

# Optimal Study on Logistics Model of Agricultural Products in East China

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## Abstract

This study is the agricultural product logistics operational mode, and the logistics mode of China's agricultural products has been summarized in this paper. It focused on the logistics mode of agricultural goods in Zhejiang province of East China. The paper used clustering analysis and operations research methods to optimize the existing logistics model. On this basis, the paper has combined with the organization theory of network, and used relative software to analyze logistics data about various regions in Zhejiang province. Finally, the paper has proposed the optimal logistics model of agricultural products in Zhejiang province.

## Keywords

Logistics of Agricultural Products, Cluster Analysis, Logistics Mode, Optimization

## 1. Introduction

Agricultural goods refers to the primary agriculture products, different from industrial products, it has many characteristics, such as a large variety, short saving time, seasonal and so on. [1] Agricultural logistics ranges from agricultural production, processing, packaging, storing, transportation, distribution up to the final consumers of the whole process. However, compared with the industrial logistics, logistics of agricultural products in each of its areas has significantly different characteristics. In particular, temporal and spatial separation of production and consumption of agricultural products, that makes the market

extremely fragmented. It is difficult to fully grasp supply and demand information about competitors and collaborators in the market. [2] Furthermore, due to asymmetric information between nodes of agricultural product supply chain, that lead to imbalances between supply and demand, the lack of market regulatory, quality and safety control, and the cost of transportation, processing and marketing is too high. The development of agricultural products supply chain is a systematic project. [3] [4] Integrated agricultural supply chain is a chain-like network of structures, composed by supplier, agricultural producers, agricultural information agency, processing and marketing firms, third-party logistics companies and consumers. (Figure 1)

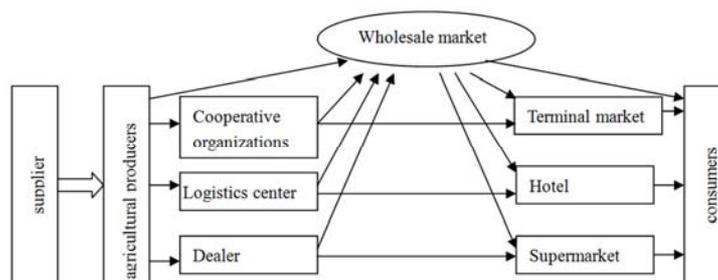


Figure 1. Rough diagram of agricultural products supply chain.

## 2. Analysis on Logistics Mode of Agricultural Products

In the new economical situation, traditional agricultural logistics systems in China no longer meet the demand of the times. Therefore, the reform of logistics mode of agricultural products, and promoting the modernization of agriculture are necessary for the development of China's agricultural economics.

At present, there are four mainly agricultural product logistics modes in China, namely: direct-marketing model, the logistics model as wholesale-market-center, the logistics model as intermediary organization-center and third party logistics.

### 2.1. Proprietary Logistics Model

Proprietary logistics model refers to agricultural producers, agro-processing and circulation enterprises that used to conduct their own business according to their management experience. [5] [6] This is the most original and primitive form of logistics, the main feature of this mode is less intermediate, low transaction costs, and low retail prices, but smaller the circulation area with radiation, and not conducive to the increase of the market share of agricultural products. [7]

### 2.2. Logistics Model as Wholesale-Market-Center

Because of more people and less agricultural land, the agricultural production based on small scale, however, the demand is large and has a wide geographical scope. The contradictions between production and big demand decided the circulation process of agricultural products firstly by dispersed to concentrated, and then by concentrated to dispersed. [8] During this process, it gradually formed the logistics mode whose center is the wholesale market, that is, for logistics model as wholesale-market-center, that relies on some scale of agricultural wholesale market, and has formed the typical "bulk-poly-bulk" three segment logistics mode, also can called "double market mode". [9] [10]

