

National and Regional Food Security and Sustainable Development Against the Backdrop of Internationalization and Greenization

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Abstract: To grasp the major contradictions of China's regional food security in the new era is the precondition for ensuring national food security. This paper introduces the current situation and the major challenges of China's regional food security, analyzes the change trend of supply and demand and development potentials for regional food security, and presents corresponding strategic visions for future development. Furthermore, it proposed several policy suggestions for ensuring China's regional food security, including implementing the dual responsibilities of food security assurance and environment protection by governments at all levels, rationally planning major special funds for regions, fostering novel business entities, and promoting modern agriculture by improving its quality.

Keywords: internationalization; greenization; food security; sustainable development

1 Introduction

Food is an important strategic commodity for any country and directly affects people's livelihoods, particularly in countries where agriculture is a major economic contributor. In China, although grain production has increased consistently, the country is confronted with challenges related to resources, markets, climate, and ecology. Thus, it is imperative to implement a national food security strategy that takes cognizance of these challenges. Against the background of internationalization and greening, this study analyzes the mechanisms that can help China take full advantage of its natural endowments. The study divides China into six regions, exploring the decisive role that the market can play, and examines ways to promote the optimal allocation of resources, the environment, and modern production factors to form a population distribution and food production layout that is sustainable.

2 Status of regional food security in China

2.1 The overall pattern of food security

Since its reform and opening up, China's total food supply has kept pace with its demand, with a steady increase in the food production capacity and improvement in residents' nutrition and health conditions. However,

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agricultural non-point source pollution has emerged as a serious problem and green development faces significant challenges.

2.1.1 Food production capacity has gradually increased, and quality and safety levels have steadily improved.

China's grain production as a whole has witnessed a continuously increasing trend, both in terms of output and yield. The total grain output increased from 3.05×10^8 t in 1978 to 6.58×10^8 t in 2018, an increase of 116%, while the yield increased 122% from 2527.3 kg/hm² to 5607.4 kg/hm². Over the same period, sugar output increased by 4.01 times, oil output increased by 5.58 times, vegetable output increased by 1.73 times, meat output increased by 7.12 times, dairy product output increased by nearly 40.0 times, aquatic product output increased by 12.89 times, and fruit output increased by 38.10 times (Fig. 1). The output of animal products (including meat, eggs, milk, and aquatic products) has grown at an average annual rate of 7.1% during this period. With the intensification of monitoring, the quality and safety of edible agricultural products have improved, and the overall pass rate in sampling inspections has stabilized at more than 95% for many years, with this figure being 97.5% in 2018. The pass rates of vegetables, fruits, tea, livestock and poultry products, and aquatic products were 97.2%, 96.0%, 97.2%, 98.6%, and 97.1%, respectively. The pass rate of random inspection on Ractopamine in livestock products was 99.7%. These data point to continuing improvement in the quality and safety levels of agricultural products in China.

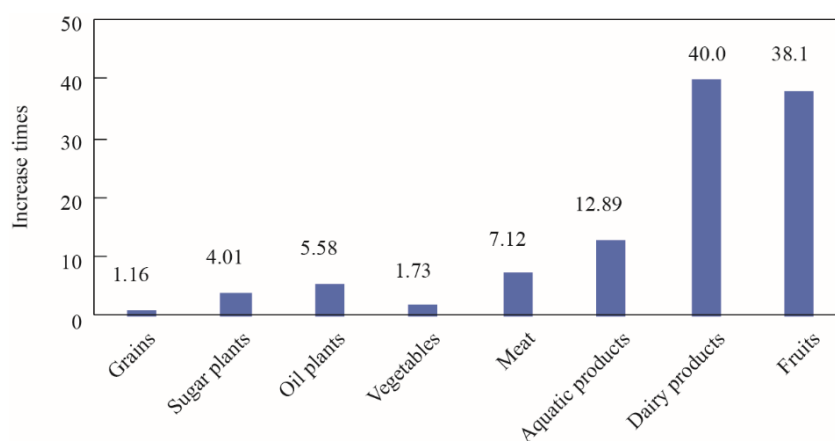


Fig. 1. Increase times of main food production in China in the past 40 years.

Source: Calculated using data from the National Bureau of Statistics.

2.1.2 The level of food consumption has further improved, and the nutritional status of residents has improved markedly.

Food production has boosted farmers' income and improved their living standards. As the income level of residents increased, the Engel coefficient decreased, and the dietary structure of urban and rural residents further improved. In 2017, the per capita consumption of grains (raw grains) for urban residents was 109.7 kg, edible oil 10.7 kg, vegetables 106.7 kg, meat 29.2 kg, poultry 9.7 kg, aquatic products 14.8 kg, eggs 10.9 kg, dairy products 16.5 kg, and dry and fresh fruits 59.9 kg. As against this, the per capita consumption of food grains for rural residents was 154.6 kg, edible vegetable oil 10.1 kg, vegetables 90.2 kg, meat 23.6 kg, poultry 7.9 kg, aquatic product 7.4 kg, eggs 8.9 kg, dairy products 6.9 kg, and dry and fresh fruits 35.1 kg (Fig. 2). Overall, the nutritional level of China's residents ranks among the top in developing countries.

