New-Era Food Security Perspective and Food Supply-Side Reform (Postprint)

Authors: Cheng Shengkui, Wang Shouyang

Date: 2017-10-21T00:00:00+00:00

Abstract

Food security constitutes a major strategic issue of overarching significance that bears upon national development and stability, as well as independence and self-reliance. China' s food security philosophy and institutional framework emerged from the planned economy era and presently confront certain challenges amid the current domestic and international landscape. In response to the new development stage, an urgent imperative exists to reform the traditional perspective on food security and establish a new-era food security concept to guide and propel the supply-side reform of grain. This paper endeavors to synthesize the principal circumstances and challenges confronting both the supply and demand sides of China' s grain sector at the present juncture, explicating that the ongoing supply-side reform constitutes a critical opportunity for forging a new-era food security concept. The approach should prioritize streamlining government-market relations, cultivating a global vision and dual-bottom-line thinking, and promoting healthy and green lifestyles, thereby furnishing scientifically grounded perspectives and solutions for charting a path forward on China' s food security challenges.

Full Text

New Situations and Problems on the Food Supply Side

Significant Spatial Aggregation, Scaling, and Intensification of Grain Production

The aggregation of grain production toward major producing regions represents the most substantial change on the supply side over the past three decades, and this trend continues to strengthen. Among the three major grain varieties, wheat is concentrating in the North China Plain, rice in the middle and lower reaches of the Yangtze River, the Northeast Plain, and the Lingnan region, and

corn in the Northeast and North China Plains, while grain production in southeastern coastal provinces has gradually retreated. In 2016, 15 provinces each produced over 10 million tons of a single grain variety, with their combined output accounting for 76% (wheat), 76% (rice), and 69% (corn) of national production for each respective category, demonstrating pronounced spatial aggregation characteristics .

Beyond spatial concentration, grain production entities and scales are undergoing rapid transformation. Driven by urbanization, improved agricultural productivity, and socioeconomic structural changes, agricultural cultivation has evolved from the household contract responsibility system dominant in the early reform period to a diversified model comprising individual farmers, specialized cooperatives, agricultural enterprises, and multinational corporations. Following the central government' s 2016 clarification of the "three rights separation" (ownership, contract right, and management right), land transfer has accelerated dramatically. In 2007, only 64 million mu of farmland was transferred nationwide, but by early 2017, this figure reached 447 million mu, representing 35% of total contracted farmland [4]. In terms of land transfer destinations, 59% flowed to individual farmers, 22% to cooperatives, and 9% to enterprises. Agricultural operation scales have expanded from previous plots of three to five mu to modern large farms and cooperatives covering dozens of hectares. This intensification has improved planting efficiency, reduced costs, released labor, stimulated reform in grain production and circulation, and enhanced the international competitiveness of Chinese agricultural products. However, in terms of operational scale, entities larger than 50 mu still constitute only 1% of the total number of operations as of end-2016, while 80% of operators manage less than 10 mu, indicating that traditional household-based autonomous and contract operations remain the dominant form of grain production.

The "North-to-South" and "West-to-East" Grain Flow Patterns Have Become More Pronounced

With the rapid development of national railway and highway networks and strong logistics industry support, a nationwide grain circulation system has been established, essentially achieving national distribution and marketing. The market economy now plays a price-regulating role, maintaining overall balance between grain production and consumption. High-quality japonica rice from Northeast China now continuously supplies provinces such as Yunnan, Guangdong, and Xinjiang, while millet, oats, and other coarse grains from Gansu and Xinjiang in Northwest China have entered the diets of residents in Beijing and Shanghai.

Nevertheless, significant problems persist in grain circulation under the current supply-demand structure. First, functional concentration in major grain-producing regions has intensified the "north-to-south" and "west-to-east" transportation patterns, imposing substantial challenges on the transportation system and post-harvest grain transfer. For instance, as rice and corn production concentrates in Northeast China, autumn and winter grain shipments conflict

with coal transportation from the same region, leading to increased costs, extended transfer times, and risks of grain spoilage or nutritional loss. Second, under natural conditions where water resources are scarcer in northern and western regions than in southern areas, these grain flow patterns will further exacerbate water resource threats in these regions and cause irreversible damage to ecological projects such as poverty alleviation and the "Grain for Green" program [5]. Additionally, urbanization and socioeconomic development have transformed public habits—people no longer store grain at home as they once did, keeping minimal reserves and relying entirely on market supply, which has accelerated grain circulation speed and placed higher demands on market and circulation system construction and operation. Simultaneously, the market plays a guiding role in the new grain circulation system, using price fluctuations to guide farmers in adjusting agricultural and planting structures according to market conditions.

