader. [1] Li Zhiguo (2017) divided agricultural e-commerce platforms into B2B and B2C according to the target of the transaction; he classified agricultural e-commerce platforms into platforms specialized for agricultural products and general platforms covering agricultural business according to the proportion of agricultural products sold; he also divided agricultural e-commerce platforms into self-run platforms and third-party platforms according to whether the platform was self-built by the seller. Typical classifications of e-commerce platforms are shown in Table 1.

Table 1. Typical Classifications of E-commerce Platforms

Types of classification	E-commerce platforms specialized in agricultural products		General e-commerce platforms
	Self-run platforms	Third-party platforms	
B2B	Songxiaocai, Food Chain, etc.	Yimutian, Hengkelai, etc.	Qiyiwang
B2C	www.tootoo.cu, YIGUO.COM	Sushengxian, Xiaoxiangxiansheng, etc.	SF Best, Taobao

2.3 Summary

In summary, there have been many in-depth studies of e-commerce platforms for agricultural products at home and abroad. In addition to giving detailed explanations of the definition of the agricultural e-commerce platforms, scholars have also been involved in research in related fields. However, there are still many related problems to be analyzed, such as the optimization of e-commerce distribution for agricultural products and the improvement of agricultural e-commerce information systems. By establishing a mathematical model, this paper compares the two-stage, three-stage and four-stage supply chains, and analyzes the absolute advantages of agricultural e-commerce platforms. Meanwhile, it studies the advantages and disadvantages of the current agricultural e-commerce supply chains, and then proposes some possible optimization strategies.

3. Current Development and Problems of Agricultural E-commerce in China

3.1 Current Development of Agricultural E-commerce in China

Since 1995, China's rural areas have been committed to the implementation of information agriculture. Both the advancement of science and technology and government policy support have provided a favorable environment for the development of agricultural e-commerce platforms. Currently, China's agricultural e-commerce platforms can be roughly divided into two main categories, namely enterprises' self-run agricultural e-commerce platforms (independent B2C model) and third-party agricultural e-commerce platforms (C2C). According to the level of supply chains, agricultural e-commerce can be divided into three levels. First is the ground level where the main business of e-commerce platforms is to improve the network information service for agricultural products trading; second is the middle level where e-commerce firms have to improve the supply and demand information of agricultural products, and provide online trading services, but online payment is not covered; third is the high level where exists a full-scale e-commerce, not only offering services provided by the middle level but also allowing online payment. The e-commerce platform studied in this paper belongs to the high level.

In 2015, there were nearly 4,000 agricultural e-commerce platforms in China, with almost a new agricultural e-commerce company going online each day. It is estimated that from 2010 to the present, the average annual growth rate of agricultural sales on the Ali platform is 112.15%, and the sales of agricultural products reach 3.7 billion yuan. In 2014, the turnover exceeded 80 billion yuan. At the same time, the grow rate of fresh products (including aquatic products, fruits and meat) on Taobao, the most promising platform in the B2C market, hit 194.58% in 2013, ranking the first in all categories. In 2013, the fresh e-commerce transaction volume across the country reached 13 billion yuan, marking a year-on-year increase of 221%.

On August 7, 2014, Early Rice Fair held 2 online platform transactions on www.zglssc.com, achieving a transaction volume of 123 million yuan and a turnover of 42,700 tons. In the same year, the special train for fruits and vegetables leaved Guangxi Baise for Beijing for the first time, marking the official operation of the "Nan Cai Bei Yun", a full-length cold chain for fruits and vegetables. The special train also means that the demand for agricultural products has further increased and the logistics industry has developed rapidly. It can be seen from the above data that the development of agricultural e-commerce platforms in China is booming. Therefore, with the advancement of technology, e-commerce platforms will become the main channel for sales of agricultural products.

3.2 Problems Facing China's Agricultural E-commerce

3.2.1 Lack of Professional E-commerce Talents

Today, despite the booming of e-commerce, the lack of professional assistance and operations has impeded its continued progress. On the one hand, there is a lack of professional technicians. On the other hand, the lack of local government administrators who manage e-commerce is problematic. The economic differences between urban and rural areas have resulted in a gap in terms of education. Besides, imperfect infrastructure construction in rural areas and no suitable venue for training talents are also not conducive to cultivating high-quality professional talents. Moreover, problems such as brain drain and insufficient talent introduction have also led to a shortage of professionals in e-commerce. Farmers themselves are not familiar with the operation methods of computers; the construction of business websites and planning are unreasonable; the design of webpages is confusing; there is no mature operation concept; the payment methods are backward; the promotion is not effective; and after-sales service is not satisfying; all of which have hindered the development of e-commerce.