2.1.3 Foreign trade dependence increased, China turned into a net importer of bulk agricultural products, and the import value in the Eastern region exceeded 80% of the national total.

Since joining the World Trade Organization, China's trade in agricultural products has continued to develop rapidly and its trade pattern has changed significantly. In 2017, foreign trade dependence (the ratio of agricultural trade value to agricultural output value) exceeded 20%. In recent years, while soybean, cotton, and vegetable oil imports have continued to remain high, and import of sugar and dairy products have increased significantly, and China has turned into a net importer of all major food crops [1]. The increase in the import volume of most products was due to the difference between internal and external prices. In terms of different regions, China's agricultural trade is still dominated by the Eastern region. In 2017, the value of export and import of agricultural products from the Eastern region accounted for 68.1% and 81.7% of the country's total, respectively. The top five

agricultural exports were aquatic products, vegetables, livestock products, fruits, and beverages, while the five major imported agricultural products were edible oilseeds, livestock products, cereals, aquatic products, and edible vegetable oils.

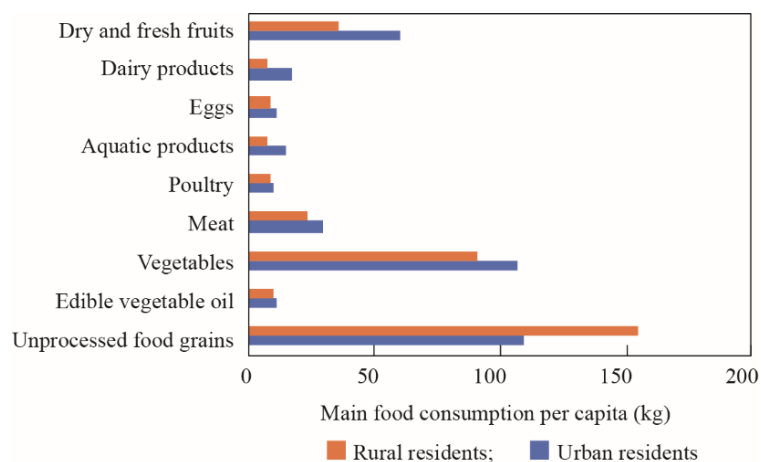


Fig. 2. Main food consumption per capita of urban and rural residents in 2017.

Source: Calculated using data from the National Bureau of Statistics

2.1.4 Endogenous environmental problems are becoming increasingly prominent, and fertilizer and pesticide application intensity remain high.

China is the world's largest producer and user of chemical fertilizers, and agricultural fertilizer application rates are increasing rapidly. Currently, China accounts for about 35% of the world's total fertilizer consumption with about 8% of the world's arable land. An excessive and unreasonable application of fertilizers has caused serious agricultural non-point source pollution. The use of pesticides has continued to increase due to the increasing resistance of pests resulting in its extensive application. However, in 2016, zero growth in pesticide use was achieved across the country.

2.2 Changes in regional food security

2.2.1 The pattern of production areas has changed, and the focus of production has shifted from South to North and from East and West to Central China.

(1) Changes in the pattern of grain production from South to North and East and West to Central China.

The grain output of the Northern region exceeded that of the Southern region in 2005, and "the Northern grain transportation to the South" has become a new feature of the North-South distribution of grain production. At the same time, the distribution of grain production in the Eastern, Central, and Western regions has also changed significantly. The grain output in the East and West have fallen considerably while increasing rapidly in the Central region.

(2) Changes in food crop production distribution in the six regions

In 1978, among the six major grain-producing regions in China, Central China accounted for the largest output of food crops, followed by North China, Southwest China, Southeast China, Northeast China, and Northwest China. With the advancement in the reform and opening up, the situation of grain production across various production areas has changed dramatically, which has changed the layout of grain production in China (Fig. 3). Central China continued to remain the largest producer of grain in 2017, accounting for 23.84% of the country's total grain output. The shares of grain production of North China, Northeast China, Southwest China, Northwest China, and Southeast China in the country's total grain production were 24.16%, 21%, 13.8%, 13.4%, and 3.8%, respectively. Among them, Southeast China is the only region in the country where total grain production has declined.

2.2.2 Regional food self-sufficiency is uneven, higher in Northeast, North, and Central China, and lower in Southwest and Southeast China.

