Modern Agricultural Development Strategy for the Southern Huang-Huai Grain Base (Postprint)

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Abstract

The border region of four provinces—northern Anhui, northern Jiangsu, southwestern Shandong, and southeastern Henan—contains over 4 million hectares of medium-low yield farmland prone to drought and waterlogging, including lime concretion black soil dominated by the Huaibei Plain and sandy saline-alkali land in the Yellow River flood-prone areas. Although located in the southern Huang-Huai region, a transitional zone between north and south with favorable natural resources such as temperature and precipitation, the area suffers from relative backwardness in science, technology, culture, and socio-economic development due to remote geography and inconvenient transportation, and its high-yield potential in agriculture has not yet been realized. Accelerating the transformation of medium-low yield farmland in the southern Huang-Huai region and constructing a second grain barn there could increase grain production by 5 billion kg, playing an important role in regional modern agricultural development and ensuring national food security. Based on the development trend of modern agriculture featuring climate warming and green quality-enhancing, yield-increasing, and efficiency-improving practices, the following modern agricultural development strategies are proposed for the southern Huang-Huai grain barn: In crop cultivation, first, develop wheat varieties resistant to Fusarium head blight and employ integrated control measures to mitigate the damage caused by wheat Fusarium head blight; second, cultivate new corn varieties tolerant to drought and waterlogging with rapid dehydration suitable for mechanical grain harvesting and rapidly demonstrate and promote them; third, expand the construction of ton-grain fields to ensure food security in the southern Huang-Huai region and nationally. In regional management, focus on transforming medium-low yield farmland in drought- and flood-prone areas such as the lime concretion black soil of Huaibei and the sandy saline-alkali land of the Yellow River flood areas, strengthen infrastructure investment in irrigation and drainage systems, and construct high-standard farmland that ensures stable yields despite drought

or excessive rain, with supporting forest networks, channels, wells, and electricity. In modern technology and equipment, increase agricultural machinery subsidies, augment the number of large and medium-sized agricultural machines, strengthen the demonstration and promotion of deep plowing and subsoiling machinery, and popularize full-process mechanization of farming operations. In green quality and efficiency improvement, actively promote the reduction of chemical fertilizers and pesticides, expand the application of environmentally friendly green bio-fertilizer preparations, and strengthen the cyclic and efficient utilization of straw return to field and biological resources. In science and education, expand the scale of vocational education, cultivate knowledgeable farmers and professional service workers, and build a professional team for socialized services. In regional economic development, strengthen and expand branded grain production in northern Anhui, enlarge large-scale grain production and cultivate modern new industries in northern Jiangsu, achieve coordinated and efficient development of agriculture, forestry, and animal husbandry in southwestern Shandong, and create a flagship for deep food processing in China in southeastern Henan. In agricultural informatization construction, increase the popularization of "Internet+" agriculture to drive the rapid development of contract farming, export-oriented agriculture, and sightseeing agriculture. It is recommended that the state promptly launch a key scientific and technological special project for the second grain barn in the southern Huang-Huai region, transforming the major grain-producing areas and economically depressed areas of the southern Huang-Huai region into a national principal grain barn, an emerging agricultural economic zone, and a sustainable development area with beautiful environment.

Full Text

Development Strategies of Modern Agriculture in South Huanghuai Granary

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Abstract: The border region of four provinces—northern Anhui, northern Jiangsu, southwestern Shandong, and southeastern Henan—contains over 4 million hectares of medium and low-yield fields, primarily lime concretion black soil in the Huaibei Plain and sandy, saline-alkali land in the former Yellow River flood areas. Although located in the South Huanghuai transitional zone with favorable thermal and precipitation resources, the region' s remote geography, poor transportation, and lagging scientific, cultural, and socioeconomic develop-