### 2.3. Logistics Model as Intermediary Organization-Center

Agricultural intermediary organizations include farmers' specialized cooperatives, professional and technical associations, marketing associations, brokers of farmers, and so on. [11] This pattern takes many agricultural intermediary organization as a link, provides a full process logistics services through whole agriculture production. It can make so many scattered small scale agricultural production operators banded together to form a larger-scale economical groups and achieve effect of scale economy, increase bargaining power in the market, and increase farmers' income. [12]

### 2.4. Third Party Logistics

Third party logistics refers to the third-party logistics

enterprises through specialized operations offer integrated logistics services for agricultural trade. The biggest advantage of this mode is to promote cooperation between the circulation and production, reduce circulation costs, improve the circulation efficiency, and be beneficial to a standardization of logistics. [13] This mode led by the third-party logistics enterprise can achieve reductions in logistics through the effect of scale economy, reduce the logistics costs, and conducive to the distribution patterns of modernization and socialization. [14] [15]

## 3. Agricultural Products Logistics Mode in Zhejiang Based on Network Organizations Theory

Known by the above mentioned, the literatures about agricultural product logistics in Zhejiang province were limited on the management method and management mode. It was the lack of quantitative study. The perspective of this paper is from quantitative analysis to study the logistics mode of agricultural products in Zhejiang province. So-called logistics network is constituted by logistics enterprises, and it is formed by the combination among logistics network, logistics infrastructure network, and logistics information network. Based in Zhejiang province, the paper analyzed network integration of agricultural products' logistics organization.

Networks within regions is more of contact nodes connected together in a network system, and nodes of location identification and selection has critical influence on the efficient operation of the network as a whole. Therefore, the core mode of agricultural products based on network organizations theory is how to determine the appropriate nodes in the region between urban and rural areas, reasonable layout of the nodes will not only avoid repetitive construction waste of resources, but also improves the efficiency of the logistics in the region. The most important function for the rural logistics node is collecting function, and urban logistics node not only for the city, demand for logistics services within the province, but also to play a role in national and even international logistics system. This paper has designed different functional planning for different logistics nodes of logistics services.

## 4. Determination of Center Node in Agricultural Product Logistics Network in Zhejiang Province

### 4.1. Foundation of the Determination

Logistics network should include the crisscross among logistics service system of each node, small family enterprises, a wholesale market or a warehouse, even a port, a town, a city can become the logistics nodes of network. Because of the

location of each city, population size and levels of economic development as well as the intensity of contact with outlying areas of logistics and other differences, can decide which city is the main node of Logistics Center City, and which city is the secondary node of logistics city. Agricultural production capacity, level of local logistics and sales demand, transportation development, consumption level and

purchasing power are the factors affecting the construction of logistics center in the area level. From the actual situation in Zhejiang Province, compares the city's comprehensive capacity of agricultural product logistics, strong or weak, then the city categories and levels to build different types of logistics parks, relative data are shown in table 1.

Table 1. Capacity of agricultural product logistics in Zhejiang province in 2014.

Region	total retail sales of consumer goods (100 million yuan)	gross export (USD 100 million)	Farming value (100 million yuan)	Transport storage and post and telecommunications industry employees (10000 persons)	Sown area of farm crop(1000 hectares)
Hangzhou	2944.63	412.62	207.72	9.75	370.12
Ningbo	2329.26	614.45	201.19	6.04	309.45
Jiaxing	1083.74	196.03	120.6	1.65	340.45
Huzhou	703.87	73.96	93.63	0.98	224.25
Shaoxing	1158.66	255.57	175.41	1.47	331.13
Zhoushan	290.54	92.24	10.12	1.53	23.32
Wenzhou	1929.29	176.96	79.59	3.07	247.08
Jinhua	1260.41	213.13	121.13	2.01	274.82
Yiwu	398.74	90.05	18.19	0.52	30.64
Quzhou	396.36	18.59	61.3	0.51	230.22
Taizhou	1304.3	172.39	126.41	1.85	251.37
Lishui	371.09	19.76	79.6	0.48	170.71

Table 1. Continue.