This study categorizes food into three levels: one is rations, including rice and wheat; the other is grains, including rice, wheat, and corn; and the third is food, including rations and converting meat, eggs, and milk into equivalent feed grains. According to our calculations, the national per capita consumption in 2015 was 248

kg/person for rations, 424 kg/person for grains, and 450 kg/person for food. The gaps in production and demand—defined as the self-sufficiency rates—for rations, cereal grains, and grains calculated for various regions are illustrated in Table 1. As is evident, China’s regional food self-sufficiency rate is unevenly distributed—higher in the Northeast, North, and Northwest, and lower in Central, Southwest, and Southeast China. The self-sufficiency rate of ration in the Southwest, Northwest, and Southeast regions is less than 100%; the self-sufficiency rate of cereal grains in the Central, Southwest, and Southeast regions is less than 100%; the self-sufficiency rate of grains in all regions except Northeast China is less than 100%; and the self-sufficiency rate of food in Central, Southwest, and Southeast China is less than 100%.

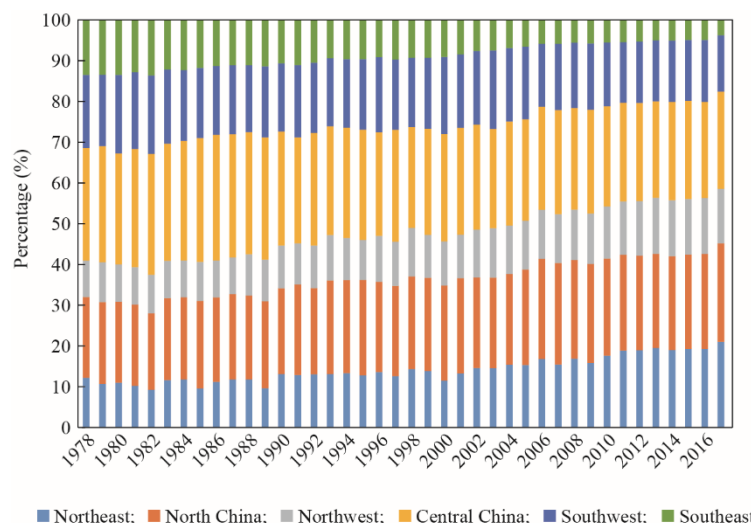


Fig. 3. Changes in the share of grain output of the six regions of China (1978–2017).
 Source: Calculated using data from the National Bureau of Statistics.

Table 1. Self-sufficiency rate of ration, cereal grains, grains, and food in different regions of China (%).

Region	Ration	Cereal grains	Grains	Food
Northeast China	143.0	227.4	225.3	100.7
North China	107.2	100.6	91.5	112.5
Central China	169.8	98.0	87.8	86.7
Southeast China	34.9	23.9	18.4	59.8
Northwest China	50.0	103.4	95.3	106.8
Southwest China	68.4	68.0	64.5	84.6

Source: Calculated using data from the National Bureau of Statistics and survey data.

2.2.3 Obvious regional characteristics of grain consumption.

Rice consumption is mainly concentrated in East, South Central, and Southwest China, while corn is mainly concentrated in South, East, and Southwest China, and wheat in East, South Central, and North China.

From a regional perspective, due to factors such as dietary habits, rice consumption is mainly concentrated in East China, South Central China, and Southwest China. From 2000 to 2017, the proportion of rice consumption in the three regions did not change much, remaining above 80% of the total grain consumption; however, the consumption amount decreased by 41.77% during this period. Corn consumption, which is mainly concentrated in Central and South China, East China, and Southwest China, increased by 188.84%, while the share of corn consumption increased by 8.88% during the 2000–2017 period. Wheat consumption is mainly concentrated in East, Central South, and North China, which together accounted for 70.99% of total Chinese grain consumption. Wheat consumption in Central and South China has gradually decreased.

2.2.4 Regional food supply and demand imbalances have intensified, and the distribution pattern has changed significantly.

The regional supply and demand pattern of grains in China has changed—production has become more concentrated while production and sales have become more differentiated. This differentiation has transformed the

original production and sales within the province and the region into cross-province and cross-region production and sales, leading to a change in the pattern of regional food circulation. The pattern has shifted from “Southern grain transportation to North” to “Northern grain transportation to the South,” with this pattern getting further strengthened every year. Three types of grain circulation areas have been formed currently, and six inter-provincial logistics channels ensure the balance between regional production and sales. The three types of food circulation areas are net food outflow areas, including the Northeast and the Huang–Huai–Hai region; rice outflow and corn inflow areas, including the middle and lower reaches of the Yangtze River (Hubei, Hunan, Jiangxi, Northern Jiangsu, and Southern Anhui), which is both a rice outflow and a corn inflow area; and the net food inflow areas, including the Southeast coastal area, South China, and Beijing–Tianjin area. China has constructed six major inter-provincial grain logistics channels to ensure the balance between grain production and sales regions. The grain outflow channels are grain (corn, soybean, and rice) outflow channels in Northeast (Inner Mongolia, Liaoning, Jilin, and Heilongjiang); wheat outflow channels in the Huang–Huai–Hai region (Hebei, Henan, Shandong, and Anhui); and rice outflow channels in the middle and lower reaches of the Yangtze River (Sichuan, Hubei, Hunan, Jiangxi, Anhui, and Jiangsu). All these three channels bring together the grains from 14 major grain-producing provinces. The grain inflow channels include the ones in the East China coastal main sales area, the South China main sales area, the corn inflow channel in the middle and lower reaches of the Yangtze River, and the Beijing and Tianjin main sales area.

