THE IMPACT OF DIGITAL FINANCIAL INCLUSION ON AGRICULTURAL GREEN TOTAL FACTOR PRODUCTIVITY IN CHINA: THE MEDIATING ROLE OF RURAL FINANCE

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AD	Agricultural Development level
AFE	Agricultural Fiscal Expenditure
AGD	Agricultural Green Development
AGI	Agricultural Green Investments
AGP	Agricultural Green Production
AGT	Agricultural Green Technology
AGTFP	Agricultural Green Total Factor Productivity
AGTI	Agricultural Green Technological Innovation
AHP	Analytic Hierarchy Process
ANSP	Agricultural Non-point Source Pollution
APRA	Agricultural Production Resources Allocation
ATI	Agricultural Technology Innovation
ATMs	Automated Teller Machines
BRI	Belt and Road Initiative
CB	Coverage breadth
CBBs	Commercial Bank Branches
CFA	China Forestry Administration
CH4	Methane
CI	Confidence Interval
CO2	Carbon Dioxide
CV	Coefficient of Variation weighting method

D	Degree of disaster
DD	Digitization Degree
DDF-ML	Directional Distance Function- Malmquist–Luenberger
DEA	Data Envelopment Analysis
DF	Digital finance
DFI	Digital Financial Inclusion
DID	Differences-In-Differences
DMU	Decision-Making Unit
DVD	Digital Village Development
EI	Effective Irrigation degree
EOL	Education level of the Labour force
FE	Fixed Effects
FI	Financial Inclusion
GDP	Gross Domestic Product
GEC	Green technology Efficiency
GHG	Greenhouse Gas
GML	Global Malmquist Luenberger
GTC	Green Technology progress
GTFP	Green Total Factor Productivity
GTI	Green Technology Innovation
IC	Information Channels
IMF	International Monetary Fund

IPCC	United Nations Intergovernmental Panel on Climate Change
ISO	Industrial Structure Optimization
ISU	Industrial Structure Upgrading
ITU	International Telecommunication Union
LOS	Loans Outstanding
LT	Land Transfer
ME	Degree of agricultural mechanization
MOAOs	Mobile Agent Outlets
MOMOs	Mobile Money transactions
MPSR	Maize Purchasing, and Storage Policy Reform
N2O	Nitrous Oxide
OLS	Ordinary Least Squares
OPEN	Openness
PCA	Principal Component Analysis
PKU_DFIIC	Peking University Digital Financial Inclusion Index of China
PMG	Panel auto-regressive distributed lags
PSM-DID	Propensity Score Matching- Differences-In-Differences
PSTR	Panel Smooth Transition Regression
PVAR	Panel Vector Autoregressive Model
RE	Random Effects
RF	Rural Finance
SARAR	Spatial Autoregressive model with a Spatial Autoregressive

	error term
SBM	Slack-Based Model
SBM-GML	Slack-Based Model- Global Malmquist Luenberger
SDG	Sustainable Development Goals
SEM	Structural Equation Modelling
SFA	Stochastic Frontier Analysis
TFP	Total Factor Productivity
UD	Usage Depth
UR	Urbanization level
WBGFD	World Bank Global Findex Database
VAR	Vector Autoregressive Model
VIF	Variance Inflation Factor
YRD	Yangtze River Delta

IMPAK KEWANGAN INKLUSIF DIGITAL ATAS PRODUKTIVITI HIJAU TOTAL FAKTOR PERTANIAN DI CHINA: PERANAN PENGANTARA KEWANGAN LUAR BANDAR

ABSTRAK

Kajian ini meneliti trend Kewangan Digital Inklusif (DFI), Kewangan Luar Bandar (RF), dan Produktiviti Jumlah Faktor Hijau Pertanian (AGTFP) di China dari tahun 2011 hingga 2022, serta mengkaji hubungan antara ketiga-tiganya. Berdasarkan Indeks Kewangan Inklusif Digital China Universiti Peking (PKU_DFIIC), yang dilengkapi dengan penunjuk seperti kadar pengangguran, penembusan internet, struktur industri, campur tangan kerajaan, dan penaiktarafan industri, satu indeks DFI telah dibina menggunakan kaedah entropi. Hasil kajian menunjukkan bahawa, berbeza dengan pertumbuhan pesat yang digambarkan dalam PKU_DFIIC, DFI meningkat secara sederhana antara 2011–2014, berfluktuasi sedikit pada 2015–2017, dan berkembang pesat pada 2018–2022, khususnya selepas 2020 dengan percepatan promosi aplikasi. RF mencatat pertumbuhan stabil pada 2011–2015, turun naik ketara pada 2016–2017 akibat reformasi dasar, pemulihan pantas sepanjang 2018–2020, dan penstabilan selepas 2021. Wilayah Timur mengekalkan tahap tinggi, manakala wilayah Tengah dan Barat secara beransur-ansur mengecilkan jurang, menonjolkan keberkesanan reformasi dan dasar kewangan inklusif. Menggunakan model SBM-GML, AGTFP nasional didapati meningkat secara keseluruhan, daripada sekitar 1.0 pada 2011 kepada 1.15 pada 2022, meskipun terdapat turun naik. Walaupun berlaku penurunan mendadak pada 2020 akibat COVID-19, ia melonjak semula pada 2021–

