An Outlook on Agricultural Modernization Path with Chinese Characteristics from Scale Agricultural Operation

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Abstract First of all, this paper discusses the scale agricultural operation of China from the aspects of practical exploration and rational thinking. Later, it puts forward the concept of further promoting scale agricultural operation according to the present conditions of China, which includes encouraging large household pattern and scale breeding, developing various forms of socialized agricultural services, promoting agriculture industrialization, accelerating regional distribution of advantageous agricultural products and promoting the progress in agricultural science and technology comprehensively.

Key words Scale agricultural operation, Agricultural modernization, Socialized services

1 Practical exploration

Scale agricultural operation of various forms breaks a path to solve the contradiction between scattered small household operations and socialized mass production, which is the biggest difficulty for agricultural modernization in China, and is also an unavoidable and lingering confusion in the theory and policy research on agricultural problems. At present, there are around 250 million peasant households in China with average land scale of less than 0.5 hectare. It is far less than the land scale of America, European countries, Japan, Korea and even India. Many people doubt if it is possible to achieve agricultural modernization on the basis of such a small scale of scattered household operations. But according to the development practice in our country, the road to agricultural modernization is increasingly bright and clear through extensive exploration on multiple forms of scale agricultural operation in different agricultural fields.

1.1 Expanding agricultural business scale through land circulation On the basis of household-based land contract system, the circulation of land-use right in the forms of subcontracting, leasing and pooling etc. has been developed gradually in different places. In 2006, rural land circulation area of the whole country was 55512000 mu, accounting for 4.57% of household contracted farmland area. Provinces with higher proportion of land circulation include Shanghai (accounting for 40.99% of household contracted area), Guangdong Province (20.08%) and Zhejiang Province (19.75%). The proportions of other provinces are all below 10%. One of the effects of land circulation is that land operation of moderate scale has been promoted. In practice, a batch of large grain production households has emerged across the country. In the southern part of China with per capita land area of less than 1mu, large grain production households with hundred-mu and even thousand-mu of land have emerged; and in the northern part, there emerges large grain production households with thousand-mu and even 10 thousand-mu of land. The benefits of these large grain production households are generally in a good condition, and their agricultural labor productivity is significantly higher than that of the ordinary small-scale households. As a large grain production household in Longyou County of Zhejiang Province, Fu Xianjun contracted 677.5 mu farmland in 2007 to apply the rice cultivation pattern of "dual machine applying, dual scattered-planting and dual 500 kg yields". Full mechanization is almost achieved in ploughing, harvesting and pest control. Applying the pattern of seedling breeding and scattered-planting with plastic plate, the yields of both early and late season rice per mu have achieved 500 kg and above. Annual grain output has achieved 453.9 tons with total output value of 818000 yuan, bringing in net benefits of up to 179000 yuan from grain-growing in the whole year. This pattern is a combination of fine breed and good method, a matching of agricultural machinery with agricultural technology, and a dynamic integration of labor-saving, cost-saving and efficiency increase. This shows that it is completely feasible to achieve scale operation through land circulation.

1.2 Achieving large scale production through cross-regional agricultural machinery operation services In middle 1980s, some farmers in northern part of China created cross-regional machine wheat harvesting pattern according to the different timing of wheat maturity in different regions. Later in 1990s, this pattern had been expanded to most wheat production areas of China, and the number of combine-harvesters for cross-regional operations kept increasing year by year. In 2007, the number of combine-harvesters taking part in cross-regional operations reached 418000, and mechanized harvest area reached 350 million mu, achieving comprehensive mechanization level of over 81% in wheat production. Combine-harvesters travel for hundreds or thousands of kilometers across counties and even provinces with the quarterly operation area per unit increasing from 400500 mu in local operation to

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1000 – 1500 mu. The working time is extended from 5 – 7 days to 30-40 days with effective operation time of around 200h. The operation time of high-performance combine-harvesters can even reach over 50 days, covering an operation area of over 4000 mu. According to statistics, the annual average operation area of combine-harvesters per unit in America and Canada is 1200 – 1800 mu with operation time of 120 – 180 h; and the annual operation area in Japan is only 300 – 400 mu with operation time of 60 – 80 h. With the small-scale agricultural situation that average agricultural acreage per household is only 7.3 mu in China, which is less than 1/40 of European countries and even 1/400 of America and Canada, cross-regional operation helps to achieve full mechanization in wheat harvesting with even higher machinery operation efficiency and utilization rate than the developed countries. This is a wonderful example to prove that it is completely feasible to achieve high-performance and high-efficiency agricultural mechanization and large scale modernized production on the small-scale land of China.

