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Views & Comments

China's Rural Transformation and Policies: Past Experience and Future Directions

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1. Introduction

China's rural areas have experienced a significant transformation in the past four decades. During the period 1978–2019, agricultural production increased at an average rate of 5.4% per year [1]. Although China's water availability per capita is only one fourth of the global average and the nation's cultivated land is only 9% of the global total, China's increased agricultural production has largely met the food needs of one fifth of the world's population [2]. Between 1990 and 2020, the prevalence of undernutrition in China dropped from 22.9% to below 2.5% [3]. The rapid growth of China's agricultural sector has been accompanied by a significant shift in production, from a primary focus on grain production to a focus on more diversified and high-value agricultural products such as vegetables, fruits, livestock, and fish [4]. Meanwhile, an increasing number of rural laborers are engaged in non-farm employment. A recent study showed that the proportion of rural laborers engaged in non-farm activities increased from 9.3% in 1978 to 84.4% in 2018 [5].

Growth in agricultural production and off-farm employment has raised farmers' incomes and massively reduced rural poverty. During 1978–2018, the per capita income of rural households in real term (deflated by consumer price index) increased by nearly 22 times [1]. Over the same period, the number of people living in poverty fell from 770 million in 1978 to 551 000 in 2019 in rural China, decreasing the incidence of rural poverty from 97.5% to 0.6% [1]. Recently, the national leader declared that China had completely eliminated rural poverty as of the end of 2020. China is the first developing country to be ten years early in meeting the United Nations Sustainable Development Goal of eliminating poverty by 2030.

Although these achievements are impressive, China's rural development is encountering great challenges in terms of promoting sustainable agricultural development, ensuring national food security, and reducing the income gap between rural and urban populations [2]. Given the size of the country, the question of how to deal with these challenges has implications for both China's rural development and global food systems. Recently, in order to foster agricultural and rural development, China initiated its Rural Revitalization Strategy (RRS) early in 2018. An understanding of China's rural transformation and major policies in the past, as well as the effectiveness of recent polices in response to current challenges, is relevant not only for China's own future development but also for that of many other developing countries.

This paper aims to provide insights into China's rural transformation and policies in the past and the future, with particular focus on the following questions: ① How have China's rural areas been transformed over the past 40 years? ② What are the major policies that have stimulated rural transformation in the past? ③ What are the current major challenges in China's agricultural development and rural transformation? ④ How has China's government responded to these challenges, and what will the future policy directions be?

2. Rural transformation in the past four decades

As rural transformation covers many dimensions and the focus of rural transformation often varies among different disciplines [6–8], we have adopted the definition of rural transformation by the International Fund for Agricultural Development (IFAD), which defines rural transformation as "the process involving rising agricultural productivity, commercialization and diversification of production patterns and livelihoods, and expanded off-farm employment" [9]. In this definition, the two major aims of rural transformation are shifting the structure of agricultural production from primarily staple grain production to more diversified non-grain or high-value agriculture and shifting rural laborer employment from primarily farm work to more non-farm employment. The structural transformation of agricultural production can be measured by the proportion of non-grain commodities in the total agricultural output values, and the transformation of rural laborer employment can be measured by the proportion of rural laborers with non-farm employment. These two indicators have been widely used in the rural transformation literature in many countries in Asia and Africa [9–12]. As for the consequences of rural transformation, we focus on provincial rural income (or per capita income in rural areas) and rural poverty incidence. Based on these indicators of rural transformation and its consequences, the

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following four major points are key features of China's rural transformation in the past 40 years [4,13,14].

First, the shift in agricultural production from being grain-dominated to a focus on high-value crops, livestock, and fish is the main feature of the structural transformation of China's agricultural production. This trend has occurred in all regions, although there are some variations among provinces (Fig. 1). Nearly 70% of China's provinces had a high-value agriculture proportion of more than 85% in 2018. Many provinces that had a low proportion of high-value agriculture in the late 1970s have speeded up their agricultural transformation in the later stage of transformation.