2022. Corak wilayah secara umum sejajar dengan trend nasional tetapi dengan ciri tersendiri: Timur berfluktuasi sederhana, Tengah lebih tidak stabil, dan Barat menunjukkan pertumbuhan stabil sebelum COVID-19 tetapi dengan penyusutan dan pemulihan lebih ketara selepasnya. Akhirnya, analisis empirikal menilai hubungan antara DFI, RF, dan AGTFP. Hasil regresi menunjukkan bahawa DFI dengan signifikan meningkatkan AGTFP (pekali = 0.449) dan memacu RF secara positif (pekali = 0.335) pada aras 1%. Analisis pengantaraan selanjutnya menunjukkan bahawa RF memberikan kesan pengantaraan negatif dalam hubungan DFI–AGTFP, sekali gus melemahkan peranan positif DFI. Ujian Sobel dan Bootstrap, bersama semakan keteguhan, secara konsisten menyokong penemuan ini. Secara keseluruhan, DFI memainkan peranan penting dalam meningkatkan AGTFP, namun keberkesanan RF yang terhad membataskan impaknya. Implikasi dasar termasuk mengoptimumkan pengagihan sumber, memperluas aplikasi kewangan digital, memperkukuh instrumen kewangan hijau, serta mengurangkan ketidaksamaan wilayah bagi mempertingkatkan AGTFP, seterusnya memajukan strategi Pemerkasaan Luar Bandar China dan matlamat membina Negara Pertanian yang Kuat.

THE IMPACT OF DIGITAL FINANCIAL INCLUSION ON AGRICULTURAL GREEN TOTAL FACTOR PRODUCTIVITY IN CHINA: THE MEDIATING ROLE OF RURAL FINANCE

ABSTRACT

This study examines the trends of Digital Financial Inclusion (DFI), Rural Finance (RF), and Agricultural Green Total Factor Productivity (AGTFP) in China from 2011 to 2022, and investigates their interrelationships. Based on the Peking University Digital Financial Inclusion Index of China (PKU_DFIIC), supplemented with indicators such as unemployment rate, internet penetration, industrial structure, government intervention, and industrial upgrading, a DFI index was constructed using the entropy method. Results indicate that, unlike the sharp growth reflected in PKU_DFIIC, DFI increased moderately between 2011–2014, fluctuated slightly from 2015–2017, and expanded rapidly from 2018–2022, particularly after 2020 with accelerated application promotion. RF showed steady growth from 2011–2015, sharp fluctuations in 2016–2017 due to policy reforms, rapid recovery during 2018–2020, and stabilization after 2021. The Eastern region maintained a high level, while the Central and Western regions gradually narrowed the gap, highlighting the effectiveness of reforms and inclusive finance policies. Using the SBM-GML model, the national AGTFP was found to rise overall, from about 1.0 in 2011 to 1.15 in 2022, albeit with fluctuations. Despite a sharp decline in 2020 due to COVID-19, it rebounded strongly in 2021–2022. Regional patterns largely followed the national trend but with distinct features: the East showed mild fluctuations, the Central region

experienced greater instability, and the West displayed stable growth before COVID-19 but with sharper contraction and rebound afterward. Finally, the empirical analysis evaluates the interconnections among DFI, RF, and AGTFP. Regression results reveal that DFI significantly promotes AGTFP (coefficient = 0.449) and positively drives RF (coefficient = 0.335) at the 1% level. Mediation analysis further indicates that RF exerts a negative mediating effect on the DFI–AGTFP nexus, weakening the positive role of DFI. Sobel and Bootstrap tests, along with robustness checks, consistently support these findings. Overall, DFI plays a crucial role in enhancing AGTFP, but the limited efficiency of RF constrains its effectiveness. Policy implications include optimizing resource allocation, broadening digital finance applications, strengthening green finance instruments, and reducing regional disparities to improve AGTFP, thereby advancing China's Rural Revitalization strategy and the goal of building a Strong Agricultural Country.

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter begins by introducing the overall background of the research, including the current state and challenges faced in Chinese agriculture, Rural Finance (RF), Digital Financial Inclusion (DFI), and Agricultural Green Production (AGP). It focuses on analyzing the interconnections between DFI, RF, and Agricultural Green Total Factor Productivity (AGTFP). Then, based on this, the problem statement is made. By establishing the connections between these elements, the chapter frames the research questions and objectives, aiming to investigate how DFI and RF can enhance AGTFP and drive Agricultural Green Development (AGD) in China. Finally explaining the significance of the study. This research holds significant value in informing policy and practical interventions to promote high-quality agricultural growth and address environmental concerns.

