Challenges and Policy suggestions for China's Agricultural Modernization

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Abstract: Agriculture is the foundation of national economy. Since 1960, China's agricultural modernization has made remarkable progress, but it is still faced with great challenges in agricultural efficiency, transformation, and farmers' quality. China's agricultural modernization needs to focus on three key points, make efforts in three aspects, and realize three transformations. (1) The three key points are: modernization of agricultural efficiency, of agricultural structure, and of farmers. (2) The three aspects are: agricultural innovation system, farmers' training, and agricultural regionalization. (3) The three transformations are: transformations from food-dominated to nutrition-dominated, from yield-dominated to benefit-dominated, from production and supply-oriented to market demand-oriented.

Agriculture is the cornerstone of human civilization. Without agriculture, there is no continuation of humankind or prosperity of human civilization. Agricultural modernization is the world frontier of agricultural development, and the actions and process of reaching and keeping up with the world frontier. The frontier process of agricultural modernization during the 18th-21st centuries can be divided into two stages. The first agricultural modernization (1763 - 1970) is the transition process from traditional agriculture to primarily modern agriculture and from self-sufficient agriculture to market-based agriculture. The second agricultural modernization (1970 - 2100) is the transition process from primarily modern agriculture to highly modern agriculture and from industrialized agriculture to knowledge-based and ecological agriculture (He Chuanqi, 2012).In policy terms, there are two major objectives for national agricultural modernization: to improve agricultural productivity and farmers' quality of life, and to maintain the stability of agricultural ecosystem and national food safety. The goal of developed countries is to maintain the world's advanced level in agriculture, while that of developing countries is to catch up with and reach the world's advanced level in agriculture.

China is still a country with preliminarily developed agriculture. Although China's agricultural modernization has made remarkable achievements since 1960, with some agricultural indicators already reaching the world's advanced level and the international gaps of some other agricultural indicators gradually narrowing, yet it is still faced with great challenges in agricultural efficiency, transformation, etc.

I. Two Large Gaps Concerning China's Agricultural Labor Productivity

The convergence of agricultural and non-agricultural rates of return is an important aspect of agricultural modernization, and the key to reaching such a convergence is the improvement of agricultural labor productivity. Agricultural labor productivity affects agricultural development, farmers' income, rural economic growth, etc. (Gao Fan, 2016). In 2012, China's per unit yield of cereal, per unit yield of rice and wheat reached the level of developed countries, per unit yield of corn reached the level of moderately developed countries, but China's agricultural labor productivity[1] was only over 50% of the world's average level, about 3% of the average of high-income countries, and about 1% of that of the United States and Japan. Therefore, China's agricultural modernization is quite unbalanced with "one long leg" (high land productivity) and "one short leg" (low labor productivity). On one hand, China's agricultural labor productivity has increased significantly since 1960; in 2012, China's agricultural labor productivity was 615 dollars per person (Table 1), which was over 5 times of that in 1960 (Table 2). On the other hand, there are still two large gaps concerning China's agricultural labor productivity.

First, there is a large gap between China's agricultural labor productivity and the world's highest level. According to the *World Development Indicators* of the World Bank (Table 1), in 2012, China's agricultural labor productivity was 615 dollars, while the world average was 1097 dollars per person, which was nearly 2 times of the former; the average level of high-income countries was 19908 dollars, which was over 30 times of that of China. In 2012, France's agricultural labor productivity was 59401 dollars, which was nearly 100 times of that of China. The US's labor productivity was 51881 dollars, which was over 80 times of that of China (Table 1).

Second, the relative gap between China's agricultural labor productivity and industrial labor productivity is over 10 times (Table 2). Since 1960, China's modernization actually follows the strategy of unbalanced industrial development where the agricultural sector is used to support the industrial sector. As a result, industrialization is faster than agricultural modernization, and the gap between the two sectors is widening. For example, from 1960 to 2012, the absolute gap between China's agricultural labor productivity and industrial labor productivity has widened from over 400 dollars to over 7300 dollars, and the relative gap has widened from 5 times to 13 times (Table 2). The difference between industrial and agricultural labor productivity has already seriously affected China's labor productivity level.

The relatively low agricultural labor productivity has become a bottleneck constraining China's agricultural modernization. Increasing the agricultural labor productivity will become a fundamental task and priority in China's agricultural modernization.

[1] In this paper, the agricultural labor productivity is represented by the agricultural value-added of each agricultural laborer, and the agricultural value-added is the dollars calculated at 2000 constant price.