Second, rural laborer participation in non-farm employment has risen substantially in the past four decades. On average, among all the provinces, only about 7% of rural laborers worked in non-farm sectors in 1978. This proportion increased to more than half (51%) in 2018. Similar to the rural transformation that took place within the agricultural sector, there was a large variation in non-farm rural laborer employment across provinces. For example, rural households in more economically developed provinces have gained much more non-farm employment than those in the less developed regions.

Third, there is a strong positive relationship between provincial rural transformation and rural income growth (Fig. 1). A significant increase in rural income has accompanied China's rural transformation. The average real income increased by 16 times from 1978 to 2018, ranging from an increase of 10–12 times in less developed provinces in western China to an increase of more than 20 times in more developed provinces in eastern China. The stage and speed of rural transformation, measured in either the proportion of high-value agriculture or the proportion of non-farm rural laborer employment, are closely associated with the level and growth of rural income. Moreover, this relationship is nonlinear: The per capita income tended to increase moderately in the early stage of rural transformation and then rose dramatically after the proportion of high-value agriculture exceeded 60% or the proportion of non-farm rural laborer employment reached 40%.

Last but not least, there is a strong positive relationship between rural transformation and rural poverty reduction [15]. With the rapid rural transformation, a rapid fall in the incidence of rural poverty can also be observed. This decrease in rural poverty is the most successful story in China's rural transformation and poverty alleviation. Interestingly, the positive relationship between rural transformation and poverty reduction is stronger in the early stage of the transformation, which indicates the importance of agricultural transformation and rural laborers attaining non-farm employment in the early stage of rural development [15]. These results also suggest that a targeted poverty-alleviation program is required for those who have difficulty escaping poverty through general rural transformation in the later stage of rural transformation.

3. The major rural policies driving China's rapid and inclusive rural transformation in the past

Before discussing the major rural policies that drive rural transformation, it is worth noting that rural transformation interacts with structural transformation [10]. Structural transformation driven by urbanization and industrialization has increasingly created employment opportunities for rural laborers. Together with the increase in agricultural productivity, the proportion of agricultural employment in the national economy has decreased more than the proportion of agricultural products in the gross domestic product (GDP). In regard to rural policies, numerous studies have analyzed the factors contributing to China's rapid and inclusive rural transformation. These factors include sequencing institutional reforms, embracing technological progress and innovation, providing incentives for agricultural production and transformation, and