1.2 Background of the Study

The sustainable development of agriculture and food systems is central to the Sustainable Development Agenda proposed by the United Nations in 2015 (FUND, 2015). AGTFP plays a crucial role in assessing sustainable agricultural practices and directly contributes to Sustainable Development Goals (SDG)13 (Climate Action) by minimizing agriculture's environmental footprint (Taoumi & Lahrech, 2023). China is

the largest developing country in the world, which places agriculture at the core of its economic development (Chen & Lu, 2025). The 19th National Congress of the Communist Party of China emphasized the importance of improving Total Factor Productivity (TFP) to achieve high-quality economic development (Dhar & Mutalib, 2020). The 2021 Government Work Report in China underscored that "quality and efficiency" and "sustainable health" of economic development are now prioritized over mere economic growth, signaling the end of an era where Gross Domestic Product (GDP) alone measured progress (Zhang, 2022). As outlined in the State Council's Government Work Report of 2024, promoting high-quality economic growth is a central objective (Qiang, 2024). In this context, improving TFP is not only an essential goal but also a prerequisite for advancing this quality-driven development.

However, China's agricultural sector continues to face significant challenges. These include a large population with limited arable land (Zhu et al., 2024), underdeveloped rural infrastructure in certain areas (Islam, 2024), and relatively outdated agricultural technologies (Li et al., 2024). Additionally, the penetration rate of agricultural insurance remains low (Sun et al., 2024), leaving agricultural production vulnerable to the dual risks posed by natural disasters and market fluctuations. Agricultural development cannot be separated from financial support, yet rural areas in China still experience financial exclusion (Liu et al., 2024). The demand for RF is characterized by small-scale, short-term, and decentralized needs, which creates a mismatch between traditional financial services and actual demand (Shao et

al., 2024). This issue is compounded by inadequate rural financial infrastructure and the high operational costs for financial institutions, which further exacerbate the regional disparities in financial resource allocation, heavily favoring more developed areas (Hong et al., 2024).

In response to these challenges, the rise of Digital Finance (DF), particularly through the development of DFI, presents a promising solution. DFI, with its low cost and broad coverage, offers notable advantages in resource efficiency (Chen & Zhang, 2024) and environmental sustainability (Ozturk & Ullah, 2022), aligning with China's goals of promoting a greener and low-carbon economy. This transformation underscores the importance of studying the impact of DFI on AGTFP, as well as the role that RF can play in it. At present, China's economy is moving towards a stage of high-quality development, which is a crucial period for improving economic efficiency and quality (Yao & Pan, 2025). Agriculture, as the backbone of the national economy, is entering a transformative stage, shifting its focus from maximizing yields to optimizing quality and efficiency.

1.3 Agricultural Sector in China

The agricultural sector plays a vital role in China's national economy. The Chinese government places high importance on agricultural development and the well-being of farmers. It has implemented the strategy of "storing grain in the land and storing grain in technology," aiming to enhance food production capacity (Chen & Weng, 2025). At the same time, it encourages Agricultural Technological Innovation

(ATI), promotes agricultural modernization, ensures food security, and increases farmers' income, thereby achieving Comprehensive Rural Revitalization Plan (2024-2027) and Plan for Accelerating the Building of a Strong Agricultural Country (2024–2035).

1.3.1 Performance of Agriculture

This section examines the performance of China’s agricultural sector, focusing on trends in the output of crop farming, forestry, livestock, and fishery, its contribution to GDP, and the evolution of farmers’ income.

1.3.1(a) The value-added of the primary industry has consistently grown

With the continuous development of China's economy and the improvement of living standards, the agricultural sector has played a crucial role in contributing to national food security (Pawlak & Kołodziejczak, 2020) and the well-being of the populace (Tomar et al., 2024). According to preliminary calculations by the China Bureau of Statistics, the annual GDP for 2024 was 134.91trillion yuan, reflecting a 5.0% increase from the previous year at constant prices. As illustrated in Figure 1.1, the value-added of the primary industry amounted to 9.14 trillion-yuan, accounting for approximately 6.78% of the GDP. The value-added of crop farming, forestry, livestock, and fishery total 9.66 trillion yuan, representing about 7.16% of the GDP. Both the "value-added of the primary industry" and the "value-added of crop farming, forestry, livestock, and fishery" nationwide exhibited growth. This indicates the significant role that Chinese agriculture plays in the context of economic development.