ment have prevented the full realization of its high-yield agricultural potential. Accelerating the transformation of these medium and low-yield fields to build a “Second Granary” in South Huanghuai could increase grain production by 5 billion kilograms, playing a vital role in regional modern agricultural development and national food security. Based on trends in climate warming and modern agriculture focused on green, quality-enhancing, and efficiency-improving development, we propose the following strategies: For crop production, first, breed wheat varieties resistant to scab and mitigate scab damage through integrated control measures; second, develop and rapidly demonstrate new maize varieties with drought and waterlogging tolerance plus rapid dehydration suitable for mechanized grain harvesting; third, expand “ton-grain field” construction to ensure food security in South Huanghuai and nationally. For regional land management, prioritize improving medium and low-yield fields in the Huaibei lime concretion black soils and the easy-dry, easy-waterlog areas with sandy, saline-alkali soils, strengthen investment in irrigation and drainage infrastructure, and build high-standard fields with supporting forest networks, roads, channels, and wells to ensure stable yields despite drought or excess rain. For modern technology and equipment, increase machinery subsidies, expand the fleet of large and medium-sized agricultural machines, promote deep plowing and subsoiling machinery, and popularize whole-process mechanization. For green quality and efficiency improvement, actively reduce chemical fertilizer and pesticide application, expand use of environmentally friendly bio-fertilizers, and enhance efficient cycling of straw return and biological resources. For science and technology education, expand vocational education to cultivate knowledgeable farmers and professional service workers, creating specialized teams for socialized services. For regional economic development, strengthen grain branding in northern Anhui, expand large-scale grain production in northern Jiangsu, promote coordinated agriculture-forestry-animal husbandry development in southwestern Shandong, and build a flagship food deep-processing industry in southeastern Henan. For agricultural information construction, expand “Internet+” agriculture to drive rapid development of contract farming, export-oriented agriculture, and sightseeing agriculture. We recommend that the state promptly launch key science and technology projects for the South Huanghuai “Second Granary” to transform this major grain production area and economic “depression zone” into a national principal granary, emerging agricultural economic zone, and environmentally beautiful sustainable development region.

Keywords: South Huanghuai; Food security; Modern agriculture; The Second Granary; Development strategy

1. The Increasingly Prominent Strategic Position of South Huanghuai Granary

Agricultural development in the Huang-Huai-Hai region holds an important position nationally, representing China’s second largest grain production center after Northeast China. Among China’ s five major grain-exporting provinces, three

(Heilongjiang, Jilin, Inner Mongolia) are in the Northeast, while two (Henan, Anhui) are in South Huanghuai [1]. The Huang-Huai-Hai region is a rare stable, high-yield, high-quality double-cropping area in China, with cultivated land accounting for 38% of the national total and grain output comprising approximately 25% of national production. It is China' s largest wheat production area and second largest maize cultivation zone, serving as a crucial pillar for ensuring the security of wheat, maize, and other agricultural products. The region plays a vital role in supplying grain and agricultural products to China' s three major economic zones—the Pearl River Delta, Yangtze River Delta, and Bohai Rim, as well as the Beijing-Tianjin-Hebei region—and its grain security strategic positioning should be further strengthened in China' s future development [2].

South Huanghuai refers to the southern part of the Huang-Huai-Hai Plain south of the Yellow River and north of the Huai River. Its hydrothermal resources and agricultural production potential are superior to those of North Huanghuai, which is relatively dry and cold with serious groundwater over-exploitation. South Huanghuai is China' s largest wheat cultivation area [3], accounting for one-third of the nation' s 20 million hectares of wheat sown area. However, the region contains 4 million hectares of medium and low-yield fields with lime concretion black soil, sandy land, saline-alkali soils, and low-lying, flood-prone areas, primarily distributed in the "Second Granary" region spanning northern Anhui, northern Jiangsu, southwestern Shandong, and southeastern Henan. The agricultural production potential of these areas remains to be fully tapped.

In recent years, with climate warming and adjustments to planting structures, the low-yield, low-efficiency winter wheat-summer soybean pattern has been transformed into a high-yield, high-efficiency winter wheat-summer maize system [4], leading to a continuous increase in "ton-grain" counties and cities. The development of ton-grain counties in South Huanghuai provinces demonstrates the enormous production potential of this Second Granary. Huantai County in Shandong became the first county north of the Yangtze River to achieve ton-grain status in 1990. In 2016, Shandong Province announced plans to create a batch of "ton-grain cities," "ton-grain counties," and "1.5-ton-grain townships." In 2013, Henan Province' s Department of Agriculture announced plans to build 4 million hectares of high-standard fields with yields exceeding one ton per mu, establish a group of "1.5-ton-grain townships" and "ton-grain counties," and achieve 65 billion kilograms of grain production capacity by 2020. By 2015, Jiangsu Province had recognized 21 counties (cities, districts) as "ton-grain per mu"producers. Notably, Anhui Province, with superior hydrothermal conditions compared to Henan and Shandong, has only one ton-grain city—Bozhou. These facts fully illustrate the grain production advantages of the South Huanghuai Second Granary and its potential to make tremendous contributions to China' s food security strategy.