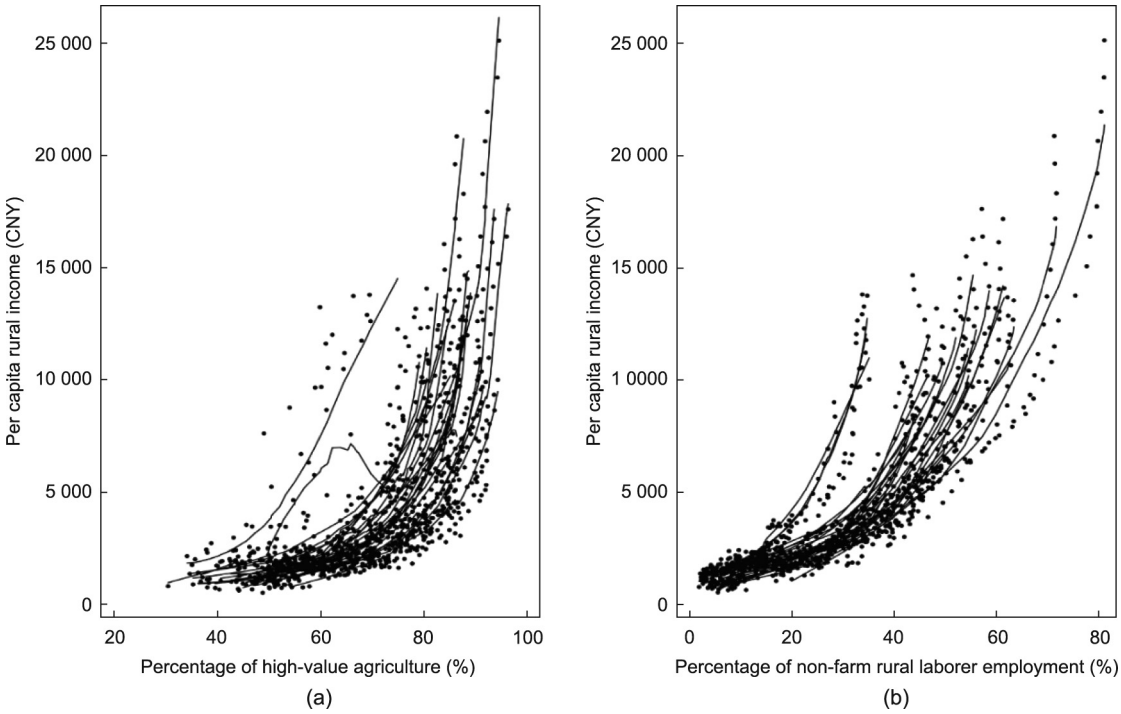

Fig. 1. Locally weighted scatterplot smoothing (LOWESS) fitting results for China's rural transformation and per capita rural income by province during 1978–2018. Each dot represents (a) high-value agriculture as a percentage of agricultural production or (b) non-farm rural laborer employment as a percentage of total rural laborer employment plotted against the per capita rural income for a province in a year. Reproduced from Ref. [15] with permission of China Center for Agricultural Policy, Peking University, © 2021.

increasing public and private investment in rural areas in the past four decades.

3.1. Institutional reforms

Land reforms have facilitated China's rapid rural transformation. The household responsibility system (HRS), which was implemented during the period 1978–1984, is regarded as the starting point of China's rural transformation. This reform dismantled the people's communes and contracted cultivated land to individual households largely based on the number of people and/or laborers in the household, thereby significantly raising agricultural productivity [16–19]. Policies to enhance land property rights and land rental markets further increased the incentive to invest in land, while also increasing the efficiency of land use through land relocation. Therefore, such policies have further increased agricultural productivity since the late 1990s [20,21]. To facilitate land consolidation, an institutional arrangement separates the land operation rights from the village-owned property rights and the household's contract rights, where the latter two rights are not transferable. This arrangement has accelerated the transfer of operation rights and increased farm sizes in the past decade. These shifts are critical in raising agricultural productivity and increasing rural laborers' non-farm employment, in comparison with the past, when China's agriculture was dominated by small farms and farm sizes were declining [22,23]. This land institution reform can achieve both equity of land distribution and better use of agricultural land by transferring operation rights to more productive farmers [24]. Increasing farm size has also facilitated agricultural mechanization and off-farm employment for rural laborers [25].

Several other institutional reforms have also been implemented to accelerate the rural transformation, including institutional reforms related to the labor market, water use, and agricultural machinery. Although the *hukou* (the household registration system) still impedes the integration of rural and urban development, restrictions on internal migration have gradually been relaxed, which has promoted laborer mobility among sectors and between regions in the past 40 years [26]. By 2018, about 173 million rural migrant laborers held non-farm employment outside of their township [1]. Within the agricultural sector, major institutional changes have also occurred in the areas of irrigation and mechanization. To effectively manage water use and increase water use efficiency, water use associations have been developed in many irrigation districts [27]. Although mechanization presents a considerable challenge in a production system dominated by small farms, most of the farm activities in major crop production are now operated by machinery in China. This advance is mainly due to the rapid development of and institutional innovation in the mechanization service provided by the relatively large farms or specialized mechanization stations [28,29]. The increased level of mechanization that has been achieved through mechanization services has also facilitated the transformation of agricultural production technology from labor-intensive to capital-intensive and the transformation of rural laborer employment from the agricultural sector to other sectors [23].