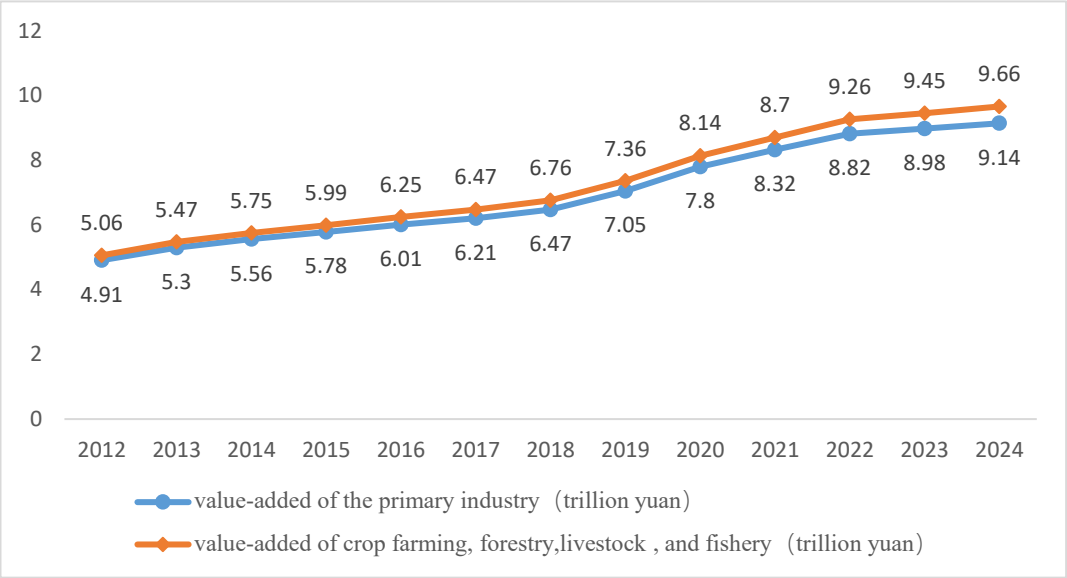

Figure 1. 1 Trends in the value added of China's primary industry and crop farming, forestry, livestock and fishery (China Statistical Yearbook, 2011-2024)

1.3.1(b) A positive development trend for agriculture in China

As illustrated in Figure 1.2, the gross output values of crop farming, forestry, and fishery have shown a continuous upward trajectory from 2011 to 2024, reaching 8.96 trillion yuan, 0.76 trillion yuan, and 1.67 trillion yuan, respectively, by 2024. Although the gross output value of the livestock has generally trended upward, declines were observed in 2017, 2018, 2021,2023 and 2024, with the 2024 output value standing at 3.87 trillion yuan. Overall, these data indicate a positive development trend for Chinese agriculture.

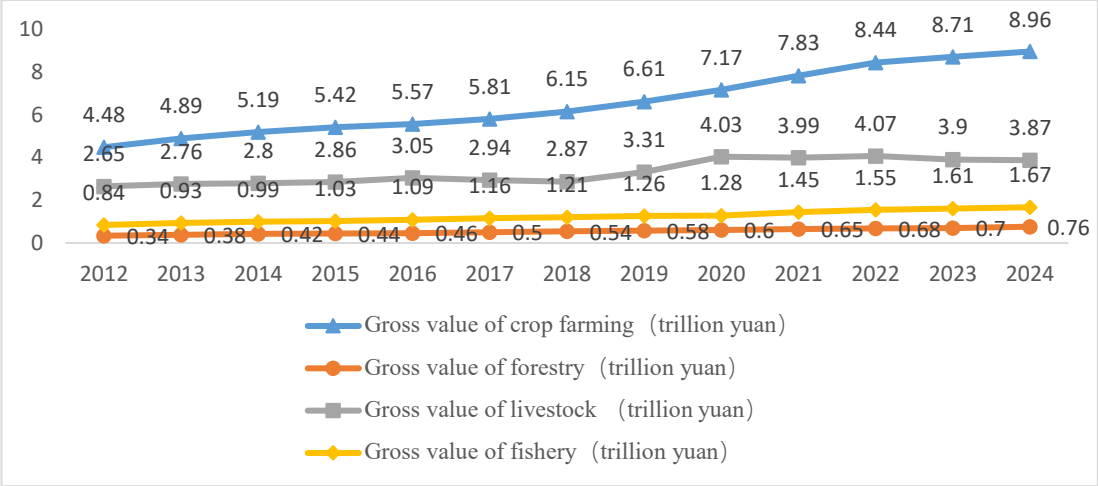

Figure 1. 2 Trends in the gross value of crop farming, forestry, livestock and fishery in China (China Statistical Yearbook, 2011-2024)

1.3.1(c) Contribution of agriculture to GDP

The Figure 1.3 presents the evolution of the total output value of agriculture, forestry, livestock, and fishery in China, alongside GDP levels, and the share of the agricultural sector in GDP from 2011 to 2024. The blue bars depict the agricultural sector's total output value, which rose from 7.88 trillion yuan in 2011 to 16.28 trillion yuan in 2024, nearly doubling over the period. This steady increase reflects both production expansion and improvements in agricultural productivity and value-added processing. Meanwhile, GDP (orange bars) expanded at a faster rate, rising from 49.57 trillion yuan to 134.91 trillion yuan over the same period. As a result, the agriculture share of GDP (gray line) gradually declined from 15.9% in 2011 to 12.07% in 2024, consistent with the structural transformation of a developing economy transitioning toward industry and services.