3 Regional food security faces problems in the context of green internationalization

3.1 Universal problems in regional food security

3.1.1 Agricultural products generally lack international competitiveness.

Currently, China is actively promoting the development of a new open economy and is actively integrating and adapting to global economic and trade rules. However, the cost and price of agricultural products in China are generally not competitive, and the quality is still not high. In recent years, China’s agricultural production costs have continued to rise, and the prices of agricultural products have risen firmly. Further, it is difficult to meet the demand for high-quality high-end agricultural products through domestic production, where the quality standards are low. Domestic rice quality research is relatively low, with a shortage of excellent breeding materials.

3.1.2 Resources and environmental constraints are increasingly threatening green development.

Although the rate of contribution of science and technology in the agricultural field has been increasing annually, the extensive growth model of agricultural development, which has relied on resources and investment for a long time, has not fundamentally changed. Due to the shortage of agricultural resources, excessive development, serious non-point source pollution, and pesticide and excessive heavy metal residues in some areas, the issues of quality and safety of agricultural products, such as grains and vegetables, have become increasingly prominent. The agricultural and rural environments have become extremely polluted, and the agricultural ecosystem has been severely damaged.

3.2 Main regional issues in regional food security

3.2.1 Different regions in China face different challenges of resources and environment to promote green development.

Although agricultural production across the country is confronted with increasing pressures on resources and the environment, the issues faced by different regions are different.

(1) Northeast China faces challenges including black soil loss, the overexploitation of groundwater resources, and the insufficient utilization of surface runoff. According to the statistics of the Songliao Water Resources Commission of the Ministry of Water Resources, the black soil layer of the cultivated land in the Northeast Plain has fallen by 60–70 cm, and soil erosion is a critical issue. Currently, the West Liaohe River has exceeded the carrying capacity of water resources, and the development and utilization degree of water resources such as the Heilongjiang mainstream and Suifen River is only about 10%.

(2) In North China, the problem of groundwater funnel is severe, the development of water-adapted agriculture is critically lagging, and the scale of agriculture significantly exceeds the capacity of water resources. The promotion of water-saving irrigation technology in the North China plain has been insufficient, and the proportion of crops that require more irrigation water has continued to increase. Currently, the agricultural scale of North

China plain far exceeds the capacity of water resources, which critically threatens the sustainable development of regional irrigated agriculture.

(3) The application of chemical fertilizers and pesticides in Central China is increasing and land pollution is acute. In 2015, the amount of fertilizer applied in Central China reached 1.382×10^7 t, the use of pesticide reached 5.2×10^5 t, and that of the agricultural plastic film reached 4.2×10^5 t. The overall quality of cultivated land has declined, high-yielding fields have been decreasing while low- and medium-yielding fields have been increasing annually.

(4) The natural environment in Northwest China is restricted, and drought and water shortages are severe. Resource and engineering water shortage coexist. The total water resources in the Northwest account for about 10% of the country's total water resources. The extensive and disorderly management of water resources has led to its transitional and irrational use, which has worsened the water resources restriction on industrial development.

(5) Southwest China has been facing the twin challenges of more disasters and less arable land and is ecologically fragile. The disaster-affected area in the Southwest region was 6.294×10^6 hm², accounting for 27.71% of the total cultivated land area of the region. The arable land accounts for only 9.6% of the total land area and 18.2% of the total arable land in the country. Karst topography and rocky desertification have become major obstacles to social and economic development and food security in the Southwestern region. The ecological environment is complex and the contradictions between humans and land are acute.

3.2.2 Weak infrastructure in the Western region has not fundamentally changed.

The lower input levels in the Northwest and Southwest regions have restricted the development of modern agriculture. The agricultural science and technology development is in its infancy, with a weak foundation and incomplete system. The farmland water conservancy infrastructure in Northwest China is weak, and the investment in agricultural machinery and the proportion of mechanical farming have not increased significantly. The planned construction area of high-standard farmland accounts for an insignificant share of total farmland. The supporting role of information technology in the development of modern agriculture has not yet fully manifested, the independent innovation capacity of the modern seed industry is insufficient, the agricultural technology extension system is incomplete, and the achievements of the science and technology demonstration system are not substantial.

3.2.3 The problem of coordinated development of food security areas still exists.

(1) Imperfect coordination mechanism aggravates imbalances among food security regions

Due to the unreasonable distribution of benefits between major grain-producing areas and major marketing areas, the increase in income is not commensurate with the increase in grain production. Currently, the decline in the comparative benefits of grain production has caused an inversion of food prices, and the food subsidy mechanism is unreasonable. Under the current direct subsidy structure, the source of food subsidy funds has caused the phenomenon of food security costs in the main production areas, resulting in uneven distribution of benefits between main food production and sales areas. Under the current direct subsidy structure, the food security costs in the main sales areas are paid by the main production areas, resulting in the uneven distribution of benefits between the two areas.