High Grain Inventories Have Triggered Numerous Problems

China currently faces severe inventory problems with both corn and rice. Following the implementation of the corn "temporary reserve policy" (national temporary grain storage) in 2007, corn planting area increased substantially. In 2009, China' s annual grain output was approximately 530 million tons (including 164 million tons of corn). Based on a per capita consumption of 395 kg/year, grain demand was about 525 million tons, essentially achieving supply-demand balance. However, total grain inventory in state-owned enterprises reached 225 million tons in 2009, with an inventory-to-consumption ratio of 43%, far exceeding the 17%-18% standard set by the UN Food and Agriculture Organization (FAO). By 2016, corn output reached 219 million tons, with inventory soaring to 260 million tons. Based on consumption demand of 212 million tons for 2016-2017, the inventory-to-consumption ratio reached 123%. In recent years, the significant increase in converting corn fields to rice ("dry-to-wet conversion") has posed severe challenges to already high rice inventories.

These high inventories pose serious threats to market stability and food security. On one hand, they create heavy fiscal burdens. Calculating only storage costs at 80 yuan/ton/year, 260 million tons of corn inventory requires over 20 billion yuan in annual central fiscal expenditure. Additionally, since 2016, the three northeastern provinces and one autonomous region have provided subsidies of 100-300 yuan/ton to corn deep-processing enterprises, along with increased export tax rebate rates for such enterprises—all ultimately funded by the central government. On the other hand, the temporary reserve policy drove corn prices continuously upward, far exceeding the import "ceiling price" and resulting in large volumes of foreign corn and substitutes entering the market, distorting price formation mechanisms and severely disrupting grain market order.

High inventories also delay market entry timing and encourage adulteration, seriously affecting public health and nutrition levels. These factors combined to create the situation of "new grain entering warehouses, foreign grain entering markets, and old grain entering mouths" during 2013-2015. In 2016, the

government canceled the corn temporary reserve policy, causing corn prices to drop immediately. Subsequent policies to reduce inventory, revitalize grain processing enterprises, and guide multiple entities into market procurement have driven profound transformation in the corn industry. Currently, corn inventory has steadily declined, achieving phased success in corn supply-side reform and essentially eliminating the medium- to long-term threat of corn inventory to national food security.

For rice, considering its share of over 70% in the national dietary structure, the government continues to implement a prudent minimum purchase price policy, though the 2017 price was reduced by 0.05 yuan/jin compared to 2016. However, due to favorable growing conditions and high quality, rice from Northeast China enjoys strong market demand. Coupled with spillover effects from canceling the corn temporary reserve policy, a "dry-to-wet" conversion trend emerged in the region in recent years. According to our research team, at least 5 million mu of dry land were converted to paddy fields annually in Jilin and Heilongjiang during 2016-2017. Therefore, under the current policy scenario of contrasting fortunes for corn and rice, rice inventory will likely reach new highs in the short term, and the phenomenon of high grain inventories has not been fundamentally reversed.

Grain Import and Export Is Mainly Regulated by Market Supply and Demand Rather Than Domestic Production

Following the conclusion of the WTO Uruguay Round negotiations in 1986-1994, grain has gradually developed into a commodity with well-established trade attributes. Under the WTO framework, China' s grain import and export system has become increasingly sophisticated. In the nearly 70 years since 1949, China has been a net grain exporter for only 10 years in the 1950s, 1 year in the 1960s, 2 years in the 1980s, 5 years in the 1990s, and 2 years after 2000, but a net importer for the remaining nearly 50 years. This directly relates to factors such as limited arable land, relatively low grain production levels, and a large population base.