Region	Grain (ton)	Output of meal (ton)	volume of rail freight (10000 tons)	volume of Highway freight (10000 tons)	Length of highways(km)	Length of expressway (km)
Hangzhou	968847	334907	322.47	23243	14938.58	550
Ningbo	865700	212430	2594.34	16570	10661	463
Jiaxing	1384286	392718	29.21	8432	7863	348
Huzhou	899386	189648	0	7081	8110.93	289
Shaoxing	1200558	182493	120.08	8204	9587.19	394
Zhoushan	52194	21517	0	4697	1801.69	32
Wenzhou	927081	131526	646.93	8022	7915.53	289
Jinhua	897784	255992	147.36	12691	11861.73	310
Yiwu	105658	45968	31.18	3668	1380.61	54
Quzhou	796868	320125	368.47	8364	7822.9	317
Taizhou	791920	139118	8	11744	11453	298
Lishui	523670	97899	98.99	4496	14284.8	329

Data source:Statistical Yearbook of Zhejiang Province(2015)

Using the mathematical software MATLAB clustering analysis on the data in the table, in a variety of clustering method uses squared deviations is widely used in the field of

social sciences and law (ward), the squared Euclidean distance is used, the paper has made the tree clustering results, as shown in Figure 2.

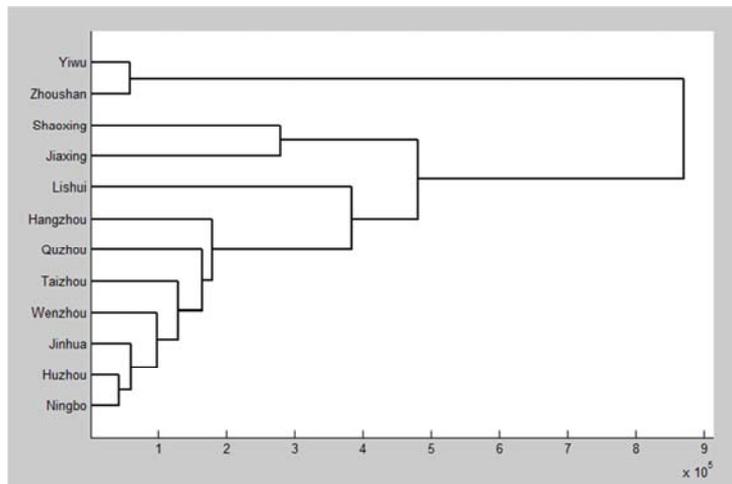


Figure 2. Capacity of agricultural product logistics in Zhejiang province in 2014.

From the diagram above, it can be seen that the first class city is Hangzhou, which has the strongest integrated logistics capacity of agricultural products; Ningbo as a second class city, have weaker agricultural products logistics ability than Hangzhou; Zhoushan and Yiwu of agricultural product logistics capability is the weakest, can be thought of as fourth class cities; Remaining 8 cities as a third class city. In order to build logistics centers at various levels in the network node city in Zhejiang province. Hangzhou and Ningbo should be served as the primary logistics centre of node-cities, focus on building a large logistics base, integrated logistics hub for the Eastern Province of Zhejiang. Around Hangzhou and Ningbo, because of their different status, and environmental factors determine the three logistics centers will have different logistics functions.

**4.2. Function and Patterns of Agricultural Product Logistics Node Cities in Zhejiang Province**

As a node city of logistics network, the logistics functions should include: the first is the transportation hub of logistics nodes, mainly refers to the transit hub of variety of transport for backbone net, or the conversion hub of cross-regional and long-distance transport for the urban region distribution system. The second is distribution nodes of city, mostly secondary hub which play a logistics role. It is the logistics bases which be specialized in regional relays distribution. At the same time, these nodes should ensure urban commerce and production. The third is mainly relied on their special geographic environment; play the special logistics function which other cities cannot have, such as near the port or airport of the city.