Table 1 Gap between China's and world's agricultural labor productivity in 2012

Country/Region	Agricultural labor productivity	Index of agricultural labor productivity
China	615	100
High-income countries	19908	3237
World average	1097	178
The United States	51881	8436
Japan	37757	6139
Germany	28079	4566
The United Kingdom	23736	3859
France	59401	9659
Australia	41028	6671
Italy	39275	6386
Russia	4865	791
Mexico	3392	552

Source: World Bank, 2015. The agricultural labor productivity is calculated at 2000 constant price.

Table 2 Gap between China's agricultural and industrial labor productivity from 1960 to 2012

Item	1960	1970	1980	1990	2000	2005	2012	2012/1960
Agricultural labor productivity / dollars in 2000	110	164	183	263	364	439	615	5.6
Industrial labor productivity / dollars in 2000	547	609	681	1263	4382	5060	7958	14.5
Industry - Agriculture	437	445	498	1000	4017	4621	7343	
Industry ÷ Agriculture	5	4	4	5	12	12	13	

Source: World Bank, 2015.

II. China's Nutrient Structure Has Changed, but Still Has a Gap from High-income Countries

In recent years, the average nutritional status of Chinese people has significantly improved, the consumption of animal nutrition has significantly increased, and Chinese people's food consumption structure is changing remarkably. This is mainly shown in the fact that the per capita demand for and consumption of grain have approached the limit, and that the per capita demand for vegetable oil and fruits, per capita demand for animal nutrition, dairy, and meat, and per capita demand for feed cereal have all significantly increased.

(1) China's Consumption Structure for Agricultural Products Has Changed

First, the average nutrition supply of Chinese people is increasing. According to the data of the United Nations Food and Agriculture Organization (FAO), in 2011, the per capita nutrition supply in China was 3075 kcal/day, which was over 2 times of that in 1961 (Table 3); the per

capita animal nutrition supply was over 10 times of that in 1961; and the proportion of animal nutrition was over 5 times of that in 1961 (Table 4).

Table 3 International comparison of per capita nutrition supply in China from 1961 to 2011 (unit: kcal/day)

Region	1961	1970	1980	1990	2000	2005	2011	2011/1961
China	1415	1840	2146	2504	2806	2877	3075	2.17
The United States	2880	3029	3178	3493	3755	3833	3639	1.26
The United Kingdom	3231	3279	3116	3242	3363	3440	3414	1.06
Japan	2525	2738	2799	2949	2900	2828	2719	1.08
Mexico	2300	2539	2999	2969	3037	3065	3024	1.31
Brazil	2209	2405	2698	2720	2880	3078	3287	1.49
India	2010	2111	1994	2204	2378	2267	2459	1.22
High-income countries	3016	3175	3306	3374	3465	3486	3523	1.17
World average	2193	2388	2489	2619	2726	2761	2868	1.31
China ÷ World	0.65	0.77	0.86	0.96	1.03	1.04	1.07	

Source: FAO, 2015.

Table 4 Nutrition supply and food consumption in China from 1961 to 2011

Indicator	Unit	1961	1970	1980	1990	2000	2005	2011	2011/1961
Per capita nutrition supply	**kcal/day**	1415	1840	2146	2504	2806	2877	3075	2.17
Per capita animal nutrition supply	**kcal/day**	58	115	177	313	572	639	689	11.88
Per capita plant nutrition supply	**kcal/day**	1411	1772	2029	2299	2335	2335	2386	1.69
Proportion of animal nutrition	%	4	6	8	13	20	22	22	5.50
Per capita protein supply	**g/day**	40.3	46.9	55.1	67.5	86.2	89.4	95	2.36
Per capita fat supply	**g/day**	15.6	24.5	35.1	56.4	81.1	87.8	93	5.96
Per capita cereal consumption	**kg/year**	93	131	157	178	165	156	153	1.65
Per capita meat consumption	**kg/year**	4	9	15	26	50	54	57	14.25
Meat consumption index	Meat/cereal consumption	0.04	0.07	0.09	0.15	0.30	0.35	0.37	9.25

Source: FAO, 2012, 2015.

Second, the per capita cereal consumption in China has a limit. Since 1961, the per capita cereal consumption in China (not including beer consumption) has increased from 93 kilograms to 182 kilograms in 1984, and then gradually decreased to 153 kilograms in 2011 (Table 4). From 1961 to 2011, the proportion of cereal consumption in China has decreased from 64% to 53%, and

the proportion of feed cereal has increased from 19% to 31%.

Third, China's consumption of non-cereal agricultural products has significantly increased. From 1961 to 2011, the per capita consumption of cereal in China increased by 65%, the per capita consumption of meat increased by over 12 times, the meat consumption index increased by over 7 times, and the consumption of fat increased by over 4 times. Regarding consumption of plant-based food, the per capita consumption of fruits, vegetable oil, and vegetables respectively increased by over 13 times, 6 times, and 2 times. Regarding consumption of animal-based food, the per capita consumption of eggs, dairy, and fish respectively increased by over 10 times, 7 times, and 4 times.