1.3 Developing scale breeding in various ways In recent years, our country has accelerated the transformation of the development pattern in breeding industry. Livestock breeding has transformed from traditional scatter-breeding to modern and intensive breeding gradually, and the scale of livestock breeding has also been increased gradually. In 2006, the number of scale pig breeding households with annual output of over 50 accounts for 43% of the total, the number of scale chicken breeding households with annual output of over 10000 accounts for 46.6% of the total, and the number of scale laying hen breeding households with annual inventory of over 2000 accounts for 40.5% of the total. As compared with the year 2000, the percentages had been increased by 17.3%, 18.7% and 21.7% respectively. The number of scale cow breeding households with annual inventory of over 20 accounts for 33% of the total, which is 4.4% higher than that of 2002. Large-scale feeding comes in several forms, and can be generally divided into large-scale breeding households (mostly specialized breeding households), breeding aquatics villages (still household breeding, but centralized in unified animal raising zones) and large-scale modern livestock farms. With the increasing degree of scale breeding, modern breeding techniques and methods have been more widely used. The breeding mode of "company + household", that is "several unifications and one acquisition" (unified breed supply, feed supply, epidemic prevention and technical guidance etc. and unified purchasing), has started from chicken breeding first, and then expanded to other livestock and poultry industries. Taking live pig for example, Xindai Town of Pinghu City in Zhejiang Province has promoted the new breeding mode of "company + base + household", which gives rise to a great number of large-scale pig breeders. At present in the whole town, there are 80 breeding households with over 50 pigs, 40 breeding households with over 100 pigs and 22 breeding households with over 1000 pigs. In addition, Mingda Ecological Breeding Demonstration Zone has been built with planned sow inventory of 1000 annual pig output of 10000 and a complete set of supporting facilities. In this way, an intensive and industrialized pattern of professional breeding and centralized management has taken the initial shape. From the development practice of breeding industry, the pattern of scattered households - breeding aquatics villages - large-scale livestock farms shows a successful development mode and path for breeding modernization.

1.4 Scale operation of agricultural reclamation system makes remarkable achievement In the agricultural reclamation system of China, the per-capita cultivated area is 6.1mu, which is 3.2 times of the average per-capita cultivated area across rural areas of China; and the cultivated land area per labor is 23.77mu, which is 6.5 times of the cultivated area per labor across rural areas of China. This has presented a series of advantages in achieving agricultural modernization initiatively. Comprehensive mechanization rate of agricultural reclamation, cultivation and harvesting has reached over 74%, which is almost two times of the national average level in rural area; grain output per mu in agricultural reclamation is 381.6 kg, which is 18.8% higher than national average level; cotton yield per mu is 140kg, which is 69% higher than national average level; sugar crop yield per mu is 4696 kg, which is 13.8% higher than national average level; and milk yield per unit is 4106 kg, which is 5.3% higher than national average level. As the largest reclamation area for agricultural production in China, Heilongjiang reclamation area covers cultivated land of 35 million mu. The per-capita cultivated area is 22 mu, which is 15.7 times of the national per-capita cultivated area. In 2007, there were 183400 household farms in the reclamation area, and the contract land area was 33.87 million mu, resulting in a contract land area per household of 185 mu. At present, the largest scale of dry farmland in the reclamation area reaches up to 15000 mu and the largest scale of paddy field reaches up to 6000 mu. Comprehensive mechanization rate of Heilongjiang reclamation area reaches up to 93%. Among the household farms, the number of households possessing agricultural machinery accounts for 29.4% of the total. Large-scale household farms are also large agricultural machinery households. The land area contracted by households possessing agricultural machinery is 12.23 million in total, accounting for 36% of the total contract area. These households also provide cultivation services for other households. That is to say, the agricultural machinery owned by the 30% equipped households has completed all the cultivation and harvesting operations in the whole Heilongjiang reclamation area. This shows that scale operation has been achieved, bringing about higher labor productivity. In crop production, annual grain yield per labor is 35.4 tons, ranking the first place in the whole country. It is also higher than the grain yield per labor in developed countries, which is 28 tons. In 2006, the comprehensive grain yield per mu in the reclamation area is 362 kg, and the average yield per mu of the four major crops (including rice, corn, wheat and soybean) is also much higher than the level of rural area. The total grain output reached up to 11.3 billion kg, contributing commodity grain of over 10 billion kg.