3.2. Agricultural technology changes

China has developed a strong science and technology system and has invested hugely in agricultural research and development (R&D) and technology extension [30]. The increase in agricultural productivity due to technological changes has facilitated a shift in the agricultural sector from grain-based to more diversified and high-value agriculture. In 2015, public expenditure on agricultural R&D was estimated to reach more than 26 billion CNY (about 4.1 billion USD), overtaking the public spending of the United States and ranking as the highest in the world [31]. China's agricultural R&D and technology extension system have generated a wide range of innovative technologies used by millions of small farms involved in crop, livestock, and fish production. For example, the current adoption rates of modern varieties of rice, wheat, and maize all exceed 96%, which is largely due to China's strong seed R&D system. Although the public sector has played the most important role in agricultural technology innovation, the role of the private sector in this area has been growing in recent years.

With its strong agricultural R&D and technology extension system, China has significantly increased its agricultural productivity and accelerated its rural transformation. China was one of the first developing countries to develop and extend the "green revolution" technology in rice in the 1960s and in hybrid rice since the 1970s. Technological changes in wheat, maize, cash crops, and animal production have also been impressive since the 1990s [32]. Empirical studies show that the average annual growth rate of agricultural total factor productivity (TFP) in the grain sector increased by about 3% before 2005 [33–35]. The TFP growth rates for cash crops and livestock and for the whole agricultural sector were even higher after 1992, exceeding 3.5% per year [34]. Rapid agricultural productivity growth has enabled the country to conserve its limited land and water resources. Since the late 1990s, China has also applied biotechnology to raise its agricultural productivity growth. The wide cultivation of *Bt* cotton is an example of the successful use of genetic modification in the developing world—a technological change that has benefited millions of farmers [36].

3.3. Market development and incentive policies

Market development has fostered rural transformation since the mid-1980s. Reforms have been gradually implemented in both the agricultural output market and the agricultural input market, which has facilitated China's smooth transformation from a planned economy to a market-oriented economy. Over time, significant improvements in marketing, logistics, and transportation infrastructure have accompanied gradual market reform, fostering market integration and linking hundreds of millions of small farms to markets during agricultural commercialization [37]. Farmers have benefited from the efficient use of land and laborers due to market development and adjustment of the production structure according to changes in market prices [38].

Between 2004 and 2013, China attempted to intervene in agricultural markets through government procurements to raise farmers' income, which resulted in a structural unbalance of agricultural supply and demand—and a major lesson to be learned. The results of this intervention further show the importance of market reform in agricultural development and rural transformation [2]. China abolished direct market-intervention policies in 2014, and the overall market distortion has fallen since 2015.

China has also significantly liberalized its agricultural trade since the early 1990s, particularly after China joined World Trade Organization in 2001. This has accelerated China's rural transformation by shifting agricultural production toward commodities with more comparative advantages. External reform has made China one of the most liberal countries in the world in terms of agricultural market [39]. The export of labor-intensive products (e.g., horticulture and livestock) and the import of land- and water-intensive commodities (e.g., soybeans, cotton, edible oil, and sugar) have been rising. The nature of trade—which reflects China's comparative advantage—has improved the efficiency of China's resource allocation and agricultural production.

Since the early 2000s, China has shifted its policy regime from taxing to subsidizing agriculture [2]. Like many developing countries, China used to tax agriculture in order to support industrialization in the early stages of development. However, China eliminated all

agricultural taxes and fees in 2004 and then started an agricultural subsidy program in the same year, which is implemented in a way that is largely decoupled from agricultural production. However, given the number of rural farming households, the program's contribution to increasing farmers' income is very moderate. Therefore, China capped the total amount of agricultural subsidies in 2012 and thereafter shifted more of its budget toward income transfer and investment in agricultural infrastructure, greening agriculture, and the living environment.