However, the declining share of agriculture in GDP does not diminish its strategic importance. On the contrary, agriculture remains foundational to national food security,

rural employment, and social stability, particularly in a country with nearly500 million rural residents, accounting for 33% of the total population (China Statistical Yearbook 2024). During economic disruptions, such as the COVID-19 pandemic in 2020, the agricultural sector exhibited remarkable resilience, with its share of GDP temporarily rising to 13.31%, highlighting its role as a stabilizer amidst volatility. Moreover, agriculture plays a pivotal role in China's rural revitalization strategy (Yang et al., 2023), poverty alleviation (Jiang et al., 2024), and ecological conservation (Yang & Solangi, 2024). As China moves toward high-quality development, the emphasis is increasingly on green, inclusive, and efficient agricultural growth, ensuring that the sector contributes not only to GDP but also to long-term sustainability and balanced regional development.

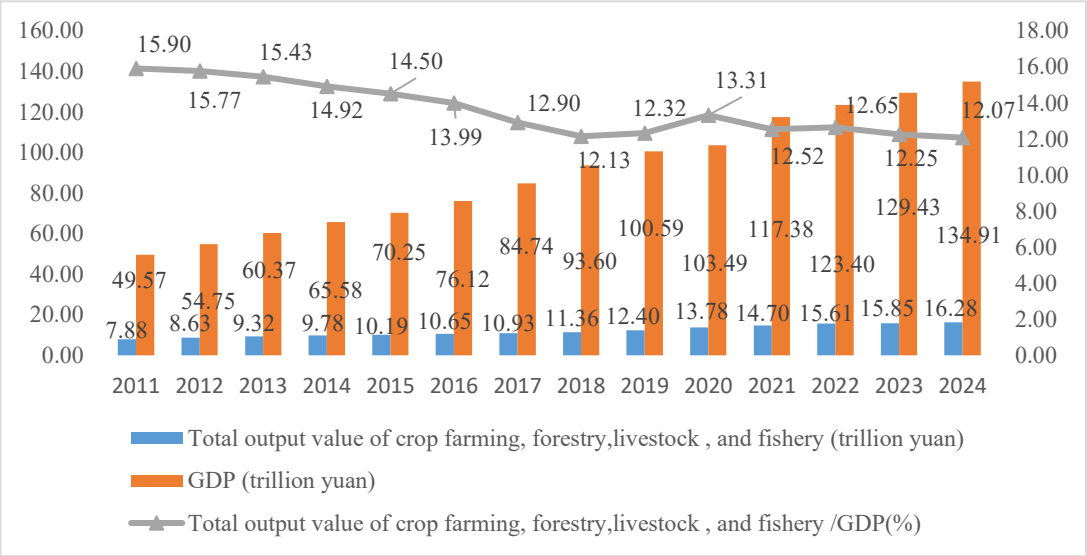

Figure 1. 3 Agricultural output and its share in China's GDP (China Statistical Yearbook, 2011-2024)

1.3.1(d) Slow growth in farmers' incomes

China faces a substantial urban-rural income disparity (Chen et al., 2024), with the growth rate of farmers' income lagging (Wang et al., 2024). The volatility of

agricultural product prices and high market risks present significant challenges for increasing farmers' income (Mustafa et al., 2024). The Figure 1.4 illustrates the trajectory of per capita disposable income for urban and rural residents in China over the period from 2011 to 2024, along with their respective growth rates. The blue bars represent urban per capita disposable income, which increased consistently from 21.43 thousand yuan in 2011 to 54.19 thousand yuan in 2024. The orange bars represent rural per capita disposable income, which also rose from 7.39 thousand yuan in 2011 to 23.12 thousand yuan in 2024.

Despite the absolute income levels in urban areas being significantly higher, the rural population has witnessed substantial relative income growth. However, the growth rates, shown as lines, have demonstrated a general downward trend for both sectors, reflecting a deceleration in income expansion. Specifically, the growth rate for rural income (yellow line) declined from 11.4% in 2011 to 6.3% in 2024, while urban income growth (gray line) dropped from 9.6% to 5.6% over the same period. An exceptional spike occurred in 2021, with rural income growing at 9.7% and urban income at 7.1%, likely a rebound from the sharp decline in 2020 caused by the COVID-19 pandemic (with growth rates at only 1.2% and 3.8%, respectively). The chart reflects the ongoing narrowing of the urban-rural income gap, though the income disparity remains considerable. The slower income growth in recent years may also point to structural changes in China’s economy and the diminishing marginal returns from earlier poverty alleviation efforts.