Preliminary estimates indicate that transforming the medium and low-yield fields in this region could achieve a grain production increase of 5 billion kilograms or more [2]. The strategic position of the South Huanghuai Granary is

becoming increasingly prominent in regional modern agricultural development and national food security assurance.

2. Challenges and Opportunities for South Huanghuai Granary Development

The South Huanghuai Granary primarily comprises the border region of four provinces: northern Anhui, northern Jiangsu, southwestern Shandong, and southeastern Henan. This transitional zone between China' s northern and southern agricultural regions features a double-cropping system with relatively abundant precipitation, favorable heat conditions, and rich groundwater resources—significantly better agricultural climate conditions than the northern Huang-Huai Plain. With climate warming, the extended maize growing period facilitates mechanized grain harvesting and the development of wheat-maize ton-grain fields. However, wheat scab has become the main disease in this region, seriously threatening wheat production and quality safety.

The area was formerly a Yellow River flood zone, frequently suffering from sandstorms, drought, and flood disasters with soil salinization. Lime concretion black soil representative of the Huaibei Plain accounts for a large proportion of the region. Incomplete farmland water conservancy systems and insufficient disaster resistance capacity make it prone to both drought and waterlogging, with medium and low-yield fields exceeding 4 million hectares. The region is an underdeveloped area in the Huang-Huai-Hai region, with relatively backward scientific, technological, and economic development, including many impoverished counties. The state has launched few agricultural research projects in South Huanghuai, and no systematic grain security technology system or modern agricultural development strategy has been formed, leaving enormous potential for agricultural yield increase and economic development untapped.

Under the favorable situation of global climate warming and the Chinese government' s emphasis on transforming medium and low-yield fields and building high-standard farmland, the four provinces in South Huanghuai can seize this opportunity to innovate development concepts for granary construction. By improving farmland irrigation, agricultural mechanization, and other infrastructure; adjusting agricultural structure; strengthening the integration of primary, secondary, and tertiary industries; extending industrial chains; increasing agricultural product added value; and leveraging modern information agriculture such as the Internet of Things and e-commerce, the region can advance from underdeveloped to relatively developed status, continuously elevating its important strategic position in modern agriculture and food security.

3. Development Strategies for Modern Agriculture in Northern Anhui

Northern Anhui primarily refers to the cities of Huaibei, Bozhou, Suzhou, Bengbu, and Fuyang, along with some counties along the Huai River in

Huainan and Lu' an, covering a total area of 39,000 km². In the Huaibei Plain agricultural production zone, the total land area is approximately 37,400 km², with cultivated land of 2.138 million hectares, accounting for the vast majority of northern Anhui and 47.8% of Anhui Province' s total cultivated land. Per capita cultivated land is 0.14 hectares, making it the largest and most populous grain concentration area in the province. Rich in wheat, maize, and soybean production, it serves as an important national commodity grain production base. Fuyang, Bozhou, and Mengcheng are all major grain production cities/counties, with some counties continuously recognized as national commodity grain base counties and top 100 national grain production counties, making important contributions to national food security [5]. The region is a semi-humid rain-fed dry farming area with dense population, most of whom work as migrant laborers elsewhere, low cultural and educational quality, incomplete agricultural irrigation infrastructure, low levels of agricultural mechanization equipment, slow agricultural technology upgrading, low development level of rural cooperative organizations, and relatively backward economic development. Previously dominated by a winter wheat-summer soybean production pattern with single planting structure, small ton-grain field area, it represents a typical region of major grain production counties with economic poverty [6].