Since 2004, China' s net grain import volume has remained around 20 million tons, and the relationship between net grain import volume and domestic production has been inconsistent [Figure 2: see original paper]. For example, 1997-2003 were all net export years, yet domestic grain production consistently declined; conversely, during the current import surge since 2009, domestic production has increased annually. These patterns demonstrate that grain import and export are primarily regulated by market conditions (such as domestic-international price differentials and policy controls) rather than fully reflecting domestic production situations. This corresponds to the "new grain entering warehouses, foreign grain entering markets" phenomenon in recent years and partially reflects imperfections in domestic grain trade market mechanisms.

Resource Environment Is Seriously Affected by Grain Production Increases

Grain cultivation is a human activity with environmental externalities. Excessive groundwater extraction for irrigation in the North China Plain has created underground water funnels. Currently, groundwater levels in Northeast China are also declining significantly due to rice and corn expansion, with depths reaching over 70 meters in western Heilongjiang and Jilin and eastern Inner Mongolia —an unimaginable negative impact for the "Great Northern Wilderness" that has only been developed for several decades. The single-minded pursuit of increased output has damaged farmland productivity and topsoil, causing rapid depletion of soil organic matter without timely replenishment, as well as soil compaction and hardening. Northeast China' s black soil has begun comprehensive degradation, while incidents such as "cadmium rice" in Hunan, "chromium pollution" in Yunnan, and watershed pollution in Jiangxi have sounded alarms for water and soil contamination and food safety in China.

Since 2016, the Chinese government has emphasized "storing grain in land," with the fundamental purpose of protecting farmland and land productivity. Protection requires sacrifice, and from the current perspective, sacrificing some grain production capacity by concentrating grain production from scattered, inefficient, and extensive areas to high-standard farmland and major grain-producing regions with high efficiency and intensification is the breakthrough for reducing the resource and environmental impacts of grain production. Achieving this goal requires removing unreasonable administrative interventions and policy supports while adopting scientific compensation measures to enable protective farming or land retirement.

Changes and Problems on the Food Demand Side

Increased Supply Has Driven Dietary Structure Changes

Since the founding of the People' s Republic of China, citizens' dietary structures have undergone significant changes, roughly divided into three stages. (1) Around 1949-1980: Grain production for the primary purpose of having enough to eat achieved considerable development, with per capita annual grain output increasing from less than 150 kg in 1949 to 235 kg in 1980. During this period, per capita annual income grew slowly, reaching only 220 USD (at current prices) by 1980. The dietary structure was grain-dominated, with shortages in meat, eggs, milk, and vegetables/fruits; most people lived in hardship, barely solving the problem of having enough to eat. (2) 1981-2003: This period witnessed China' s industrialization and urbanization wave, with per capita GNI steadily increasing to over 1,200 USD/year, lifting most people out of poverty. Grain production experienced four major fluctuations, with per capita annual grain output growing slowly to only 248 kg by 2003. However, due to rapid development in animal husbandry and modern agriculture, supplies of meat, eggs, milk, and vegetables/fruits continuously increased, and dietary structure diversified. (3) 2004-present: Since 2004, China' s socioeconomic development has entered a fast track, with per capita GNI exceeding 8,000 USD/year, essentially entering the ranks of upper-middle-income countries. Driven by national poli-

cies ensuring grain output, per capita annual grain output rapidly increased to over 400 kg. With abundant food supply, diverse varieties, and enriched dietary structure, public demand for agricultural product quality and food safety has gradually increased. Additionally, driven by international agricultural trade, many high-quality international agricultural products have entered the Chinese market, further diversifying Chinese consumers' dietary structures and demands [Figure 3: see original paper].

Grain Demand Structure Faces Major Changes

The three primary uses of grain (direct consumption, industrial use, and feed) are all undergoing significant changes. Research shows that absolute direct consumption demand has exhibited a rising-then-falling trend, with Chinese residents' daily grain food intake decreasing from 512 grams in 1992 to 337 grams in 2012, with similar trends in both rural and urban areas [6]. The structure of grain varieties for direct consumption has also changed considerably. High-quality rice from Northeast China now faces supply shortages, and market demand for high-quality strong gluten wheat is gradually increasing. With the development of China' s liquor, starch, and other deep-processing industries, industrial grain demand has increased substantially, related to the longer value chain of industrial grain use. Before the 1990s, China' s industrial grain use did not exceed 10 million tons annually, but reached 100 million tons in 2012—a more than tenfold increase [6]. Industrial grain demand is projected to reach 166 million tons by 2020 [7]. Feed grain demand was around 70 million tons annually before 1985, accounting for less than 1% of total grain consumption; this proportion has continuously risen, reaching 150 million tons in 2013, accounting for 25% of that year' s grain output.