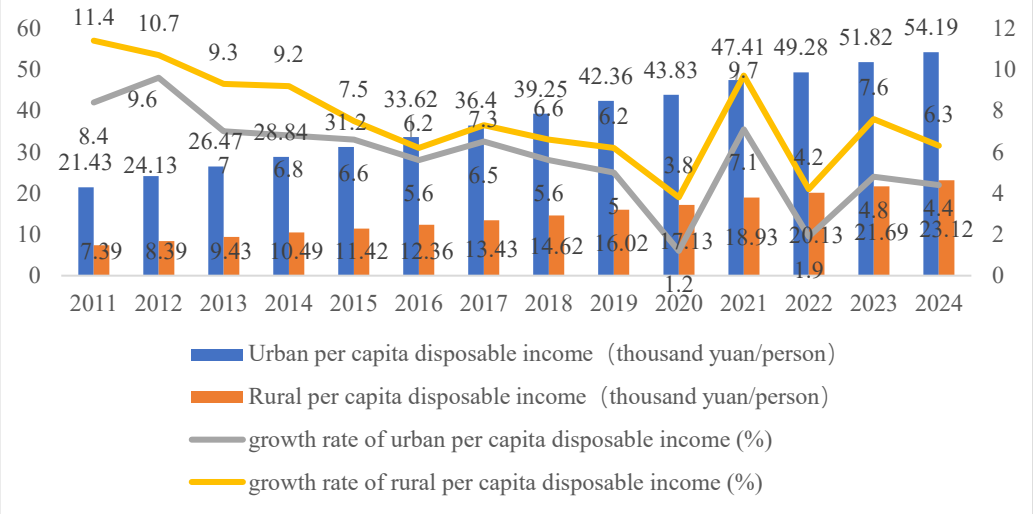

Figure 1. 4 Urban and rural per capita income and its growth rate (China Statistical Yearbook, 2011-2024)

As the second most populous country in the world, China faces the challenge of having per capita natural resources significantly below the global average (Wang et al., 2024). Nevertheless, recent years have witnessed remarkable progress in the country's crop farming sector, with output steadily increasing (Qiu et al., 2024). Additionally, outputs in forestry, livestock and fishery have shown upward trends, further promoting the diversification of agriculture. However, it is noteworthy that the excessive use of agricultural inputs such as fertilizers, pesticides, plastic and feed mulch has led to the deterioration of the agricultural ecological environment (Zhao et al., 2024), posing significant threats to the quality and safety of agricultural products (Zhou et al., 2025). This phenomenon not only results in resource wastage and environmental pollution but also triggers serious negative externalities.

1.3.2 Challenges of Agriculture

This section examines the key challenges confronting China's agricultural sector, focusing on issues related to per capita arable land, agricultural labor, and environmental sustainability.

1.3.2(a) Per capita arable land in China continues to decline

Urbanization and industrialization have consumed significant portions of arable land (Liu & Zhou, 2021), exacerbating the strain on these resources (Zahoor et al., 2022). China faces a scarcity of per capita arable land (Yang et al., 2023), and high-quality arable land is particularly limited (Ye et al., 2024). As illustrated in Figure 1.5, agricultural land in China has been decreasing, stabilizing at 5.207 million square kilometers by 2021. Furthermore, it also depicted in Figure 1.5, from 2010 to 2021, per capita arable land in China has consistently declined, remaining significantly below the world average. In 2021, China's per capita arable land was 0.0771 hectares, merely 43.53% of the world average of 0.1771 hectares. The development of Chinese agriculture is thus constrained by the limited availability of land resources.

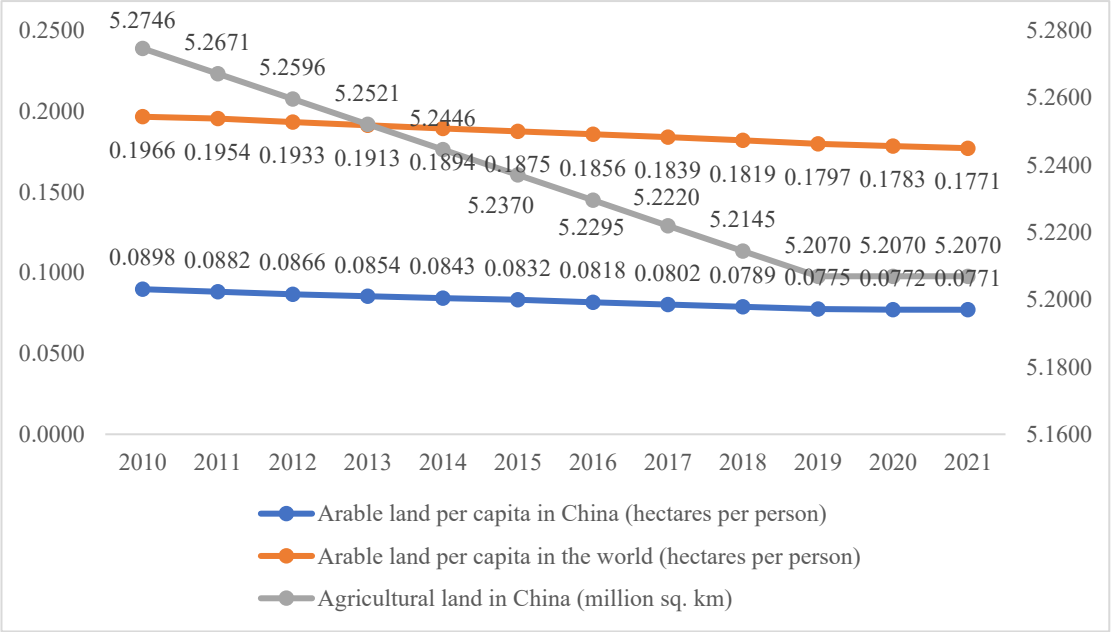

Figure 1. 5 Trends in Agricultural land in China, Arable land per capita in China and the World (World Bank, 2010-2021)