(2) Poor comparative benefits of crops amplify the gap in regional food security development

The grain production in the main producing areas has increased consistently, but the comparative income derived from grain cultivation has gradually decreased. In fact, the prices of some grains have fallen, implying an increase in production to even retain the earlier level of income, thereby reducing farmers' enthusiasm for cultivating grains. The production quality of bulk agricultural and allied products is not high, resulting in an incompatibility between the supply structure of agricultural products and the structure of market demand. Further, the circulation of agricultural products is not smooth, resulting in a large backlog of agricultural products, falling prices, and increasing production without a commensurate increase in income.

(3) Imperfect coordination mechanism highlights conflicts in food security guarantees between regions

The South imports a great amount of food. Due to the lack of competitiveness in price and quality, major agricultural products such as corn and wheat cultivated in the major grain production areas cannot meet the demand of residents in the main sales areas, which has witnessed upgrading of agricultural consumption. As against this, the North is heavily stockpiled. In the past few years, with the changes in food demand and fluctuations in supply, the total grain imports in Central China's main sales areas have increased, from 9.855×10^6 t in 2010 to 1.798×10^7 t in 2015.

4 Supply and demand changes and development potential of regional food security

4.1 Trends in supply and demand for regional food security

The total supply of food in Northeast China exceeds demand. The area under rice cultivation is likely to exceed 1×10^8 mu ($1 \text{ mu} \approx 666.667 \text{ m}^2$) in 2030 and grain cultivation is projected to reach 1.8×10^8 t in 2035. Although Central China's food production has grown rapidly, food demand has grown steadily, and rations, vegetables, and aquatic products can be transported outside the region in large quantities. The supply and demand for food in the Southeast coastal areas is unbalanced. The self-sufficiency rate of food and milk is projected to drop below 30% and the food gap is expected to reach 7.625×10^7 t in 2035. Vegetables, fruits, and aquatic products can be easily transported outside the region. The Southwestern region has changed from a rations net outflow area to a net inflow area. The supply of non-grain food has increased sharply, while its demand has grown steadily. Vegetables and fruits can be transported outside in large quantities. Food supply in the Northwest region is growing slowly, and the self-sufficiency rate of rations is declining. Although large quantities of ration need to be transported to the region, vegetables, fruits, and milk can be transported outside in large quantities.

4.2 Analysis of the potential of green development

The total amount of cultivated land resources from North to South in China is basically balanced, although the regional differences are large. The amount of cultivated land is limited, is of medium quality, difficult to develop with very limited scope for productivity enhancement, thereby implying that the potential for ensuring food security is not substantial. At the same time, the contradiction of "water reduction and food increase" is prominent, and the lack of water resources has become a restrictive factor for food crop production, posing a huge threat to the sustainability of China's food security [2].

4.3 Analysis of the economic potential of coping with the impact of internationalization

4.3.1 Increased funding support for national and local agricultural policies

China has always attached great importance to the development of agriculture, rural areas, and rural residents, and has implemented a series of policies toward achieving this objective. Various agricultural subsidies were increased in 2004, agricultural taxes were comprehensively reduced or exempted in 2005, agricultural insurance was implemented in 2006, and the construction of a new countryside began in 2007. At the turn of the new century, 14 "Document No. 1 of the Central Government" were issued focusing on "agriculture, rural areas, and rural residents" and promoting the development of modern agriculture.

4.3.2 Reduced labor force and insufficient effective labor input

The agricultural labor force is the main driver of agricultural production. Given a certain level of mechanization and technology, the quantity and quality of labor input directly affect the food production capacity of a region. From 1978 to 2012, the proportion of China's agricultural labor in rural employed labor declined steadily throughout. This shows that a considerable amount of rural labor has shifted from agricultural production to secondary and tertiary industries that offer better income. Across many rural areas of China, most labor currently remaining in food production comprises women, children, or the elderly, indicating a lack of effective agricultural production labor.

4.3.3 The rapid accumulation of agricultural production support technology resources

China's agricultural production material equipment level and mechanization have greatly improved. In 2015, China's agricultural mechanization rate exceeded 62%, and it began to gradually shift from "agricultural mechanization" to "mechanized agriculture." The development of mechanized production has effectively improved labor productivity and the ability of agriculture to resist natural disasters and has accelerated the progress of agricultural production. This, despite a large reduction in labor, mechanized agriculture can effectively slow down the shrinking of the grain industry.