(2) China's Nutrition Supply Lags Behind Some Countries

China's per capita nutrition supply has already exceeded the world's average level, but it still lags far behind the average level of high-income countries. Since 2000, China's per capita nutrition supply has already exceeded the world's average level (Table 3). In 2011, China's per capita nutrition supply, per capita animal nutrition supply, per capita plant nutrition supply, per capita protein supply, per capita fat supply, and per capita meat consumption have all exceeded the world's average level, but they still fell far behind the average level of high-income countries (Table 5).

Table 5 Comparison of nutrition supply and food consumption between China and other countries in 2011

Region	Per capita nutrition supply	Per capita animal nutrition supply	Per capita plant nutrition supply	Per capita protein supply	Per capita fat supply	Per capita cereal consumption	Per capita meat consumption	Meat consumption index
Unit	kcal/day	kcal/day	kcal/day	g/day	g/day	kg/year	kg/year	Meat consumption / cereal consumption
China	3075	689	2386	95	93	153	57	0.37
The United States	3639	995	2644	109	162	106	118	1.11
The United Kingdom	3414	989	2425	103	138	114	83	0.73
Japan	2719	553	2166	88	87	104	49	0.47
Mexico	3024	613	2411	85	93	158	61	0.39
Brazil	3287	803	2484	95	116	114	93	0.82
India	2459	228	2232	60	52	152	4.2	0.03
High-income countries	3523	1124	2399	106	152	115	87	0.76
World average	2868	507	2362	80	83	147	42	0.29
China ÷World	1.07	1.36	1.01	1.19	1.12	1.04	1.36	1.30

Source: FAO, 2015.

As the main sector for grain production and nutrition supply, China's agriculture is still faced with many challenges in guaranteeing food supply in the context of consumption structure transformation.

III. Policy Suggestions

China's agricultural modernization can make use of the experience of developed countries, and exert its own advantages, make up for the weaknesses in the modernization process, and develop a canal path for agricultural modernization through continuous innovations. The content may include: coordinating the two periods of agricultural modernization and continuing to transform towards the second agricultural modernization; coordinating the market-oriented development, mechanization, IT application, green development and internationalization of agriculture, accelerating the industrial restructuring and upgrading in agriculture, enhancing agricultural efficiency and farmers' income, improving farmers' welfare and quality of life, reducing the proportion of agricultural value-added and the employment in agriculture, enhancing the international competitiveness in agriculture.

China's agricultural modernization may focus on three key points, make efforts in three aspects, and realize three transformations. (1) The three key points are: modernization of agricultural efficiency, modernization of agricultural structure, and modernization of farmers. (2) The three aspects are: agricultural innovation system, farmers' training, and agricultural regionalization. (3) The three transformations are: transformations from food-dominated to nutrition-dominated, from yield-dominated to benefit-dominated, from production and supply-oriented to market demand-oriented.

1. Establishing the Agricultural S&T Responsibility System, and Improving China's Agricultural Innovation System

Agricultural labor productivity is the weakest point in China's agricultural modernization. Increasing the agricultural labor productivity should become the priority in China's agricultural modernization. The main approaches to increasing agricultural labor productivity include increasing farmers' per capita capital, increasing farmers' skills, agricultural technological progress, optimization of resources allocation, and economies of scale. Among them, building an agricultural innovation system, increasing the ratio of agricultural scientific and technological input, and increasing agricultural innovation and agricultural technological service capacity are important to increase agricultural production efficiency.

We suggest that a new agricultural science and technology innovation system should be built that adapts to the development of modern agriculture. This innovation system may include two levels: the national agricultural innovation system and regional agricultural innovation system. The national agricultural innovation system consists of national scientific research institutes, comprehensive universities, and central government-owned enterprises pertaining to agricultural

science and technology. The regional agricultural innovation system is formed at provincial scale, agricultural universities are the hinge, and agricultural enterprises are the backbone.

A regional agricultural S&T responsibility system should be built in which agricultural universities are responsible for the agricultural S&T services and personnel training in the local province. Efforts should be made to promote the regrouping of agricultural scientific research institutes and agricultural universities, and form a regional agricultural S&T center. Priority should be given to exerting the role of key modern agriculture enterprises and agricultural cooperatives, and enhancing the skills of all farmers.