1.3.2(b) Agricultural labor force continuing decline

Since the reform and opening, the quality of life of Chinese residents has been greatly improved, and a moderately prosperous society has been built in an all-round way (Zhang & Xie, 2019). With the continuous development of urbanization, the demand for migrant workers in urban areas is also growing rapidly (Guan et al., 2018). In addition, the development speed of China's rural areas is relatively slow, and the income of farmers is relatively low, which leads to more farmers giving up agricultural production and going to work in cities. This has largely promoted the urbanization process, but also seriously restricted the development of rural areas. According to Figure 1.6, the number of the labor force in China's primary industry has declined greatly both in absolute terms and in proportion. In 2011, China's primary industry employed 264.72 million people, accounting for 34.8% of the total employment, and exhibited a long-term declining trend, to the end of 2024 to the lowest (162.98 million),

the proportion also dropped to 22.2%. However, a temporary rebound was observed in 2022. The COVID-19 pandemic and associated economic uncertainties prompted many rural migrant workers to return to their hometowns, either due to job losses in urban areas or as a precautionary measure during lockdowns. While the long-term structural decline in primary sector employment is expected to continue, the brief increase in 2022 reflects the sector's role as a labor buffer and a stabilizer during economic shocks.

On the one hand, the reduction in the number of employments in the primary industry is due to the reduction in the demand for agricultural labor caused by technological progress, but the most important reason is the loss of agricultural employees caused by external demand. Many rural families, with only the elderly and children at home, can engage in the agricultural labor force to go out to work, resulting in arable land being abandoned, which has a great negative impact on the development of the rural economy.

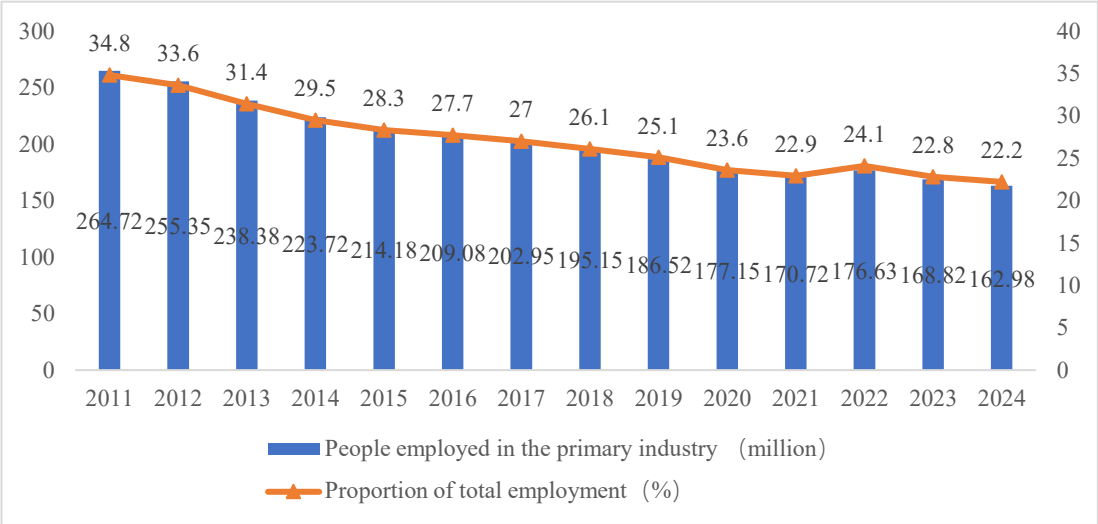

Figure 1. 6 Population employed in agriculture and proportion of total employed persons (China Statistical Yearbook, 2011-2024)

1.3.2(c) Excessive use of fertilizers and over nutrition on agricultural land

The excessive use of pesticides and fertilizers is a primary contributor to water pollution (Wato et al., 2020). Nitrogen and phosphorus from fertilizers can easily runoff into rivers and lakes, leading to eutrophication (Ngatia et al., 2019). Despite the rapid development of Chinese agriculture, overuse of fertilizers and pesticides, coupled with inefficient irrigation practices, has resulted in soil degradation (Lal, 2018), water resource contamination (Sun et al., 2022), and ecological deterioration (Wang et al., 2022). Additionally, Greenhouse Gas (GHG) emissions from agricultural activities exert pressure on the environment (Ma et al., 2024).

As illustrated in Figure 1.7, from 2010 to 2021, China's fertilizer consumption per hectare of arable land has consistently exceeded the global average. In 2021, China's fertilizer consumption was 374.81 kilograms per hectare, compared to the global average of 139.79 kilograms per hectare, representing a usage rate 2.68 times higher than the global level.