4.4 Analysis of the environmental potential of food security guarantee in green areas

4.4.1 Agricultural environmental pollution is a serious problem and it is difficult to prevent it.

The "three wastes" of industrial production and urban living—wastewater, waste gases, and industrial residuals—have spread to agricultural and rural areas, with the major soil pollutants exceeding the national

standard rate of 16.1%. Heavy metals such as cadmium, mercury, and arsenic are constantly penetrating the agricultural production areas, while sewage irrigation has caused problems such as the levels of heavy metals in soil exceeding safety standards. The utilization rate of fertilizers and pesticides, the comprehensive utilization rate of straw, the recovery rate of agricultural film, effective treatment rate of livestock and poultry manure, and treatment rate of rural garbage collection and village sewage need to be further improved. Agricultural and rural environmental pollution is spreading locally, which directly affects the quality and safety of agricultural products and the health of the people [3].

4.4.2 Ecologically fragile areas have a limited environmental carrying capacity.

The ecological environment in the Northwest and Southwest regions is relatively fragile, with limited resources and environmental carrying capacity, and agricultural infrastructure is relatively weak. With the intensification in global climate change, droughts have occurred in large areas in the Northwest and Southwest, and crop growth has been significantly affected. Insufficient efforts in farmland capital construction and construction of water conservancy facilities have resulted in a decline of input and output efficiency of agriculture and animal husbandry, with economic development adding to the pressure. With the implementation of policies such as returning farmland to forests and grasslands, high-standard farmland construction, and the ecological “red line” of cultivated land, the ecological and environmental conditions for regional food security have improved, and the environmental potential of food production has also increased.

4.5 Analysis of the potential of scientific and technological support for green development of regional food security in the context of internationalization

4.5.1 Science and technology innovation supports the sustainable development of agriculture.

China’s biotechnology and information technology have developed rapidly. Technologies such as advanced agricultural machinery and its usage, the Internet of Things, and molecular breeding are widely used in agricultural production. The technological models of rain-fed agriculture, water-saving agriculture, eco-agriculture, and circular agriculture are likely to accelerate their popularization and provide unprecedented technical support for sustainable agricultural development. Agricultural science and technology colleges and agricultural scientific research capabilities continue to increase, with agricultural science and technology talents being continuously cultivated. A new path for the development of modern agriculture with a combination of agricultural science, education, production, study, and research has been formed.

4.5.2 Regional differences in the contribution rate of agricultural scientific and technological progress are huge, and the technological advantage of increasing grain production is obvious.

Through scientific and technological innovation in recent years, fine breeds have cover all of China’s major crop varieties. The comprehensive mechanization rate of major crops for harvesting is 63.8%, and the forest coverage rate is 21.66%. In 2016, China’s agricultural science and technology progress contribution rate was 56%. It is projected that in 2030, the contribution rate of agricultural science and technology progress and the comprehensive mechanization rate of main crops will increase further. Thus, agricultural development has entered a new stage of relying more on scientific and technological progress.

5 Strategic conception of sustainable development of regional food security.

5.1 Overall goal

Security of food supply has improved steadily. By 2025 and 2035, China’s total grain output is projected to reach 6.16×10^8 t and 6.23×10^8 t, respectively, the planting area is estimated to fall to 9.8×10^7 hm² and 9.7×10^7 hm², and the yield to increase to 6281.39 kg/hm² and 6428.72 kg/hm², respectively. The total food output in 2025 and 2035 is projected to reach 6.75×10^8 t and 6.89×10^8 t, respectively, the planting area is estimated to fall to 1.181×10^8 hm² and 1.173×10^8 hm², and the yield to increase to 5717.96 kg/hm² and 5874.23 kg/hm², respectively. By 2025 and 2035, the total pork output is expected to reach 5.7×10^7 t and 6.234×10^7 t, respectively, the total egg output will be 3.488×10^7 t and 3.696×10^7 t, and the total milk output is projected to touch 4.195×10^7 t and 5.014×10^7 t, respectively. In the future, the total output of horticultural crops and cash crops will continue to grow, although the area under cultivation will remain stable or reduce. Thus, total output will increase mainly due to increasing yields and the supply will balance demand [4].

Product quality and safety levels are expected to substantially improve. By 2025, food production of all types will reach pollution-free standards and above, 40% to 60% of food production will meet green food standards, and 20% to 30% of food production will meet organic food standards. By 2035, a grain quantity, quality, and safety guarantee system with stable supply, high-end products, efficient operation, sound standards, complete systems, and adequate supervision will be fully established.

The level of technical support and material equipment will improve significantly. Technological support for food production and income is expected to be enhanced. By 2035, the coverage rate of fine varieties will stabilize at more than 98%, the agricultural science and technology household registration rate and agricultural information coverage rate will all reach 100%, and the agricultural science and technology progress contribution rate will increase to 75%. The level of agricultural machinery equipment has gradually increased, and the total power of agricultural machinery is projected to reach 2×10^9 kW by 2035.

The level of sustainable development of resources and environment will improve significantly, with gradual improvement in the output level of cultivated land and the utilization efficiency of fertilizer and pesticide input resources. By 2035, grains per cubic meter of water will reach 2.0 kg, the grain yield will touch 6750 kg/hm², the effective irrigation rate of farmland is projected to touch 65%, the comprehensive utilization rate of crop straw will reach 90%, the comprehensive utilization rate of large-scale aquaculture waste will reach 85%, the water quality compliance rate of agricultural water functional areas will touch 90%, the recovery rate of agricultural films will reach 100%, and the recovery rate of waste pesticide packages will touch 80% [5].