First class cities should be able to build Logistics Park as the transport hub, such as Hangzhou City. It is mostly to become a national logistics centre, to serve as specialized

logistics park for offering special logistics activities.

The Second class cities should be constructed port Logistics Park, such as Ningbo. The purpose of establishment is to become a multi-level, socialization and specialization and internationalization of logistics in the modern logistics service network system. Its advantage can be used to provide specialized logistics services.

The third class cities may become the distribution centers, such as the distribution processing or warehousing and distribution Logistics Park. This type of nodes can be quickly transported to the first class level cities, but also for local production, living and business activity services, building as the city's logistics centre in the region.

The fourth class cities can choose different kinds of logistics services according to different demand.

**5. Selection of Agricultural Product Logistics Nodes in Zhejiang Province**

From the view of setting a model, this is the problem how to layout a single variety of diverse logistics nodes. Because the multi-level model is based on a single model, and have the same ideas and methods. The paper illustrated the idea of construction of agricultural product logistics network in rural areas through the single-level nodes of the network structure. Figure 3 is a single layer of relay node for agricultural products logistics in rural areas, where ‘A’ is the lowest agricultural producers, ‘B’ is the transit nodes, and ‘C’ is the higher level logistic node. In order to simplify calculations, ‘C’ can be thought of purchasing agricultural products within the region. To solve the problem is actually whether ‘B’ should be constructed or not.

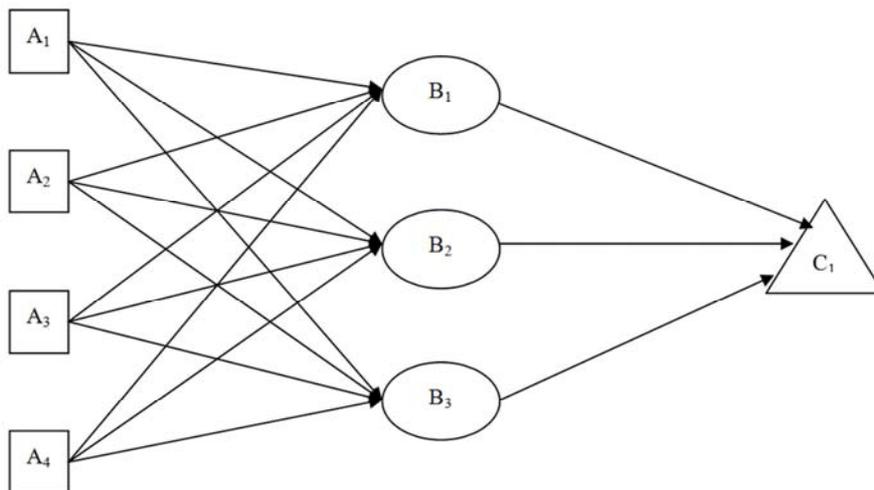


Figure 3. Structure drawing of agricultural products logistics in rural.

Model has the following definition:  $X_{ab}$  is the number of agricultural products from class ‘A’ logistics node to class ‘B’ logistics node.  $X_{bc}$  is the number of agricultural products from class ‘B’ logistics node to class ‘C’ logistics node.  $Y_b$  is the

transit node ‘B’ whether to be constructed, so ‘ $Y_b$ ’ may be 1 or 0.  $C_{ab}$  is the unit transportation cost from ‘A’ to ‘B’.  $C_{bc}$  is the unit transportation cost from ‘B’ to ‘C’.  $F_b$  is the cost of construction for node ‘B’.  $C_b$  is the cost of transit.  $Q_a$  is the

number of agricultural products for grass-roots units. C is the total cost for the whole agricultural products logistics network.