The specialized agricultural websites should be used as the platform; the research and promotion of agricultural advanced technologies should be used as support; the collection, organization, and popularization of information should be taken as the link; the market demand should be taken as the orientation. On such a basis, a virtual and flexible innovation service network should be built to promote cooperative innovation and technological transfer, improve the responsiveness, adaptability, and risk management capacity of agriculture, and enhance the innovation capacity and agricultural efficiency.

2. Implementing New Farmers' Training Program and Comprehensively Improving Farmers' Quality

Another important approach to increasing agricultural labor productivity is to improve farmers' quality. We suggest that a farmers' training program be carried out to train a new generation of farmers who are adaptable to market and being professional.

We suggest that 12-year compulsory education be gradually popularized in rural areas on the basis of 9-year compulsory education. To young and middle-aged farmers, "free skill training" or "non-profit skill training" should be provided. Full-time farmers who are engaged in farming for over 10 months should receive agricultural skill training; main-job farmers who are engaged in farming for 4 to 10 months or part-time farmers who are engaged in farming for less than 4 months should receive agricultural skill training and work skill training, so that their employability can be enhanced.

The fees for rural free compulsory education and farmers' training may be coordinated and shared by central finance and provincial finance. The trainers may come from teachers of agricultural universities, agricultural research institutes, or promotion organizations.

3. Revising the Agricultural Regionalization, and Realizing the Coordinated Development of the Three Agricultural Types

Accelerating the agricultural restructuring and promoting agricultural transformation is an important aspect of agricultural modernization in China. The main approaches to agricultural transformation include transfer of agricultural labor force and transformation of agricultural production, agricultural economy, agricultural elements and agricultural ecological environment. Agricultural restructuring not only requires coordination with other material sectors, but also requires reasonable allocation among all agricultural sectors and all crop production; therefore, the

agricultural regionalization is of important guiding significance. The agricultural regionalization can scientifically forecast the development direction of agricultural production, and can effectively guide the current agricultural restructuring and formulation of the medium- and long-term development plan for agriculture.

In 1985, the Integrated Agricultural Regionalization of China divided the country into 10 first-level integrated agricultural regions and 38 second-level regions. The tenth region was the marine fishery region, and the other nine regions were called the nine integrated agricultural regions (Table 6).

With the advancement of China's industrialization, urbanization and globalization, and with the formation of a high-speed transportation network, also people's nutritional structure and demand have changed tremendously, the original agricultural regionalization needs revision.

Table 6 Integrated Agricultural Regionalization of China

Division type	Main regions
Comprehensive division	Northeast China farming-forest region, Inner Mongolia and Great Wall-side pastoral-farming-forest region, Huang-Huai-Hai farming region, Loess Plateau farming-forest-pastoral region, middle-lower Yangtze farming-forest culture region, Southern China farming-forest tropical crop region, Southwest farming-forest region, Gansu-Shinjang farming-pastoral-forest region, Tibetan Plateau pastoral-farming-forest region, marine fishery region
Geographical division	Southern China paddy farming region, Northern China dry farming region, Northwest pastoral and irrigation farming region, Qinghai-Tibet alpine pastoral and farming region

We suggest that the integrated agricultural regionalization of China should be revised once every ten years according to the three standards which are the principles of "agricultural science, economic geography, and ecology". This new integrated agricultural regionalization can be briefly called the "three-dimensional based regionalization" (Table 6).

Table 6 Three types based on human and economic geography for China agriculture

Region type	Characteristics	Agricultural types to be mainly developed (examples)
Urban agriculture	High land rent, dense population, close to market	Capital-intensive agriculture, facility agriculture, factory farming, contract farming, etc.
Suburban agriculture	Relatively high land rend, relatively dense population, close to market	Organic agriculture, ecological agriculture, leisure agriculture, part-time farming, etc.
Rural agriculture	Low land rent, sparse population, high transportation cost	Large-scale agriculture, specialized agriculture, precision agriculture, tourism agriculture, etc.

Note: The development of the three region types are relative and may overlap.

From the perspective of economic geography, Chinese agriculture can be divided into "urban agriculture, suburban agriculture, and rural agriculture". Different regions have different features, and different agricultural focuses.

The above text briefly analyzes the challenges facing China's agricultural modernization

process and the policy suggestions for them. Agricultural modernization is a complicated systematic project. According to the past experience of developed countries, the process of agricultural modernization is also a process in which the ratio of agriculture declines (Bai Yueshi, 2004). To realize this, it is impossible to simply rely on the agricultural sector itself; great efforts must be made to develop the secondary and tertiary sectors, and enhance their capacity to largely absorb the rural labors. In the process of agricultural modernization, the "regurgitation-feeding" of the secondary and tertiary sectors to agriculture would be indispensable.

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