5.2 Overall thinking

5.2.1 The “two-line constraint mechanism” that comprises the “red line” of food security and the “bottom line” of regional production

Grain food security is the focus of food security, that is the “red line.” To achieve regional food security, we must ensure achieving both the “red line” of food security and the “bottom line” of regional production. To achieve this, the self-sufficiency rate of rations, grains, and grain food in China should be guaranteed above 95%, 90%, and 80%, respectively, and the total grain output should be above 6×10^8 t. To achieve food security, it is necessary to stabilize the grain security function in North China using moderate resources and minimizing the environmental impact, utilize the comparative advantages of the Southern economy appropriately to restore the level of food self-sufficiency in the Southern region and create multi-modal development, expanding the function of agricultural food security in West China. At the same time, it is imperative to establish a regional production “bottom line” constraint mechanism. For this, Northeast China needs to focus on the protection of black land resources, North China should focus on the two strategic priorities of “water conservation” and “absolute security of food rations,” Central China must establish a production capacity guarantee structure based on high-standard farmland and supported by the “two regions” to increase the output of major agricultural products. Further, the Southeast coastal region should establish the goal of stabilizing basic supply and changing the agricultural structure to increase the food yield, and the Southwest should focus on stabilizing the production of suitable products in the region and protect the ecological barrier for sustainable development in the upper reaches of the Yangtze River. In addition, the Northwest region needs to consolidate the achievements of returning farmland to forests and grasslands and implement key projects, such as comprehensive water conservation in agriculture, conservation of arable land quality, and enhancement in the capacity of grass and livestock industries to ensure ecological balance, regional food security, and self-sufficiency in animal products.

5.2.2 Central government top-level reconfiguration and rebalancing mechanism

Starting from the reconfiguration and rebalancing mechanism, to achieve sustainable development of regional food security, it is necessary to establish a central general transfer payment growth mechanism and improve the compensation benefits in the main producing areas and set up a new national special fund for young professional farmers to grow food. It is also imperative to strengthen the fiscal policy to coordinate the function of regional food production, increase transfer payments to major food and animal husbandry counties, improve the general transfer payment growth mechanism, and support the development of large food production counties. Further, it is important to increase the number of incentives for large food production counties, formulate differentiated and institutionalized dynamic change plans, and stabilize and enhance the production enthusiasm of large counties. Establishing a group of modern young grain growers to promote the scale and standardization of grain production in China is also needed.

5.2.3 Cooperation and win–win mechanism between main food producing and selling areas

Based on the current uneven distribution of benefits between the main grain production areas and the main sales areas, it is recommended to establish a purchase and sales cooperation mechanism between the governments of the main production and sales areas, and at the same time, explore the establishment of a diversified market-oriented production and sales cooperation model. It is also necessary to encourage governments of the food production and sales areas to sign production and marketing cooperation agreements and develop food purchase and sales cooperation. Relying on the current counterpart assistance system structure encourages governments to actively cooperate to achieve win–win regional cooperation in food security. This cooperation needs to be further strengthened.

5.3 The main strategy

The main contradiction of regional food security that China is confronted with at this stage is not the issue of total volume but that of structural contradictions and the decline in market competitiveness. It is not a problem of insufficient production capacity in the short term but that of huge pressure on resources and the environment and unsustainable development. It is not a single local problem but a problem of imbalanced food development among regions.

The first recommendation is to implement a regional food security strategy. This entails adapting to the new changes in food consumption concepts and national nutrition and health guidelines in modern society, gradually establishing a new concept of large food security, and focusing on improving quality and nutrition and the diverse needs of regional residents in terms of food nutrition, health, and a reasonable mix of dietary structures. Further, we must accelerate the construction of the regional modern food industry system based on ensuring the absolute safety of rations and the development of regionally superior food characteristics, transform the type of development from the basic guarantee-oriented type into high-quality supply-oriented type, strengthen the ability to guarantee regional high-quality food supply, and promote the coordinated development of regional food production, consumption, nutrition, and health.

The second suggestion is to implement a regional integration strategy for the entire industrial chain. This calls for extending the industrial chain, cultivating and expanding new industries and new formats, accelerating the construction of a regional industry synergy system of planting, breeding, and processing, integrating the three industries, and promoting the integration of regional seed industry, processing, and circulation. Regional agricultural helps achieve deep integration of regional primary, secondary, and tertiary industries— such as rural service industry, tourism, culture, and education industry—and the whole food chain.