3.4. Increasing investment in rural infrastructure

China has substantially invested in agricultural infrastructure, particular in irrigation. The area of irrigated agricultural land increased from 450 000 km^2 in 1978 to 690 000 km^2 in 2020, accounting for 54% of the total cultivated land [1]. In addition, China has substantially increased its investment in low- to mid-quality land since the 1990s, in order to improve the soil quality and raise agricultural production capacity. Massive investments have also been made in rural roads. By the late 2010s, nearly every village had access to a public paved road. The empirical evidence shows that government spending on rural roads has a very high impact on agricultural transformation, off-farm employment, and poverty reduction [27,40].

Farmers have also substantially increased their own investments and uses of modern agricultural inputs. For example, farmers' investments in irrigation have steadily increased over time [27]. The total power of agricultural machinery increased from 117.5 million kW in 1978 to 1056.2 million kW in 2020 [1]. The use of chemical fertilizers increased dramatically from 8.84 billion kg in 1978 to a peak of 60.23 billion kg in 2015 [1], which significantly raised crop yields, despite the resulting concern regarding the intensive use of chemical fertilizers [41].

4. Current major challenges in China's agricultural development and rural transformation

Despite the nation's impressive achievements over the past four decades, China's rural transformation is encountering a set of emerging challenges. Increased agricultural production has come at the expense of the environment and sustainable development [42]. The comparative advantage of China's agriculture in the international market has been falling, and agricultural imports have been increasing, raising concern about national food security. Despite the steady growth in farmers' income from agriculture and off-farm employment, the rural–urban income gap remains high [1].

4.1. Land and water scarcity and sustainable agricultural development

China's rapidly urbanizing and richer society with its rising food demand has put pressure on the increasing scarcity of cultivated land and water, although the conservation of both land and water is critical for sustainable agricultural development. Degradation of land and water resources is equally worrisome, due to the increasing intensification of agriculture to meet the growing food demand. China is also vulnerable to climate risks [42]. While chemical fertilizers (and pesticides) have played an important role in increasing crop production (and reducing the crops lost to pests), excessive use of chemicals has resulted in serious non-point pollution, food-safety problems, land degradation, and rising greenhouse gas emissions from agriculture [41].

4.2. Increasing food imports and rising concern about the uncertainty of the global market

China has recently become the world's largest agricultural importer, and its trade deficit has continued to increase. The nation has shifted from an agricultural net exporter to a net importer since the mid-2000s. In 2018, the net import of agricultural commodities surged to 57.3 billion USD [43]. In 2020, China imported more than 100 billion kg of soybeans and 11.3 billion kg of maize. Furthermore, China's imports of feeds, edible oils, sugar, and meats are expected to continue to increase in the coming decade [44,45], raising the country's concern regarding risks in the international markets, as seen from the recent China–United States trade disputes and the impact of the coronavirus disease 2019 (COVID-19) pandemic.

4.3. Remaining rural–urban inequality

Although farmers' incomes have improved significantly over time, the rural–urban inequality continues to pose a policy challenge. The per capita income of urban residents was 2.57 times that of rural residents in 1978, and this difference increased to a peak of 3.3 times in 2009, although it has gradually fallen since then. Still, the difference was 2.56 times in 2020 [1]. Inequality between urban and rural populations also occurs in social protection and access to public services.

5. Government responses to recent challenges and future policy directions

In dealing with the current challenges, China has initiated a series of new strategies and supporting measures since the mid-2010s.

5.1. Strategies and major measures for greener and more sustainable agriculture

China has implemented several programs to promote greener agriculture since the mid-2010s. In 2015, China announced a plan to reach zero growth in total fertilizer and pesticide use in agriculture by 2020. To achieve this goal, China implemented a special science and technology program in 2016–2020 to reduce fertilizer and pesticide application by increasing the efficiency of their use. In addition, a pilot program to promote organic fertilizer application through government subsidies has been implemented since 2017. With these efforts, agricultural chemical use (i.e., the use of fertilizers and pesticides) has recently fallen [1]. Other major programs for greener and more sustainable agriculture include—but are not limited to—compensative programs for farmers engaging in agricultural land rotation, land fallow conservation, the recovery of degraded land, grassland ecological protection, and comprehensive utilization of crop straw and animal manure.