3.2.2 Backward Thinking in Rural Areas

Because of the living environment and slow economic development, the living standards in rural areas are generally backward. As a result, peasants are usually more conservative and have difficulty accepting new things. Farmers have little understanding of e-commerce that has emerged in recently

years and thus hold a skeptical attitude towards it, which hinders the development of e-commerce in rural areas. In addition, farmers are accustomed to the traditional way of trading, only believing in cash delivery. They do not believe that the network can help them increase revenue; and think that the network is false, and that online transactions, online payments, and network revenue generation are not reliable. Farmers' low income determines that they can't bear the risks of online payment. In turn, their worry about the security of their own property and little confidence in e-commerce hinder the development of e-commerce there.

3.2.3 Imperfect E-commerce Infrastructure in Rural Areas

Logistics is an important part of the development of e-commerce. However, due to the relative backwardness of the rural economy, the rural logistics system still faces many problems. Traffic jams, rugged roads, and remote locations are all reasons why logistics are not smooth in rural areas. For example, goods can't be delivered in some remote rural areas in Qinghai. Besides, express delivery service does not have a perfect transportation system, which seriously affects the quality of agricultural products in the transportation process, thus increasing losses and reducing transportation efficiency.

In summary, China's agricultural e-commerce platforms still face many problems at present. For example, there is a lack of professional talents in e-commerce; the thinking in rural areas are conservative; the infrastructure of rural e-commerce is imperfect. These problems call for further in-depth studies and the resulting targeted and effective solutions.

4. Advantages of Agricultural E-commerce

4.1 Modeling

This paper analyzes a four-stage supply chain, three-stage supply chain, and two-stage supply chain. Generally, the four-stage supply chain is made up of manufacturers, wholesalers, retailers, and consumers. Manufacturers make products by processing raw materials, which are first acquired by wholesalers and then sold by retailers, and finally reach consumers. Market demand is usually the primary basis for retailers to place an order, and they usually order from the wholesaler more products than forecast. Similarly, wholesalers mainly order products from manufacturers based on the order placed by retailers. The manufacturers then produce according to the total demand of wholesalers and deliver products to wholesalers before the sale season comes. The three-stage supply chain includes manufacturers, wholesalers and consumers. Wholesalers directly contact consumers without retailers in this supply chain. The two-stage supply chain is a model in which consumers directly make deal with manufacturers. Since enterprises often order or produce more products than the forecast demand, they may have large inventory and get less profits. This is when the two-stage supply chain has an edge. In order to compare profits brought by different supply chains, this paper constructs a function model of supply chain overall profits. [5] The main parameters are as follows:

a: The ratio of the quantity ordered to the actual quantity demanded when there exists bullwhip effect.

P1: Manufacturer's unit production cost.

P2: The unit price of the products purchased by the wholesaler.

P3: The unit price of the products purchased by the retailer.

P4: The unit price of the products purchased by the consumer.

S1: The Residual value of the unsold products of the manufacturer.

S2: The residual value of the unsold products of the wholesaler.

S3: The residual value of the unsold products of the retailer.

Q1: Manufacturer's production volume.

Q2: The quantity ordered by the wholesaler.

Q3: The quantity ordered by the retailer.

Q4: The quantity demanded by consumers.

The model assumes the following:

(1) For the sake of generality, we suppose P>S and Pi>Si (i=1, 2, 3), P1<P2<P3<P4.

(2) The information between the parties in the supply chain is not completely symmetrical.

(3) We assume that each company is averse to loss. In other words, the loss caused by shortage will encourage enterprises to order more products than the forecast demand.

(4) We assume that the ratio (a) between the nodes of the supply chain is the same.

According to the previous assumptions, in the process of goods shifted from manufacturer to consumers, the overall profit function of the supply chain is:

$$\prod=(Pi+1-Pi)\ Qi+1-(Qi-Qi+1)\ (Pi-Si) \quad (1)$$

among them,

$$Qi=Qi+1(a+1),\ i=1,\ 2,\ 3,\ 4. \quad (2)$$

4.2 Analysis of Results

Market research demonstrates that the retail price of gift boxed tea of a brand in 2018 was 199 yuan per box, the purchase price of a retailer was 120 yuan per box, the wholesale price of the wholesaler was 75 yuan per box, and the manufacturer's production cost was 56 yuan per box, that is, P1 = 56, P2 = 75, P3 = 120, P4 = 199; the retailer sold 890 boxes of this tea in 2018, namely Q4 = 890; the residual value of the unsold products of the retailer was 55 yuan per box, the residual value of the unsold products of the wholesaler was 32 yuan per box, and the residual value of the unsold products of the manufacturer was 17 yuan per box, that is, S1=17, S2=32, S3 =55. Through data analysis, we can find that when there exists bullwhip effect in the market, the ratio (a) of quantity ordered to the quantity actually demanded between supply chain nodes is 30%. Enter the above data into the model, and we can get the profits of different supply chains as shown in Table 2, Table 3, and Table 4.