Addressing the main problems in modern agricultural development in the Huaibei region, we published "Granary Construction in North Huaihe River Should Be Accelerated" in 2013 [7]. In 2014, our proposal to accelerate South Huanghuai granary construction was adopted by the *People' s Daily* internal reference and distributed to provincial and military levels, attracting attention from leaders of the Chinese Academy of Sciences, Ministry of Science and Technology, and National Development and Reform Commission. In June 2014, former Vice Minister of Science and Technology Zhang Laiwu investigated grain production supported by science and technology in Anhui, pointing out the need to construct a "Second Granary" science and technology demonstration project in the Huang-Huai-Hai region to fully realize the grain yield potential of medium and low-yield fields [8]. In 2014, the Bureau of Science and Technology for Development of the Chinese Academy of Sciences clarified the "Second Granary" construction goals and reached consensus with the Anhui Provincial Government and research institutes. In January 2015, the Chinese Academy of Sciences invested 16 million yuan to launch the "Technology for Increasing Grain Yield at County Level in Huaibei: Technology Integration and Demonstration" project under the Science and Technology Service Network Initiative (STS) program, conducting preliminary research for the comprehensive implementation of the "Second Granary" plan. The project was led by the Hefei Institutes of Physical Science, Chinese Academy of Sciences, with participation from multiple CAS and local research institutes and enterprises.

Through investigation and summary, we propose the following modern agricultural development strategies for the Huaibei granary: (1) Accelerate planting structure adjustment, transforming the traditional low-yield, low-efficiency

wheat-soybean pattern into a modern high-yield, high-efficiency wheat-maize system. (2) Expand specialized, large-scale cultivation of cash crops, develop facility agriculture, and accelerate development of characteristic industries such as fruit, vegetables, Chinese medicinal herbs, and flowers to increase farmer income. (3) Develop large-scale breeding and food processing industries to extend industrial chains, building the Huaibei Plain into a green, ecological, high-value national commodity grain base and modern agricultural comprehensive development and utilization base. (4) Through key national and local investment, accelerate development of modern water-saving irrigation agriculture, utilizing abundant local groundwater to transform dry farming areas into supplementary irrigation areas. (5) Accelerate agricultural mechanization development, vigorously promote straw crushing and returning to fields, improve soil fertility, and amend medium and low-yield lime concretion black soils. (6) Accelerate construction of high-speed railways, highways, and aviation networks in Huaibei to facilitate transportation of agricultural and sideline products to domestic and international markets. (7) Accelerate construction of ancient civilization tourism and modern red tourism culture in Huaibei to drive coordinated development of informatization, urbanization, and modernization.

After two years of implementation at two demonstration bases—large-scale intensive modern agriculture at Nongkang Farm and county-level modern agriculture in Woyang County—multiple green quality-improving, yield-increasing, and efficiency-enhancing technologies were integrated. These included the excellent CAS maize variety "Keyu 186," water-fertilizer integrated drip irrigation and field water-saving irrigation technology, green controlled-release fertilizers and pesticides, deep loosening and precision sowing-fertilizing integrated machinery, laser land levelers, grain dryers, wheat and other crop combine harvesters, straw crushing and baling machines, and lime concretion black soil amendments. These efforts enabled Woyang County to achieve ton-grain county status one year ahead of schedule in 2015, accelerating Bozhou' s becoming Anhui' s first ton-grain city and becoming one of the highlights of CAS-Anhui cooperation [9]. The current demonstration and promotion area has expanded to Taihe County and Linquan County in Fuyang City [10]. According to current agricultural supply-side reform needs, the focus is on developing branded grain production and diversified modern agricultural operations centered on cash crop cultivation and large-scale characteristic breeding, accelerating poverty alleviation and beautiful rural construction while stabilizing grain production.

4. Development Strategies for Modern Agriculture in Northern Jiangsu

The five cities of northern Jiangsu (Xuzhou, Lianyungang, Yancheng, Huaian, and Suqian) feature flat and vast terrain at 50-100 meters elevation, high proportions of cultivated land, warm and humid climate, and good light and heat resources [11], favorable for high-quality agricultural production. With large agricultural populations, relatively large per capita cultivated land area, mini-

mal industrial pollution, and strong sustainable development capacity, the region covers 54,400 km² (53% of Jiangsu Province) and contributes about half of the province' s agricultural added value, serving as Jiangsu' s main agricultural production area [12]. In 2011, the five northern Jiangsu cities produced 22.85 billion kilograms of grain, accounting for 69.1% of the provincial total and ranking in the top five in the province [13].