The third strategy is the implementation of a regional coordinated development strategy. Take the comparative advantage as the starting point, based on the regional resource endowment and factor potential; rely on the construction of the “three zones,” namely, food production functional zones, important agricultural product protection zones, and characteristic agricultural product advantage zones; clarify the development orientation and main direction of regional food development; promote the optimal allocation of production factors in space and industry; and accelerate the formation of a new pattern of coordinated development of modern food production regions with distinct regional characteristics, the reasonable industrial division of labor, and complete industrial system.

The fourth strategy is to implement a regional green sustainable strategy. Implementing the most stringent resource management and control measures, increasing ecological environmental protection and restoration efforts, and adopting regional resource utilization efficiency and production potential is critical. There is a need to promote green agricultural production methods, develop green agricultural products relying on green mountains and clear water, and strengthen the construction of agricultural brands. In addition, it is important to enhance product quality through the high-quality and favorable price mechanism, and promote the formation of a new pattern of green modern food development in the region with efficient use of resources, stable ecosystems, good production environment, and safe product quality

The fifth recommendation is to implement a regional internationalization and opening strategy. This implies making reasonable use of domestic and foreign “two markets” and “two resources,” leveraging regional comparative advantages to participate in the international economic division of labor, increasing the international voice of food pricing, and implementing the agricultural “go global” strategy. It also entails focusing on the implementation of the Belt and Road Initiative, participating in global agricultural competition and cooperation,

improving the international competitiveness of grain and other important agricultural products, and forming an open, cooperative, and mutually beneficial pattern for the international development of regional modern food.

6 Countermeasures and suggestions.

The cost, price, and quality of China's major foods are generally not competitive. At the same time, the resource and environment constraints are tight, and overexploitation of agricultural resources and insufficient use of science and technology coexist. The report of the 19th National Congress of the Communist Party of China puts forward the implementation of the strategy of rural revitalization, the primary task of which is to ensure food security. The food security strategy should be integrated into the specific work of rural revitalization.

6.1 Implementation of double-responsibility for food security and environmental protection of governments at all levels.

To achieve "green mountains and clear waters that are as good as mountains of gold and silver" and the sustainable development of regional food security, a double-responsibility system for environmental protection and food security should be formulated at all levels of the government, thereby clarifying the responsibilities and obligations of the governments at all levels.

It is recommended to develop a comprehensive evaluation index system based on the combination of administrative and economic measures. At the same time, the sustainable development of regional food security and the governance of the ecological environment should be taken as important constituents for assessing the results of the government's work.

6.2 Reasonably plan and coordinate major regional special funds to support capital investment to ensure food production.

It is imperative to reasonably plan and formulate a systematic overall framework of major regional special agricultural funds, make overall arrangements for central and local financial funds and various types of non-public capital, and rationally allocate funds for major regional projects. It is also necessary to ensure that the financial funds are put in place, that the supervision is based on evidence, and that the capital investment is indeed effective.

6.3 Cultivate new business entities to ensure human capital investment in food production.

We should start with the implementation of the cultivation project of new-type of agricultural operators, support the participation of new-type of operators in the construction of the "two zones," and strive to cultivate several model family farms, cooperatives, and agricultural industrialization consortia. This will enable these demonstration entities to become the benchmark and the backbone of standardized operations, standardized production, and the promotion of farmers, as well as the mainstay of food security in China.

6.4 Promote the development of modern agriculture with quality agriculture

There is a need to actively build a modern agricultural industrial system and promote quality agriculture. This implies promoting standardized green production through the established system to ensure that the quality of agricultural products is stabilized at a high level. At the same time, there is a need to improve the market mechanism, establish a "good quality and good price" commercial credit system, and encourage the production of high-end agricultural products [6].

6.5 Strengthen cooperation and adopt the advantages of food security guarantee policies of countries along the Belt and Road.

Sustainable development of regional food security can be achieved by making full use of the agricultural resource advantages of countries along the Belt and Road. To achieve this, we must establish a border agricultural free trade zone, set up a comprehensive service center for cross-border agricultural cooperation projects, and provide comprehensive cross-border agricultural services. We must also encourage the establishment of a variety of new cross-border trade transaction methods to achieve diversification and modernization of market transaction methods.

6.6 Innovate and promote water resource policies that are suitable for water conservation and implement the concept of green coordinated development.

To give full play to the role of granaries in North China and the ecological security barrier in Northwest China, we should adhere to the principles of priority on water-saving, suitable water cultivation, and differential water-use, and offer compensation to those who protect ecology. We should also adjust the current water-saving and limited-use subsidy policy, and insist on promoting efficient water-saving irrigation technologies. Further, we must develop water-saving and water-efficient crops, promote sustainable development of regional food security by improving agricultural water-use efficiency, and ensure sustainable development of regional food security.

6.7 Implement special control actions to accelerate soil control and restoration.

It is necessary to continuously increase the protection of black soil in Northeast China and the control of heavy metal contaminated soil in Central China. This entails promoting the development model of circular agriculture, implementing farmland conversion and fallow cultivation in heavily polluted areas, implementing restoration and treatment based on agronomic technologies in lightly and moderately polluted areas, and replanting other cash crops.

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