A bold move toward greener and more sustainable agricultural and rural development started in 2017, when China officially issued a national policy document on green agricultural development. This document was issued by the General Office of the Communist Party of China (CPC) Central Committee and the State Council of the People's Republic of China and was titled *Opinions on innovating systems and mechanisms to promote green agricultural development*. In response to this national call for green agricultural development, in 2018, the Ministry of Agriculture and Rural Affairs (MARA) of the People's Republic of China issued the *Technical guidelines on green agricultural development for 2018–2030*. These guidelines aim to comprehensively establish an efficient, safe, low-carbon, circular, intelligent, and integrated technology system for greener agricultural development and to promote agricultural science and technology innovations to support the "three major shifts" in agricultural production. The "three major shifts" include a shift in agricultural production from a focus on quantity alone to a focus on quantity, quality, and efficiency; a shift in agriculture

from a focus on production function to a focus on both production and ecological functions; and a shift in productive growth from a focus on a single factor (i.e., the land) to a focus on TFP growth. In 2021, MARA and the other five ministries jointly issued the *Green development plan for agriculture* during the 14th Five-Year Plan period (2021–2025). The overall goals of this plan are to comprehensively promote greener agricultural and rural development with appropriate institutional systems, incentive mechanisms, and stronger technological and policy support by 2025. Specific objectives are set for each of the following: natural resource utilization, the living environment, agricultural ecosystems, green product supply, and carbon reduction and sequestration capabilities.

5.2. Strategies and major measures to raise agricultural productivity and ensure national food security

To ensure food security, China recently initiated several important strategies. Since 2015, China has enforced the "Store Grain (Food) in Land" and "Store Grain (Food) in Technology" strategies. The Store Grain (Food) in Land strategy aims to implement a strict farmland protection system with a minimum of 1.2 million km^2 of cultivated land. It also aims to significantly improve the soil quality and production capacity of cultivated land. The Store Grain (Food) in Technology strategy aims to substantially increase agricultural productivity through technological innovations. China also issued the *Food Security Guarantee Law of the People's Republic of China* in 2020 to ensure that the nation can become largely self-sufficient in cereals and achieve absolute security in food grains (rice and wheat), and to enable China to continue to increase its investment in agriculture.

The development of productivity-enhanced and greener technologies has recently been emphasized. Technological change has played a key role in increasing agricultural productivity and improving national food security in the past four decades, as discussed in Section 3. China recognizes that technological change will play an even more important role in ensuring national food security under greener and more sustainable agricultural development in the future. For example, the abovementioned *Technical guidelines on green agricultural development in 2018–2030* list a set of major necessary technological innovations that differ significantly from technological changes in the past. These include technological innovations for greener agricultural inputs, greener production technologies, greener post-harvest value-added technologies, greener and low-carbon crop–livestock production technological systems, and technological development models for greening integrative rural development.

Emphasis has been placed on embracing novel biotechnology and digital technology in order to raise agricultural productivity. The country has invested substantially in agricultural biotechnology [46,47]. *Bt* cotton, which is a genetically modified (GM) variety of cotton, has been proved to generate significant gains by raising the yield of cotton and decreasing pesticide use [46,48]. Although GM rice technology was ready in 2009, it has not been approved for commercialization due to public concern. Nevertheless, the approval of production-safety certifications for GM maize and GM soybeans in 2019–2020 suggest that these crops could be commercialized within a couple of years, as they are largely used for feed and processing. This would significantly contribute to China's greener agriculture and food security in the near future.