There are many other similar examples. According to the research on the above examples and practice tracking, think about the road to agricultural modernization in China again under the situation of small-scale scattered household operations. Has the confusion been released, doubt been reduced and the prospect of agricultural modernization in China become broad?

2 Rational thinking: scale agricultural operation is the key link to promote agricultural modernization

Since the establishment of New China, our country has made long and hard exploration on agricultural modernization and modern agriculture. The understanding of this area has been developed and deepened continuously. In 1950s and early 1960s, the main content of agricultural modernization was supposed to be "Four Modernizations" including mechanization, chemicalization, irrigation and electrification. In 1970s and middle 1980s, more emphasis had been put on science in the understanding of agricultural modernization. And in late 1980s and middle 1990s, the contents and characteristics of agricultural modernization were summarized mainly from the aspects of science, intensification, socialization and commercialization. According to this analysis, the understanding was mainly subject to technical equipment before 1960s, and was later expanded to science and economic factors after 1980s. Since the late 1990s, further attention has been paid to the overall promotion of modern agricultural development. In 2007, it was summarized in "No. 1 Document" of Central Government as "equip agriculture with modern material conditions, transform agriculture with modern science & technology, improve agriculture with modern industrial system, promote agriculture with modern management style, lead agriculture with modern development concept and develop agriculture through training of new peasants". In addition, the report of the 17th National Congress of CPC further proposed to "take the road of agricultural modernization with Chinese characteristics". In my opinion, research on "the road to agricultural modernization" according to "Chinese characteristics" conforms to the theoretical approach of Marxism localization in China, and indicates that the research on agricultural modernization has been improved to a new stage and degree of recognition. In order to take the road of agricultural modernization with Chinese characteristics under new historical conditions, first of all, we must fully understand our national conditions in agriculture.

Regarding to our national conditions in agriculture, scholars have made many explorations and have reached many basic consensuses

(i) Large population with limited land, shortage of agricultural resources and small household operation scale. The per capita cultivated land area is only 1.39mu, which is only 40% of the world average level. The cultivated area per household is less than 0.5 hectare. In addition, there is a critical shortage of water resources. The per capita hold of water resources is only 1/4 of the world average level. Amount of water shortage in agricultural irrigation is about 30 billion m3 every year. With the increase in population and the rapid development of industrialization and urbanization, there is growing pressure in the occupation of agricultural land and water resources, and the demand for agricultural products is also on the increase. In this way, the contradictions of large population with limited land and shortage of agricultural resources are becoming increasingly obvious.

(ii) Low level of agricultural productivity and extensive mode of production and management. With weak agricultural infrastructure, backward equipment, aging farmland irrigation facilities, poor quality of cultivated land and inadequate capability to resist natural disasters, agriculture is still dependent on the weather from an overall perspective. In agricultural production, the content of science and technology is relatively low. At present, the contribution ratio of technological progress to agriculture is only around 48% and the transformation rate of agricultural scientific and technology achievements is only around 30%, which are 30% and 40% lower than that of the developed countries respectively. The trend of degradation in agro-ecological environment had not yet been reversed in a fundamental way.