According to market logic, changes in grain demand structure should quickly transmit to grain production layout and resource allocation. However, due to the influence of the government' s minimum purchase price policy, most farmers still choose to plant traditional crop varieties because high yields combined with government price support generate better economic returns. In this situation, most grain-using enterprises either cultivate needed varieties themselves or turn to the international market, creating a contradictory situation where farmers' grain enters warehouses because domestic markets don' t need it, while domestic enterprises continuously import other grain varieties from abroad. This contradiction poses a serious threat to China' s food security.

Rapid Changes in Food Consumption Behavior, Concepts, and Patterns

Corresponding to abundant food supply and diversified dietary structure are various forms of nutritional excess, gradually increasing chronic diseases, and massive food waste. Research by the Chinese Center for Disease Control and Prevention (CDC) found that China' s adult overweight rate (based on BMI) increased from 16% in 1992 to 32.4% in 2013, while the adult diabetes rate increased from 3.4% in 1996 to 10.4% in 2013 [8].

When supply increases and consumption becomes affordable, waste gradually increases. Unreasonable consumption behavior and wasteful practices have intensified, causing Chinese society to experience a massive shift "from thrift and diligence to extravagance and waste." These behaviors, concepts, habits, and styles have begun affecting everyone from cities to rural areas and, through grain supply chains and markets, transmitting to all stakeholders in grain production, circulation, and processing. According to surveys of the catering industry in multiple large and medium-sized cities across China, annual food waste in urban catering reaches approximately 17-18 million tons. In addition to nutritional excess and food waste, the most significant change on the consumption side lies in the massive transformation of public food consumption patterns. In eras of grain shortage, meat, eggs, and milk were the most effective sources of energy and nutrition, while vegetables and fruits were often undervalued. With improved agricultural supply capacity and household economic capacity, most people can now have sufficient meat, eggs, and milk at every meal, while vegetables and fruits have become synonymous with healthy and nutritious diets. Additionally, due to urbanization and changes in the industrial and commercial environment, most people dine outside their homes more than half the time, making various cafeterias and restaurants the primary venues for food consumption and driving vigorous development of the urban catering industry. Furthermore, some citizens have begun advocating for and purchasing large quantities of imported agricultural products, such as rice from Japan and Thailand, beef from the United States, and lobster from Argentina. The development of vegetable greenhouses and cold-chain transportation has also ensured that public demand for agricultural products is not limited by season or region.

Food Security in the New Era under Agricultural Supply-side Structural Reform

Agricultural Supply-side Structural Reform Is an Important Opportunity for Establishing a New Food Security Concept

From the perspective of supply and demand situations, after nearly 40 years of reform and opening up and with the central government' s high attention and continuous efforts of agricultural workers across the country, China has essentially solved the problem of "having enough to eat" for its 1.3+ billion people. However, behind the tremendous achievements in grain production lie severe degradation of arable land resources, serious water shortages, rising grain production costs year by year, high grain inventories, surging imports, changing public consumption concepts, nutritional excess, serious food waste, and major challenges to grain circulation caused by the aggregation of grain production and consumption areas. Based on current domestic and international food security situations, it can be concluded that China' s food security has entered a new period characterized by prominent structural contradictions in grain supply and demand.