Models are as follows:

$$\min C = \sum_{a=1}^m \sum_{b=1}^q C_{ab} \cdot X_{ab} + \sum_{b=1}^q \sum_{c=1}^n C_{bc} \cdot X_{bc} + \sum_{b=1}^q (F_b \cdot Y_b + C_b \sum_{c=1}^m X_{cb})$$

$$st. \begin{cases} \sum_{b=1}^q X_{ab} \leq Q_a \\ \sum_{a=1}^m X_{ab} - MY_b \leq 0 \\ \sum_{b=1}^q X_{bc} - MY_b \leq 0 \\ Y_b = \begin{cases} 1 & \text{'b' will be constructed} \\ 0 & \text{'b' will not be constructed} \end{cases} \\ X_{ab}, X_{bc} \geq 0 \\ M \text{ is arbitrarily large positive number} \end{cases}$$

The model has analyzed the costs of the whole logistics network, established the objective function for the minimization cost, and then confirms the number of the logistics nodes layout in this model.

### 6. Optimization of Agricultural Product Logistics in Zhejiang Province

Zhejiang province’s regional logistics network operation system is combined the city logistics network and rural agricultural products logistics networks. Logistics mode of agricultural products is to figure out how to make

micro-operating activity contact with each other, allowing the entire logistics network works to reduce logistics costs and improve efficiency and make the whole logistics system reach its objectives. According to the theory of agricultural product logistics networks, you can construct a logistics model includes the following types.

#### 6.1. Processing Enterprises as the Core in Operation Mode of Agricultural Products Logistics Network

In logistics system of agricultural products, the producer is the weakest link, because the peasants have low degree of organization throughout the asymmetries in the system, they are in a weak position. Therefore, it is necessary to build the integrated logistics system, and the system has processing enterprises as the core. In this mode, the processing enterprises have stronger market power, centered on processing enterprises to ensure the stability of production activities, in terms of capital, technology and means of production by the company providing support to peasants. In addition, enterprises in the process won a guaranteed supply of raw material. Organizing the peasants can improve production efficiency and reduce the production costs through scale economy. As shown in Figure 4. In this mode, quality of processing enterprises becomes critical to the success of the entire system. Processing enterprises must be based on network organizations theory combined with the theory of supply chain management, and then gradually increase management efficiency and reduce management costs through business process re-engineering.

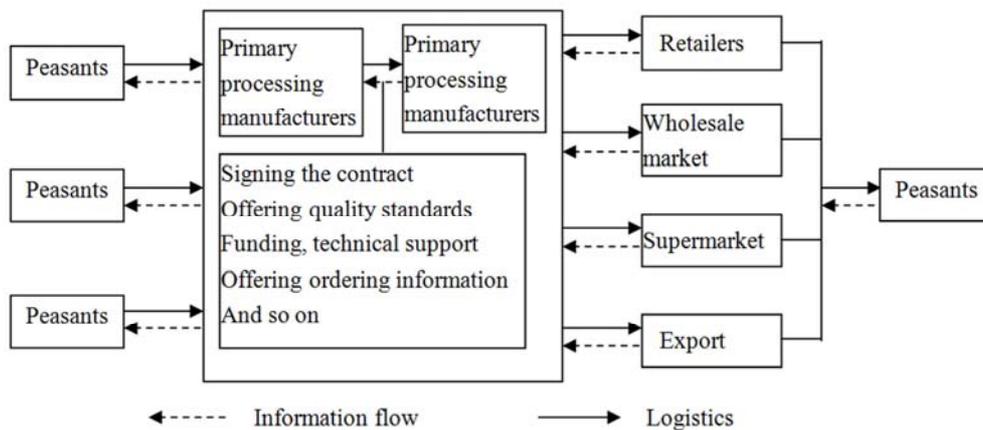


Figure 4. Processing enterprises as the core in the mode.