(iii) Low comparative benefit of agriculture and poor competitiveness. Agricultural production is facing double risks from both nature and market. At present, our agricultural industry chain is short with low added value. And most of the benefits from follow-up processing and circulation have failed to contribute back to agriculture. As compared with other industries, the comparative benefit of agriculture is always on the lower side. Agricultural labor productivity is only about 1/8 of the secondary industry and 1/4 of the tertiary industry, and the gap between agriculture and the secondary or tertiary industry is continuously expanding. Due to low comparative benefit of agriculture, rural production factors including land and funds etc. have been drained out, which further restricts agricultural development and competitiveness improvement. Another point is that urban-rural dual structure has existed for long, resulting in great system restriction on agricultural development. In China, agriculture and rural development has lagged far behind the industrial and urban development for a long time. The gap between urban and rural areas in respect of income level, public goods supply and public resource allocation etc. is too large, showing obvious contradiction of dual structure between urban and rural economies. In recent years, the efforts for balancing urban and rural development has been strengthened significantly, but the pattern of urban-rural segmentation that has formed over a long period of time has not yet been broken from the root, systematic obstacles restricting rural and agricultural development have not yet been eliminated, and the situation of inadequate rural economic and social development has not been changed fundamentally. Besides, low level of agricultural organization, low quality of farmers and large regional differences are also remarkable features of agriculture in China.

The above content reflects prominent agricultural problems in China. In this sense, the road of agricultural modernization with Chinese characteristics is mainly reflected as the modernization

path opened up against the prominent agricultural problems in China. As mentioned above, the first characteristic is large population with limited land and small household operation scale. It is also the primary and most fundamental agricultural characteristic of China, and other characteristics are all derived from, influenced by or formed together with this fundamental characteristic. Large population and resource shortage is an objective reality and is essentially an irreversible factor. If we cannot find a way out on this problem, the road of agricultural modernization will be limited. That is why we cannot bypass or avoid this problem in the research of agriculture in China. Facing up to this confusing and unsolvable difficulty, Chinese farmers have made two great creations and brought about two breakthroughs in respect of concept, policy and mechanism. Because of this, we have seen the signs of success by making progress.

The first great creation is household contract of land. In 1978, 18 peasants in Xiaogang Village of Fengyang County in Anhui Province took the lead to apply household-based contract system, breaking through the restraint of collective operation. And in the practice in Anhui and many other provinces over the years that followed, production and work contracted to households had made incredibly "prominent" achievements. It proves that this operation mode - household contract responsibility system can greatly mobilize and protect the enthusiasm of farmers, and also conforms to the agricultural productivity level of China at the present stage. This system has also been encouraged and supported in a series of central files issued thereafter, in which is has been regarded as "a great creation of Chinese farmers under the leadership of the Party". During the period of collective transformation before then, production contracted to households has gone through "three ups and three downs". It had been severely criticized and throttled as a sign of capitalism. Now the central government has fully confirmed this system and established it as the basic system for rural operations, marking a historic breakthrough at the policy level. With the wide application of household-based land contract system, other forms of land contract right transfer including subcontracting have also emerged. *The Rural Land Contract Law* promulgated in 2002 has established the legal status of land contract right as well as its subcontracting, leasing, exchange or other transfer forms. In order to enrich the farmers and construct developed rural area, the numbers of peasants must be reduced. This is a popular expression of many scholars for the development of modern agriculture in China. Household contract operation conforms to the natural, seasonal and regional characteristics of agricultural production, and can also undertake modern agricultural technology and operation pattern effectively. According to the practice of agricultural development in various countries of the world, household operation is still the most basic agricultural operation pattern in the developed countries. Therefore, household contract operation is not in conflict with the scale modern agriculture. Instead, it is an important foundation for the development of modern agriculture. Under the current situation of scattered operation with 250 million peasant households, we need to expand operation scale gradually, reduce the number of peasants and realize modernization on the basis of maintaining social stability. The contractual right of land on the basis of household contract, the system design for its transfer and corresponding policy and legal guarantee have broken a path, created conditions and offered guarantee for this.