Facing increasingly fierce competition in modern agriculture that demands high organization, advanced technology, and high efficiency, northern Jiangsu agriculture still has considerable gaps. Main problems include: (1) Agricultural structural adjustment has failed to leverage local characteristics and competitive advantages. (2) Insufficient scale of leading industries and inadequate development of leading agricultural enterprises result in weak market competitiveness of agricultural products. (3) Infrastructure such as farmland improvement, facility cultivation, market construction, and information networks is relatively backward and urgently needs special investment. (4) Insufficient depth and breadth of scientific and technological innovation, weak independent innovation capability of enterprises, and loose integration of industry, academia, and research lead to inadequate deep processing of agricultural products. (5) The agricultural technology extension system needs gradual reform to strengthen service docking with agricultural enterprises and training of farmers in new-era agricultural technologies. (6) Lack of modern agricultural management concepts and talent, weak self-discipline and coordination of industry associations, insufficient product promotion and publicity, and poor awareness of creating national and global brands.

Development strategies for modern agriculture in northern Jiangsu are as follows: (1) Learn from the advanced management concepts of the southern Jiangsu model for developing modern agriculture. (2) Expand land scale management to enhance land economic benefits and cultivate new modern agricultural industries. (3) Transform from single agricultural development to coordinated promotion of multiple ecological, efficient, and high-value industries. (4) Strengthen the establishment of specialized and socialized service systems to provide convenient and efficient disaster prevention and control technologies. (5) Extend agricultural industrial chains, increase profit sources and expand profit margins for agricultural operations, forming an agricultural management system with continuously expanding scale and gradually complete functions. (6) Focus on cultivating agricultural management entities that can transform agricultural infrastructure, extending infrastructure improvement to rural areas and changing logistics technology and management environments for agricultural development. (7) Accelerate "Internet+" industry development to speed up agricultural modernization. (8) Promote agricultural modernization through urbanization, and support agriculture through industry to drive modern agricultural development, tapping agricultural production potential, improving farmers' quality of life, and transforming rural development [14].

5. Development Strategies for Modern Agriculture in Southwestern Shandong

Southwestern Shandong includes Jining and Zaozhuang municipalities and the Heze region, comprising 19 counties, 7 districts, and 1 county-level city, with a total area of 28,400 km² [15]. Located on the Yellow River alluvial plain with flat terrain, the main crops are wheat, maize, cotton, and peanut under a double-cropping system. The region has abundant labor resources with over 1 million surplus rural laborers, offering unique advantages in attracting foreign investment and labor export. Simultaneously, it is a major distribution area for medium and low-yield fields in Shandong Province, threatened by drought, sand, and salinization, with a single agricultural structure and backward agricultural technology and economic development [16]. Consequently, Shandong Province has proposed the "Breakthrough Heze" strategy.

As the connection point between Shandong Province' s key Beijing-Kowloon industrial belt and the land bridge industrial belt, as well as the junction of China' s eastern and western regions, southwestern Shandong enjoys superior location conditions that facilitate optimization of agricultural production factors and sales of agricultural and sideline products [17].

Current main problems in southwestern Shandong' s agricultural development include: (1) Low cultural and scientific quality of the labor force. (2) Relative shortage of natural resources per capita, with per capita cultivated land below the national average. (3) Excessive application of chemical fertilizers and pesticides, causing serious environmental pollution and soil compaction. (4) Extensive cultivation and low agricultural input-output ratios. (5) Relatively single planting structure, long dominated by grain and cotton with low efficiency, and low commercialization rates of cash crops like soybean, peanut, and rapeseed. Among grain crops, wheat production is emphasized while maize production is neglected. (6) Southwestern Shandong is a major cotton production area in the Huang-Huai-Hai Plain, fully utilizing cotton's salinity tolerance as an important income source in medium and low-yield field areas, but cotton planting benefits have fluctuated greatly in recent years with low efficiency.