Following the 2015 Central Economic Work Conference, supply-side structural

reform focusing on "reducing overcapacity, destocking, deleveraging, reducing costs, and strengthening weak links" officially began. Agricultural supply-side structural reform, signaled by the cancellation of corn temporary reserve policies, officially launched in 2016. The 2017 Central No. 1 Document, themed "Deepening Agricultural Supply-side Structural Reform and Accelerating the Cultivation of New Drivers for Agricultural and Rural Development," provided comprehensive deployment across production, circulation, storage, and import-export dimensions [9]. This agricultural supply-side structural reform explicitly stated that the main contradiction in Chinese agriculture has shifted from insufficient total quantity to structural contradictions, advocating that we should "adapt to new situations and requirements, adhere to problem orientation, adjust work priorities, deepen agricultural supply-side structural reform, accelerate the cultivation of new drivers for agricultural and rural development, and create a new situation in agricultural modernization." This document, while sounding the clarion call for supply-side reform, also reflects a major transformation in China' s food security concept. This transformation manifests in: (1) shifting from focusing solely on staple grains to multi-dimensional, multi-sector coordination with emphasis on promoting reform in grain circulation; (2) transitioning from the traditional agricultural layout of "taking grain as the key link" and the production approach of "increasing output at all costs" to advocating "storing grain in land" and "storing grain in technology," emphasizing the construction of green production methods and sustainable agricultural development capacity. Therefore, it can be considered that this supply-side reform, while promoting Chinese agriculture toward greater safety, green development, and efficiency, also provides an important opportunity for establishing a new food security concept for the new era.

Based on the cancellation of corn temporary reserve policies and grain planting structure adjustments, China' s current agricultural supply-side reform has achieved certain results. However, there remains a long way to go before reaching the stage goal of allowing the market to play a decisive role in agricultural resource allocation. Innovating and popularizing the new food security concept is an inevitable outcome of agricultural supply-side structural reform. Reconstructing food security concepts from farmland to dining table and from farmers to enterprises and government can significantly accelerate the supply-side reform process and smoothly advance China' s food security into a new stage.

Clarifying Government-Market Relations Is Key to the New Food Security Concept

China's current food security system framework originated from the government-led, top-down grain production and circulation layout of the planned economy era. In the planned economy period, the government successively acted as production regulator, circulator, distributor, and price setter. Since reform and opening up, market regulation has played an increasingly important role, but the government still plays significant roles in the system, such as setting current rice minimum purchase prices, determining the scale and scope of grain

production subsidies, and approving or funding the layout and production of agricultural input industries like fertilizers and pesticides. After affirming that "the market plays a decisive role in resource allocation," the new food security concept requires greater clarity. For example, in government-market relations, which allocations and regulations can be handed over to the market, and which still require government control or what role the government should play?

Building a complete market system cannot be accomplished overnight or in a rush. It requires effective sorting of all stakeholders and different segments involved in food security, as well as answers to key scientific questions such as "How much grain does China actually need to store?" and "Where is the balance point for Chinese citizens' dietary structure?" Only then can the roles of government and market be fully and effectively coordinated.

Establishing a Global Perspective and Bottom-Line Thinking Is Core to the New Food Security Concept

In the new food security concept, it is necessary to firmly establish a global perspective and bottom-line thinking. Following the completion of the WTO Uruguay Round negotiations, grain has been increasingly endowed with attributes of ordinary traded commodities. Purchasing grain from the world market has become almost equivalent to trading oil, iron ore, or beef in global commodity markets. Due to China' s high agricultural costs, low comparative advantages, and scarce arable land and water resources, rationally utilizing international resources to ensure China' s food security has become an academic consensus [10,11]. Under the guidance of the "Belt and Road" Initiative, China' s diplomatic "circle of friends" has gradually expanded, and high-quality, cost-effective international agricultural products provide ample room for improving China' s agricultural supply-demand contradictions, alleviating agricultural resource shortages, enhancing agricultural product comparative advantages, and enriching public dietary structures. We should not rigidly adhere to the dogma of self-sufficiency in all grain varieties, disregard foreign markets and resources, and consequently miss opportunities to advance agricultural supply-side reform and adjust agricultural planting structures.

In the new food security concept, we should also resolutely maintain two bottom lines: farmers' income and resource-environment security. Farmers' income is the ballast stone for agricultural development and rural stability, so we must firmly protect farmers' earnings and living standards. Water, soil resources, and ecological environment are necessary conditions for human survival, while lucid waters and lush mountains are essential foundations for enjoying a good life and even achieving a moderately prosperous society. China should promptly adjust its agricultural structure and layout, construct major grain production functional zones and basic farmland protection areas based on resource endowments, farmland spatial distribution, and grain production potential [12], eliminate grain production capacity in resource-environment vulnerable regions, improve the utilization efficiency of water, soil resources, and agricultural inputs, increase grain yield per unit area, and ensure diversified, intensive, and modern agricultural

operations.