The second great creation is cross-regional operation of agricultural machinery. Since 1996, it has been rolled out in the wheat growing regions nationwide by the Ministry of Agriculture, which established a national leading group of cross-regional machinery wheat harvest together with the Ministry of Public Security, Ministry of Communications, Ministry of Machinery Industry, State Development Planning Commission and China Petrochemical Corporation. This leading group has provided various services and conveniences for the cross-regional operation of agricultural machinery, including free transit expenses, fuel supply guarantee and safety protection. In wheat harvest season every year, a pattern of great battle will be presented in the vast wheat area from south to north. For a single agricultural production operation, hundreds of thousands of combine-harvesters and related transportation and service equipment are centralized with the labor, resources and policy support from so many sectors. That's the unique. It is explicitly stipulated in the *Law of the People's Republic of China on Promotion of Agricultural Mechanization* released and implemented in 2004 that "the government encourages to carry out agricultural machinery operation services cross administrative regions". The central files relating to agricultural and rural work have also offered support for cross-regional operation of agricultural machinery for many times. These all reveal that cross-regional operation service is a major breakthrough with regard to the concept and policy of agricultural development. The emergence of cross-regional operation of agricultural machinery is of great historical significance. First is that it has created a socialized service mode. Second is that scale production has been achieved. Cross-regional operation of agricultural machinery has brought about great impact and profound inspiration for our thinking. The successful practice in over 20 provinces with an area of 350 million mu proves that large-scale modernized production can still be achieved by means of socialized services on the basis of small-scale agriculture in China. Therefore, cross-regional operation of agricultural machinery can be regarded as another great creation that is equal to rural household contract operations and of vital historic significance. Scale operation is an effective solution to the most primary and fundamental problem of large population with limited land and small household operation scale. As an aggregate concept, scale operation is the carrier of both technological factors and economic factors for agricultural modernization as analyzed above. It is an important condition to acquire various factors. Scale operation is beneficial to the popularized application of modern technology, cost decreasing & effect increasing, employment and transfer of rural labor force as well as the promotion of agricultural organization. That is to say, scale agricultural operation is

the key link to promote intensification, mechanization, science and socialization *etc.* On the other side, the development of these modern agricultural factors will also facilitate the expansion of agricultural scale.

To sum up, the development direction of agricultural modernization with Chinese characteristics has been made clear with smooth path and bright future. But it still will be a long and difficult process.

3 Further promoting the concept of scale agricultural operation

3.1 Supporting large household agricultural operation and scale breeding actively The development of large farmer-households is an important part for enlarging the scale of production and operation. For this, the transfer mechanism of land contractual right shall be established and improved according to the principle of legal conformity, voluntariness and compensation on the basis of the basic rural operation system as well as stable and improved rural land contracting relationship. In this way, promote and encourage the transfer of land operating right to large-scale households and capable management talents. Adjust the interest relationship rationally. The fund allowances for grain growing, fine breed, agricultural machinery and production material etc. shall be allocated to the large households of the real sense. Positive support shall be offered to large households in respect of taxes, insurance and bank credit etc. In addition, various services necessary for production and operation shall be provided to the large households, ensuring an optimal and harmonious external environment for their development. Meanwhile, the development of large livestock and aquaculture households as well as breeding aquatics villages shall also be supported, thus to promote scale breeding and improve the scientific breeding level as well as breeding benefits comprehensively.

3.2 Developing multiple forms of socialized agricultural services (i) It is recommended to develop pre-production, in-production and post-production services. Supporting the development of a wide range of socialized services, including agricultural technology guidance, agricultural material distribution, pest control, mechanized cultivation, sowing & harvesting, marketing, processing & storage, product transportation, information consultant and technical training. These services shall be provided with innovative content and in new ways according to the new social requirements, thus to achieve the effect of scale promotion. (ii) It is recommended to encourage diversified services of various forms. Mobilizing the enthusiasm of all sectors; support various service forms and organizations including large agricultural machinery households, cooperatives, and production & marketing service enterprises; and offer services that are suitable for the actual demand in local production. In this way, form a service pattern with diversified service subjects and various kinds of service content and forms. (iii) It is recommended to attract social forces to participate in agricultural services by means of market mechanism. Agricultural services can be either non-profit or for-profit. No matter what, more social capital can be attracted to the field of agricultural services through market mechanism to speed up the process of socialized services. (iv) Government sectors shall play a good role in organization, coordination and services. The organization and coordination of government sectors constitute an important part of socialized services. It can play an important role in various areas, and is also a good opportunity for the transformation of government functions. Government sectors shall provide support in respect of funds, technology and policy etc.; establish and maintain good market order; and play a positive role in promoting various security services.