Addressing these deficiencies and advantages, southwestern Shandong needs to accelerate modern agricultural development in the following aspects: (1) Strengthen vocational education development to improve the scientific and cultural quality of the agricultural labor force, transforming human resources into human capital. (2) Demonstrate and promote straw mushroom cultivation technology, wheat and maize straw return with rapid decomposition for efficient soil improvement, intercropping and relay cropping, ecological compound planting, and water-saving agriculture technology models to tap the potential for efficient agricultural resource utilization. (3) Implement agricultural brand strategy to standardize green food production and enhance international competitiveness [18]. (4) Strengthen diversified operations to promote coordinated development of grain, cash crops, and feed, integration of agriculture, forestry, animal hus-

bandry, and fishery, and combination of planting, breeding, and processing. (5) Accelerate transformation of resource utilization methods, promote major projects for soil improvement and remediation, pesticide residue management, plastic film pollution control, livestock manure treatment, and heavy metal pollution remediation, and popularize ecological circular agriculture models such as "livestock-biogas-fruit" to ensure sustainable agricultural development [19]. (6) Southwestern Shandong' s cattle are very famous, and agriculture-animal husbandry integration has distinctive features, but further efforts are needed to strengthen and enlarge the industry and create a famous premium cattle industry brand. (7) Some private large enterprises have emerged in the region, such as Zhuangzhao paulownia board processing and Yuncheng Xukai wood processing, forming certain markets for forest product processing, but further scientific and technological investment is needed to create modern production-level famous product industrial chains and form high-end furniture products.

As an underdeveloped region with large populations and limited land, traditional farming can no longer increase income. Based on agricultural, forestry, and animal husbandry resource advantages and strengthening the integration of primary, secondary, and tertiary industries, vigorously developing agricultural and sideline product processing with beef cattle and other food processing industries as the forerunner is a fundamental industrial policy for revitalizing southwestern Shandong' s agricultural economy [20]. In recent years, southwestern Shandong has achieved remarkable results in adopting diversified management models, rationally utilizing resources, and promoting sustainable agricultural development, but further strengthening is still needed to meet the requirements of building a new socialist countryside. It is necessary to fully leverage regional location advantages and develop characteristic integrated modern agriculture such as sightseeing agriculture, contract agriculture, and green agriculture according to local conditions [21].

6. Development Strategies for Modern Agriculture in Southeastern Henan

Henan Province is a major grain production province and also China' s kitchen for grain deep processing. In developed agricultural countries, the ratio of agricultural product processing industry output value to agricultural output value is 3:1, while China' s current level is roughly 0.5:1, with Henan' s overall level even lower [22]. Therefore, deep processing of agricultural and sideline products represents a field with considerable potential for Henan to transition from a major agricultural province to a strong agricultural province.

Henan Province has 4.13 million hectares of medium and low-yield fields, with one-third concentrated in the Yellow River flood area of South Huanghuai [23], namely the southeastern Henan region. This area has relatively weak agricultural foundations, with many types of agricultural disasters occurring at high frequency and broad scale. Potential for continued production increases through area expansion is limited, making sustained yield growth a formidable task. In

crop production, Henan experiences frequent natural disasters, requiring concrete improvements to agricultural production conditions, continuous perfection of infrastructure such as wells, channels, and roads, consolidation of the foundation for sustained grain production increases, and efforts to improve the situation of relying on rainfall for agriculture.

The southeastern Henan region is the central plains granary area, mainly comprising Zhoukou, Zhumadian, Shangqiu, and Xinyang cities located in the Huang-Huai Plain. With over one-third of Henan' s population, 40% of its cultivated land area, and nearly half of its grain output, it is an important core grain production area in the province. During the planned economy era, these four Huang-Huai cities were once Henan' s affluent areas. However, with the transition from planned to market economy, regions previously considered geographically disadvantaged have risen rapidly, while these plain agricultural areas have become representatives of backwardness. The status of the four Huang-Huai cities in Henan is equivalent to Henan' s status in China. The difference is that after the state proposed the "Central China Rise" strategy in 2004, the six central provinces including Henan achieved rapid development within two years, while the four Huang-Huai cities fell deeper into depression under Henan' s central rise, becoming the "Southeastern Henan Collapse Area" [24] and a typical example of major grain production cities with economic backwardness in China' s Huang-Huai-Hai basin.