Promoting Healthy and Green Lifestyles Is Essential to the New Food Security Concept

The new food security concept needs to vigorously promote healthy and green lifestyles, guiding the public toward healthy diets, rational consumption, waste elimination, and environmental protection. Through lifestyle transformation, grain demand and its patterns on the demand side can be improved. By leveraging market mechanisms, this can guide the diversification, quality improvement, and efficiency enhancement of agricultural planting structures, promote the reduction of single-crop production capacity, decrease pesticide and fertilizer application, extend agricultural product industrial chains and value chains, strengthen agricultural ecological environmental protection, and develop multifunctional, multi-format agricultural industries. This achieves the reform goal of forcing supply-side overcapacity reduction, inventory destocking, and quality-efficiency improvement through demand-side pressure.

Conclusion

China' s food security faces numerous challenges on both supply and demand sides, necessitating the reconstruction of the traditional food security concept that one-sidedly pursues high output and high reserves. Agricultural supply-side structural reform has grasped the main contradiction in current agricultural development, providing an important opportunity for reconstructing the new-era food security concept and influencing the direction of China' s agricultural development and the establishment of long-term food security mechanisms. As China' s comprehensive national strength further strengthens and domestic constraints on water-soil resources and rigid food consumption demand continue, the new-era food security concept must establish a global perspective and bottom-line thinking, actively advocate healthy and green lifestyles, and utilize the market' s "invisible hand" to rationally allocate both international and domestic "two resources, two markets." This will achieve grain overcapacity reduction, inventory destocking, alleviation of domestic water-soil resource contradictions, and agricultural ecosystem protection.

References

1. State Council. National Long-term Plan for Food Security (2008-2020). [2008-11-14]. http://www.gov.cn/test/2008-11/14/content_1148698.htm.
2. National Development and Reform Commission. National Plan for Increasing Grain Production Capacity by 100 Billion Jin (2009-2020). [2009-11-03]. http://www.gov.cn/gzdt/2009-11/03/content_1455493.htm.
3. National Bureau of Statistics. Announcement on 2016 Grain Output. [2016-12-08]. http://www.stats.gov.cn/tjsj/zxfb/201612/t20161208_1439012.html.
4. Ministry of Agriculture. Press Conference of the 12th National People' s Congress. [2017-09-25]. http://finance.people.com.cn/n1/2017/0307/c1004-

29129227.html.
5. Wang H, Yang G, Yang Z. Strategic thinking on ensuring food security under water and land resource constraints. Bulletin of Chinese Academy of Sciences, 2013, 28(3): 329-336.
6. Lü J, Yu Z, Zhao Y. Evolution of total grain demand and demand structure in China. Issues in Agricultural Economy, 2013, (5): 15-19.
7. Xiao H, Li J. Analysis of China' s grain supply and demand situation and trend forecast during the 13th Five-Year Plan period. The World of Survey and Research, 2015, (3): 3-6.
8. Chinese Center for Disease Control and Prevention. Report on Chronic Diseases and Risk Factors Surveillance in China (2013). Beijing: Military Medical Science Press, 2016.
9. CPC Central Committee, State Council. Several Opinions on Deepening Agricultural Supply-side Structural Reform and Accelerating the Cultivation of New Drivers for Agricultural and Rural Development, 2016.
10. Zhou S, Zhao M, Chen K, et al. Analysis of grain production potential in major grain exporting countries. Issues in Agricultural Economy, 2015, (6): 91-104.
11. Qu D, Hu M. Analysis of China' s grain supply dependence on external markets. Shanghai Agricultural Journal, 2016, 32, (2): 111-116.
12. Ma Y, Niu W. Core design of China' s grain production functional zones—constructing national survival security lines. Bulletin of Chinese Academy of Sciences, 2009, 24, (3): 241-247.

Cheng Shengkui is a professor at the Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, and doctoral supervisor. He serves as Chairman of the China Society of Natural Resources. His research focuses on resource ecology and agricultural sustainable development. E-mail: chengsk@igsnrr.ac.cn

Wang Shouyang is a professor at the Academy of Mathematics and Systems Science, Chinese Academy of Sciences. His research concentrates on systems engineering and management science. E-mail: sywang@amss.ac.cn

Note: Figure translations are in progress. See original paper for figures.