3.3 Striving to develop agriculture industrialization One of the important characteristics of agriculture industrialization is that the leading enterprises engaged in processing and sales of agricultural products form a production benefit community together with raw material production bases. In order to meet processing needs, the bases must be linked together in a continuous area to form a certain scale, and should also carry out standardized production according to the requirements of the enterprises. At present, some large leading enterprises have linked thousands of households for production, and many enterprises also provide related services needed for the households. Therefore, agriculture industrialization is also an effective form of scale operation development that is suitable to our national conditions and integrates processing increment together with socialized services. We need to strengthen the support and speed up to develop leading enterprises with good potential for growth and strong driving force. In addition, we need to further improve the benefit coupling mechanism, drive more households to enter the production base, and increase agricultural economic benefits and rural income greatly.

3.4 Accelerating regional distribution of advantageous agricultural products According to the factors including resource conditions, market elements and industrial basis, define the most important advantageous agricultural products as well as their advantageous producing regions. Later, carry out scientific planning and provide priority support, thus to improve the production concentration, yield, quality and market competitiveness of our advantageous agricultural products. This process itself is also a scale expanding of macro layout. On this basis, favorable conditions are created for the large-scale production of related industries. According to national requirements on the regional distribution planning of advantageous agricultural products, we need to further strengthen the construction of industrial belt; promote standardized production, industrialized operation and socialized services in advantageous regions; and drive to improve the level of scale and specialized production. Therefore, the industrial region of advantageous agricultural products is also the area that takes the lead in scale development. The comparative advantages and agricultural comprehensive benefits can be brought into fuller play by means of scale and specialized production.

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tuation. The optimal order quantity decreases in the fluctuation and the return percentage. The quantity flexibility contract will lose efficiency if the exchange rate fluctuates dramatically. In Fig. 2, X axis indicates different fluctuation ranges, and Y axis indicates the revenue shares. Fig. 2 shows that the revenue sharing contract is influenced by the exchange rate fluctuation. The optimal order quantity will exceeds the centralized order quantity, since the supplier will transfer part of extra profit to the retailer. In Fig. 3, X axis indicates different fluctuation ranges, and Y axis indicates the revenue shares. With this combined contract, the return percentage can be derived from the equation $\lambda_c + \Omega_c = 1$. Fig. 3 shows that with this combined contract, the exchange rate risk and the demand risk can be managed at the same time, and the optimal order quantity is exactly the centralized order quantity.

7 Conclusions

In the global supply chain, the exchange rate fluctuation is an important uncertainty factor. We considered the quantity flexibility contract and the revenue sharing contract in a decentralized global supply chain, analyzed the impacts of exchange rate fluctuation on the quantity flexibility contract and the revenue sharing contract. Based on our research, we can draw the following conclusion. Though both the quantity flexibility contract and the revenue sharing contract can diminish the demand risk, the differences in transfer payments lead to a different performance in the global supply chain. The exchange rate risk increases the supplier's expected profit with the revenue sharing contract while decrease the supplier's expected profit with the quantity flexibility contract. With the combined contract, the demand risk and the exchange rate risk can be managed at the same time. Hence to let the optimal order quantity equal to the centralized order quantity. So far, there have been few studies focusing on the coordinating contracts in the global supply chain, and the coordinating studies are even rarer. In the future research, there are several interesting extensions. First, in the global supply chain, most of the existing literature only concerned one kind of risk. In order to maximize the performance of global supply chain, how to manage different risks simultaneously is a crucial issue. How to evaluate the total profit of the global supply chain is also an important question. Since node-enterprises often use different currencies, an appropriate evaluation of global supply chain's total profit is the precondition for the global supply chain coordination.

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3.5 Promoting progress in agricultural science and technology comprehensively In order to promote large-scale agricultural operation and develop modern agriculture, the key is to improve the application level of agriculture science and technology, transform the agricultural development model, and transfer agricultural development to the path that relies on technological progress and higher labor quality. We need to further promote independent innovation in agricultural science and technology, speed up the transformation and application of technological achievements in agriculture, and foster new farmers with knowledge, technology and management ability. Scale operation and technological progress are both important factors of agricultural modernization. They are mutually conditional with mutual promotion effects. Promote the process of scale operation through technological progress and give full play to science and technology by means of scale operation, thus to achieve higher land output, resource utilization rate and labor productivity required by modern agriculture. With "scale operation + technological progress", the road to agricultural modernization will achieve greater progress.