Table 2. The overall profits of a four-stage supply chain

P_i	S_i	Q_i	$\prod_i$
P_1=56	—	Q_1=1955	—
P_2=75	S_1=17	Q_2=1504	$\prod_1$=10987
P_3=120	S_2=32	Q_3=1157	$\prod_2$=37144
P_4=199	S_3=55	Q_4=890	$\prod_3$=52955
Sum of profits			$\prod$=101086

Since there are no retailers in the three-stage supply chain and consumers buy products directly from wholesalers, P4 is 120.

Table 3. The overall profits of a four-stage supply chain

P_i	S_i	Q_i	$\prod_i$
P_1=56	—	Q_1=1955	—
P_2=75	S_1=17	Q_2=1504	$\prod_1$=10987
P_4=120	S_2=32	Q_4=1157	$\prod_2$=37144
Sum of profits			$\prod$=48131

Since consumers make deals with manufacturers directly and there are neither wholesalers nor retailers, P4 is 75.

Table 4. The overall profits of a four-stage supply chain

P_i	S_i	Q_i	$\prod_i$
P_1=56	—	Q_1=1955	—

P4=75	S_1=17	Q4=1504	$\prod_1$=10987
Sum of profits			$\prod$=10987

Compare Table 2 and Table 3, we can find that the price of the product purchased by a consumer of the three-stage supply chain is lower than the price faced by a consumer of the four-stage supply chain when the unit price and the residual value of the product are the same, which indicates that the three-stage supply chain has an advantage in terms of pricing. In addition, under the premise that profits at all stages are the same, the cost of the entire supply chain is greatly reduced, thus saving a lot of social resources. Similarly, by comparing Table 3 and Table 4, it can be seen that the two-stage supply chain has an edge over the three-stage supply chain in pricing, and consumers can bear less cost without affecting the profits at all stages. All in all, under the premise that the profits of the supply chain do not change at any stage, the supply chain with fewer intermediaries incurs less cost and is more efficient, saving a lot of resources for the society. Therefore, with the vigorous development of the agricultural e-commerce platforms, we should manage to reduce the intermediate participants, simplify the supply chain, and strive to maintain the advantages of the supply chain.

5. Optimization Strategies for China's Agricultural E-commerce

5.1 Optimizing E-commerce Distribution for Agricultural Products

E-commerce companies should establish an appropriate management system for the logistics and distribution of agricultural products, establish a logistics distribution model according to the different natures and types of products, and build a systematic logistics chain. As for agricultural e-commerce enterprises, they should actively establish a cold chain transportation system, including integrated cold chain solutions for product refrigeration, cold chain trunk transportation, cold chain delivery and sales. It is also advisable to strengthen the integrated construction of the cold chain processing and distribution centers at the production sites, the cold chain logistics centers at the consumption sites and related distribution centers. A wide-ranging business model helps reduce the circulation of fresh agricultural products through the comprehensive integration of various distribution areas. In addition, enterprises need to properly deal with the "last mile" distribution problem to ensure timely delivery of fresh agricultural products.

Due to the different requirements of different types of agricultural products, various distribution processes should be strictly controlled and separated. After being picked, fresh fruits and vegetables are sorted, cleaned, packaged and preserved in a cold room of 0 to 4 degrees by processing centers, and then delivered to the consumers with cold chain cars. As for the cold chain transportation of fresh poultry products, the most important are cold chain processing during the whole process and the disinfection during distribution. Before consumers receive meat products, there must be a process of slaughtering, disinfecting, freezing, dividing and weighing, packaging, storage and distribution of livestock. During this process, the temperature of meat should be maintained at 0 to 4 °C; fresh aquatic products require an even lower storage temperature (below - 18 °C) to ensure food safety. After cleaning, processing and other operations, aquatic products are frozen to below - 18 °C, transported to processing and distribution centers for storage or secondary processing, and finally delivered to consumers with cold chain vehicles.

5.2 Taking Consumer Demand into Account

Agricultural products can be customized by the production sites or subcontracted, and the specifications can be determined by the merchants. When choosing a specific method, merchants have to take into account the cost of subcontracting and the impact on product quality. Due to the short shelf life and fixed consumption cycle, agricultural products should be subcontracted from the place of origin according to the amount of consumption by consumers. The specifications of agricultural products sold need to be flexibly adjusted according to the actual situation of sales. For example, subcontracting all products at the production sites will bring higher costs and more waste, so the merchants can also choose to re-subcontract at the warehouse.