In recent years, southeastern Henan has prioritized modern agriculture as a pillar industry. On the basis of vigorously developing the food industry centered on deep processing of agricultural products, a number of characteristic agricultural economic zones have been formed, such as high-quality protein and special maize bases in Zhumadian, Zhoukou, and Shangqiu; high-quality cotton production bases in Zhoukou and Shangqiu; and fruit, peanut, and garlic production bases in Shangqiu. Large commercial grain bases in Zhoukou and Zhumadian have been established [25].

Key directions for developing modern agriculture in southeastern Henan include: (1) Cultivate a group of leading enterprises to accelerate the construction of a food industry intensive area in southeastern Henan and promote rapid development of the food industry in major agricultural production areas such as Kaifeng and Zhumadian. (2) Develop market mechanism-based agricultural production models, vigorously promote the "company + farmer" development model, and drive farmers to enter higher value-added processing and circulation links from production, allowing farmers to obtain tangible benefits. (3) Implement high-quality grain industry projects, establish a batch of national large commercial grain bases such as in Zhoukou, Zhumadian, and Shangqiu, and change the situation of relying on rainfall for agricultural production. (4) Cultivate new crop varieties in southeastern Henan with high-quality wheat as the main focus, introduce, breed, and promote high-quality varieties from outside the province, establish a batch of crop seed breeding bases, and promote seed industry development. (5) Focus on constructing high-quality forest vari-

ety domestication and breeding bases in western Shangshui County, Zhoukou City. (6) Accelerate rapid development of "Internet of Things+" agriculture to improve agricultural labor productivity and promote agricultural modernization. (7) Select a batch of agricultural industrialization leading enterprises and farmer cooperatives for support. While strengthening leading enterprises, radiate and drive standardized production and industrialized management of base farmers, rapidly promoting overall improvement of industrial development levels. (8) In major grain-producing cities like Zhumadian and Zhoukou, agricultural comprehensive development projects should encourage 倾斜 toward major grain-producing counties and townships, remote agricultural areas with poor facilities and large development potential, and contiguous areas with open fields that are easy to manage. Through scientific project selection, concentrated investment, and breaking administrative boundaries, implement large-scale development to ensure stable, high-yield production capacity [26].

7. Modern Agricultural Development Strategy for South Huanghuai Granary

Based on trends in climate warming and modern agricultural development focused on green, quality-enhancing, yield-increasing, and efficiency-improving approaches, and according to regional advantages and natural resource endowments across South Huanghuai, we propose the following comprehensive strategies: For crop production, first, breed wheat varieties resistant to scab and utilize integrated control measures to reduce scab damage; second, develop and accelerate demonstration and promotion of new maize varieties with drought and waterlogging tolerance and rapid dehydration suitable for mechanized grain harvesting; third, expand ton-grain field construction to ensure food security in South Huanghuai. For regional land management, prioritize improving medium and low-yield fields in the Yellow River flood area' s sandy, saline-alkali land and Huaibei lime concretion black soils, strengthen investment in farmland irrigation and drainage systems, and build high-standard fields with supporting forest networks, roads, channels, and wells to ensure stable yields despite drought or excess rain. For modern technology and equipment, increase machinery subsidies, expand the number of large and medium-sized agricultural machines, strengthen demonstration and promotion of deep plowing and subsoiling machinery, and popularize whole-process mechanization.

For green quality and efficiency improvement, actively promote reduction of chemical fertilizers and pesticides, expand application of environmentally friendly green bio-fertilizers, and enhance efficient cycling of straw return and biological agriculture. For science and technology education, expand vocational education scale to cultivate knowledgeable farmers and professional service workers, creating specialized teams for socialized services. For regional economic development, strengthen and enlarge grain branding in northern Anhui, expand large-scale grain production in northern Jiangsu, promote coordinated and efficient agriculture-forestry-animal husbandry development in southwestern

Shandong, and build a flagship food deep-processing industry in southeastern Henan. For agricultural information construction, expand "Internet+" agriculture to drive rapid development of contract farming, export-oriented agriculture, and sightseeing agriculture. Transform the South Huanghuai grain production area and economic "depression zone" into a national principal granary, emerging agricultural economic zone, and environmentally beautiful sustainable development region.

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