#### 6.2. With the Core of the Third-Party Logistics Operation Mode of Agricultural Product Logistics Outsourcing

It is necessary to build third party logistics which is combined by dispersed individuals in rural areas, such as transport, storage, agro-processing, packaging, and so on. The company can be propitious to serve the demand of agricultural products logistics. Meanwhile, agricultural producing enterprises at all levels of supply chain should outsource to the

third party logistics company, for connecting peasants, cooperatives and agricultural production base through specialized distribution activities. Finally, the mode can be established, which is called ‘with the core of the third-party logistics operation mode of agricultural product logistics outsourcing’. On the basis of it, the logistics resources will gradually be fully integrated. It will be formed which is set across urban and rural, trans-regional and inter-trade logistics strategic alliance. As shown in Figure 5.

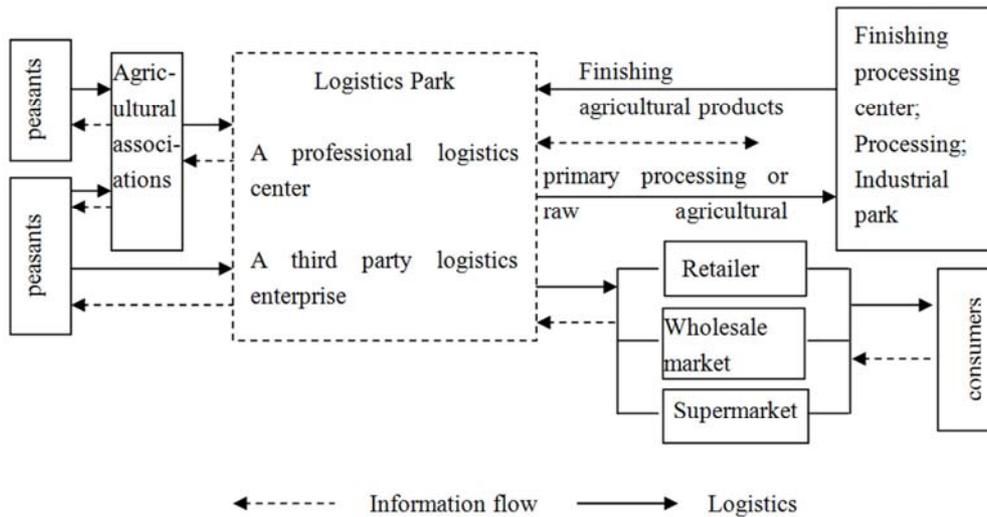


Figure 5. With the core of the third-party logistics in this mode.

**6.3. With the Core of Specialized Cooperative Organizations Operational Mode of Agricultural Product Logistics**

Specialized cooperative organization is the product of the development of the market economy, whose members are the majority of small-scale peasants that are at a disadvantage in the market competition. On the premise of that peasant household are in the family contracting business, and maintaining their property ownership does not change, in accordance with the principle of voluntary participation, the mutual economical organization will be built. If the cooperation is more mature and

larger, it can undertake responsibility for integrated management of production and marketing of agricultural products, and connect peasant household and supermarkets and other retailers to form simple integrated logistics systems for agricultural products. Entered peasants cooperate on a particular aspect of management by the agricultural marketing, technology, information services and agro-processing, and so on to reduce the cost of their diversification, and realize scale economy. They also can increase bargaining power in the market, and ultimately achieve the goal of increased operating income. As shown in Figure 6.