The selling prices of agricultural products should be determined according to the actual needs of consumers, who may like to select products themselves or prefer pre-weighted products. This approach has an advantage in that it can bring more benefits to customers and attract consumers who have different requirements for sales specifications. However, its drawback lies in that it needs a sophisticated system and might have a certain impact on the efficiency of selection. Nowadays, in order to improve efficiency and convenience, merchants usually sell pre-weighted products. This approach enables warehouses to evaluate sales more accurately so that they can start production in advance and increase the speed of delivery. Besides, in order to maintain its regional competitiveness, a company need to investigate the regional market, compare its price with competitors', formulate a more reasonable sales price and gross profit, and make good use of market regulation.

5.3 Building an Efficient Network Information System

At present, agricultural e-commerce is faced with an evident problem, that is, slow development of the information system. Therefore, it is urgent to build a multi-level information network system and e-commerce information system for agricultural products from the state to the locals. First, the government should assume the responsibility for constructing public platforms and establish a set of information management operating mechanisms and institutional systems. In addition, relevant legislation needs to be perfected so that this information system can guarantee the development of regional agricultural e-commerce supply chain system in terms of information release, update and management, and help minimize the negative impact caused by confusing information. Second, all parties in the market must fulfill their responsibilities in line with related laws and regulations. Finally, the operation of agricultural supply chains and e-commerce should be standardized, including information coding, content standardization, and industry standards. This should be realized through compulsory implementation according to laws and regulations, which is an important strategy for protecting and supervising the rights and interests of all parties.

5.4 Strengthening Communication between All Parties of Agricultural E-commerce

Based on regional agricultural e-commerce supply chains, we should build a business alliance involving suppliers from different stages of a supply chain. In traditional regions, the supply chain system of agricultural e-commerce platforms is too loose. In order to solve this problem, enterprises involved in an agricultural supply chain should establish a virtual business alliance to continuously strengthen the communication and mutual interests between them and effectively build up close business relationships. The virtual business alliance combines the strengths of the members of the alliance, which helps involved enterprises better integrate with the value chain of the virtual alliance by virtue of their advantages. In this way, involved companies make contributions to the alliance and the alliance invest in those companies at the same time, thus leading to a win-win situation. The investment from the virtual business alliance can help members internalize the core value chain because involved companies can share their own core value chain and promote cooperation and innovation within the alliance.

6. Conclusion

To sum up, from the analysis of the current development of agricultural e-commerce platforms and supply chains in China, it can be found that agricultural e-commerce platforms are still confronted by some problems despite the fact that they are gradually promoted across China and have brought a lot of benefits to farmers. For example, there is a lack of professional talents; some areas are conservative about the idea of agricultural e-commerce; infrastructure remains to be improved. By comparing profits brought by two-stage, three-stage, and four-stage supply chains with a mathematical model, this paper concludes that fewer middlemen involved in a supply chain can bring greater profits to manufacturers. It finally proposes some possible optimization strategies for the further development of agricultural e-commerce and supply chains, such as optimizing distribution, paying attention to consumer demand, building network information systems, and

strengthening communication among different stages, which can effectively reduce the cost of supply chains and maximize the income of farmers.

References

[1] Liu Yiping. 2018, The Evaluation Index System and Empirical Study of Development Level of Agricultural E-commerce Platform Under the Background of Big Data, Chongqing Technology and Business University.

[2] Yao Jiaqi. 2019, Research on Optimization Strategy of Regional Agricultural E-commerce Supply Chain System, Accounting Learning, (21):185-186.

[3] Li Huizhong. 2018, Analysis of the Optimization Strategy of E-commerce Supply Chain of Fresh Agricultural Products, Shanxi Agricultural Economy, (16):56-57.

[4] Cao Xinlei, Song Li & Yu Wanning. 2017, The Operation Optimization of Supply Chain in Vertical Fresh E-commerce, Logistics Engineering and Management, 39 (07):88-89.

[5] Duan Zihao, Wang Chuanlei, Zhang Wenru & Lu Xue. 2019, Research on Trust Problem between Supply Chain Nodes in Blockchain Technology, Modern Business Trade Industry, 40 (16):25-26.

[6] Zhao Yousen, Wang Lian, Wang Fei & Yang Weimin. 2017, Evaluation Index of Agricultural E-commerce Based on Principal Component Analysis, Jiangsu Agricultural Sciences, 45 (07): 287-290.

[7] Lu Zhaoyang & Liao Shanshan. 2016, he Factors about the Different Financing Choices of the Online Enterprise of Agricultural Products, Statistics & Information Forum, 31 (11): 103-111.

[8] Hong Tao. 2015, Research on Innovation of Agricultural Products E-commerce Model, Rural Finance Research, 2015 (08): 7-12.

[9] Wang Sheng & Ding Zhongbin. 2015, Agricultural Products E-commerce Ecosystem--A Theoretical Analysis Framework, China Rural Survey, (04): 39-48+70+96.