The recent development and adoption of digital technologies—particularly rural E-commerce—have added fuel to agricultural and rural transformation, providing a new approach to help smallholder farmers overcome barriers to accessing the market and new technologies [49,50]. In 2020, in order to accelerate the application of digital technologies in agriculture, MARA issued the *Plan for digital agriculture and rural development (2019–2025)*. This plan aims to develop modern digital infrastructure; enhance the digital transformation of agricultural production, business, and services; and improve digital governance in rural areas. The plan also aims to raise the proportion of value-added digital agriculture in total agriculture from 7.3% in 2018 to 15% in 2025.

To ensure food security, a huge amount of investment has been allocated to the construction of high-standard farmland (HSF). HSF is farmland with contiguous plots, high resilience to drought and flood, water conservation, a stable and high yield, and ecological friendliness. The area of HSF reached 400 million mu (1 mu = 666.67 m^2) in 2015, increased to 800 million mu in 2020 (which is equivalent to nearly 42% of the currently cultivated land), and is expected to reach 1.075 billion mu in 2025 and 1.2 billion mu in 2030 under the national plan.

In addition, reducing food loss and food waste has become a national strategy, which has contributed to both food security and greener and more sustainable agriculture. In 2010, the State Administration of Grain (rebranded and restructured as the National Food and Strategic Reserves Administration in 2018) issued *Recommendations to combat food waste*, which include raising public awareness on reducing food loss and food waste, and major measures for reducing food loss and food waste. One well-known example is the "Clean Your Plate" initiative to reduce food waste. In 2020, China issued the *Anti-Food Waste Law of the People's Republic of China* and became the first country in the developing world to use the law to reduce food loss and food waste.

5.3. Strategy and major measures for raising farmers' income and narrowing urban, rural, and regional divides

China has set a target of faster income growth in rural areas than in urban areas in the coming decade. The Common Prosperity for All People Strategy and the RRS are two major national initiatives to promote the rapid growth of rural household incomes in future. Although detailed policy measures to raise farmers' income have not yet been specifically identified, fostering rapid and inclusive rural transformation by developing high-value agriculture and creating more non-farm jobs for rural laborers was a key pathway to raise rural household incomes in the past and will continue to be a major way to raise rural income in the future. In addition, farmers can gain more income from greener agriculture and productivity-enhanced investments. With the recent national call for integrated urban and rural development, more equitable access to social protection, public services, and urban jobs is expected for rural residents in the coming decade. With the rising level of non-farm employment, the remaining few agricultural laborers will expand their farm sizes, increase agricultural laborer productivity, and thereby increase their income.

6. Concluding remarks on the pathway forward

China's RRS has achieved full implementation now that China has completely escaped rural poverty as of 2020. While the RRS covers many areas in the rural economy, ecology, a livable environment, rural civilization, local governance, and a wealthy life for citizens, the key policy goals of agricultural and rural development now and in the coming decade include emphasizing greener and more sustainable agriculture, ensuring food security, and increasing farmers' income, particularly for low-income farmers. A successful rural transformation will contribute not only to the goals of the RRS but also to the nation's ambitious action plans to achieve a peak in greenhouse gas emissions by 2030 and carbon neutrality by 2060. We expect that more efforts to facilitate greener agricultural and rural development and raise farmers' income will be

made with the implementation of the RRS in the coming decade. This has already been emphasized in the recently released 14th Five-Year Plan (2021–2025) and the 2035 Vision Goals on common prosperity for all people.

As China works to achieve the goals of the 14th Five-Year Plan and 2035 Vision Goals, it is essential to establish a rapid, inclusive, and greener rural transformation. To make this happen, learning from past experiences and lessons in agricultural development is key. This paper of China's agricultural development and rural transformation in the past four decades shows that institutional innovations, policy support for technology and incentives, and investment in rural areas (IPIs) matter, and that the sequence of IPIs is critical. China should make greater efforts to implement the RRS through more innovative and greener IPIs so that the overall goals of modernizing agriculture and rural areas can be successfully achieved. The views, experiences, and lessons learned that were presented in this paper may also have important implications for agricultural development and rural transformation in other developing countries.

Acknowledgments

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