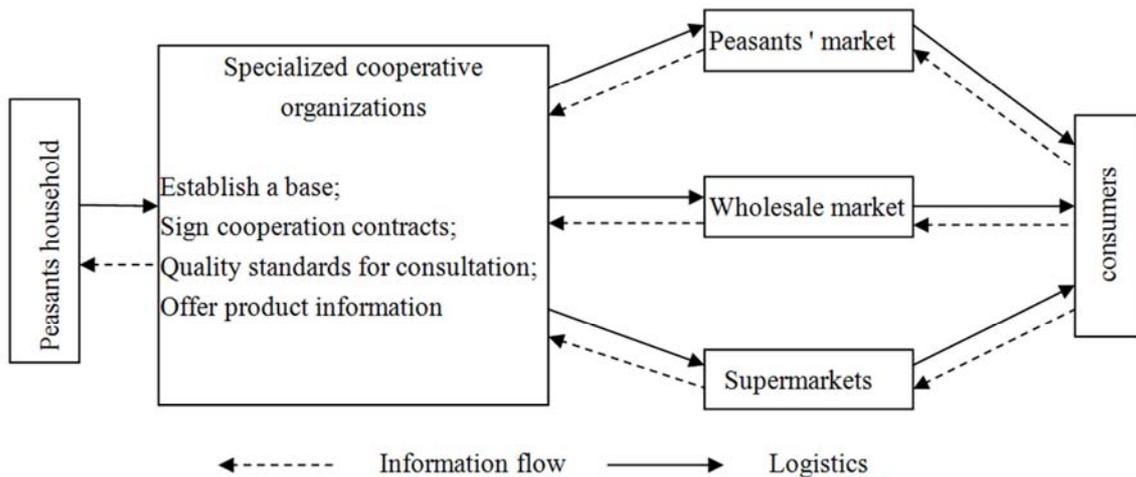


Figure 6. With the core of specialized cooperative organizations in this mode.

**6.4. With the Core of Wholesale Markets Operational Mode of Agricultural Product Logistics**

With the core of wholesale markets operational mode of agricultural product logistics is dominated by commercial circulation enterprises' integrated logistics system. Traditional wholesale market reform is needed in order to improve the efficiency of logistics systems. Wholesale markets has

become the core of the whole supply chain by using advanced electronics and information technology, as well as other systems of logistics and information technology platform. Through the use of computer networking technology integration and vertical and horizontal integration of database technology and writing, the operational mode of agricultural products logistics system reach high efficiency, high user satisfaction, and higher profit. As shown in Figure 7.

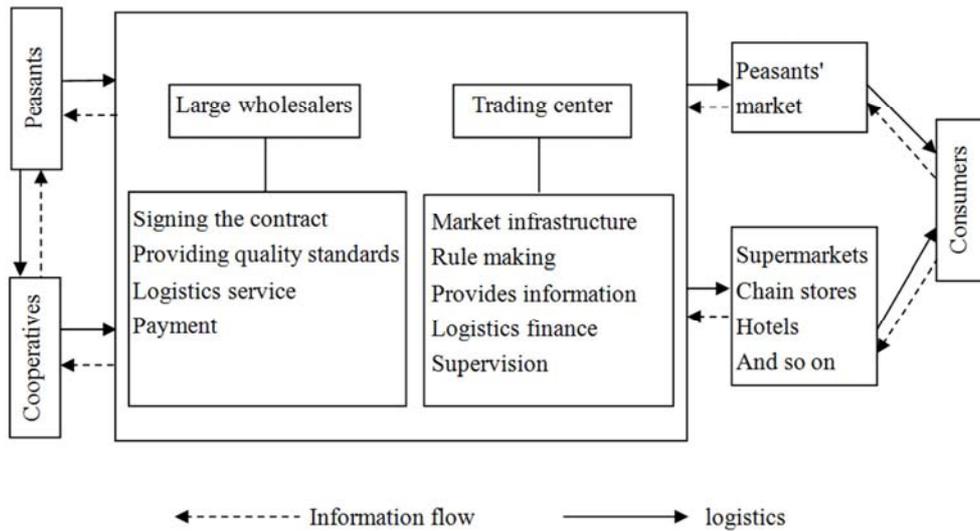


Figure 7. With the core of wholesale markets operational mode of agricultural product logistics.

## 7. Conclusion

From the above discussion, we know that, improvement of agricultural product logistics modes should be a unified planning of logistics system of agricultural products, has the characteristics of integrated, simple, and adds value through optimization of operation mode. It can provide guarantee for reducing costs and smooth operation. Rationality and coordination is an important feature of logistics system of agricultural products that could make every link can be achieved under the unified system of "seamless connection". Therefore, the process of agricultural products' logistics can form a complete agriculture supply chain.

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