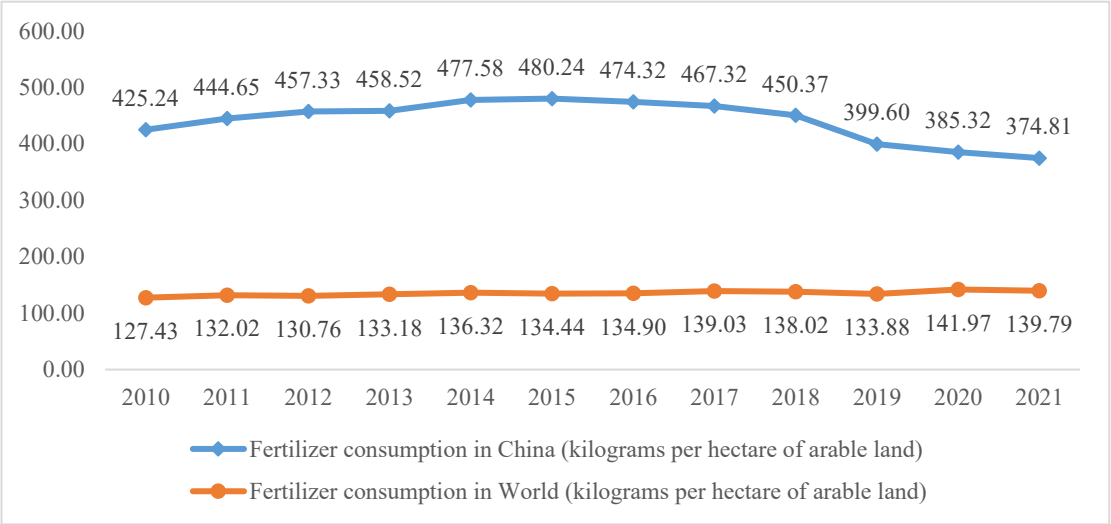

Figure 1. 7 Fertilizer consumption in China and World (World Bank, 2010-2021)

In conclusion, while China's agricultural sector has achieved remarkable growth, it faces substantial environmental challenges due to the overuse of agricultural inputs. Addressing these issues is crucial for AGD and environmental conservation.

1.3.2(d) Chinese agriculture is a huge contributor to global Greenhouse Gas emissions

Agriculture is a significant source of GHG emissions, including carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). As depicted in Figure 1.8, CO2 emissions from Chinese agriculture exhibited a steady increase from 2010, peaking at 297,671.67 metric tons in 2017, accounting for 16.83% of global agricultural CO2 emissions. Following this peak, emissions showed fluctuations, with 2021 figures at 273,422.21 metric tons, representing 15.62% of the global share.

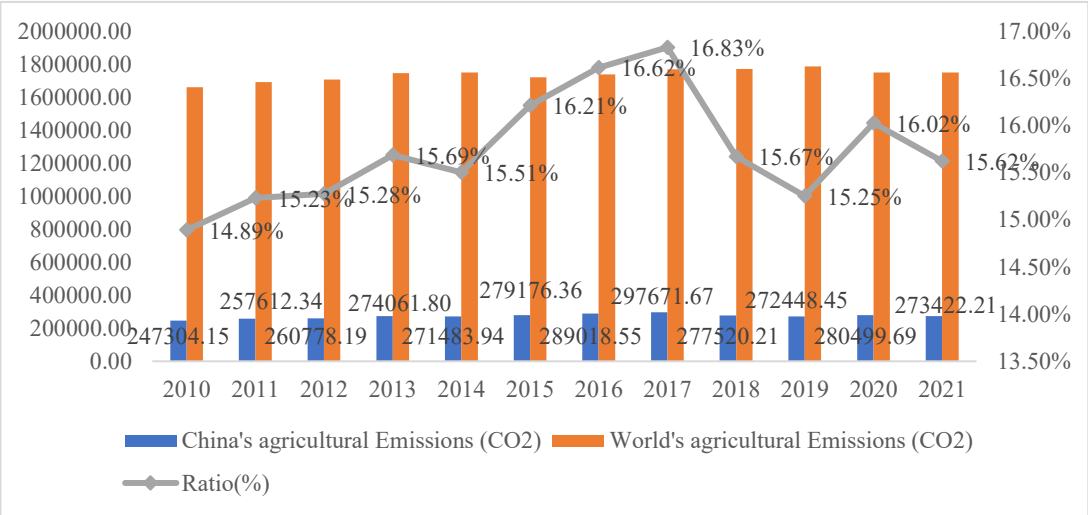

Figure 1. 8 CO2 Emissions in Agriculture of China and World (FAOSTAT database, 2010-2021)

Figure 1.9 illustrates that China's agricultural CH4 emissions have fluctuated from 2010 to 2021, reaching a low of 19,842.68 metric tons in 2019, which constituted 22.16% of the world's agricultural CH4 emissions. Throughout this period, China's share of global agricultural CH4 emissions remained above 22%, peaking at 23.05% in 2016.

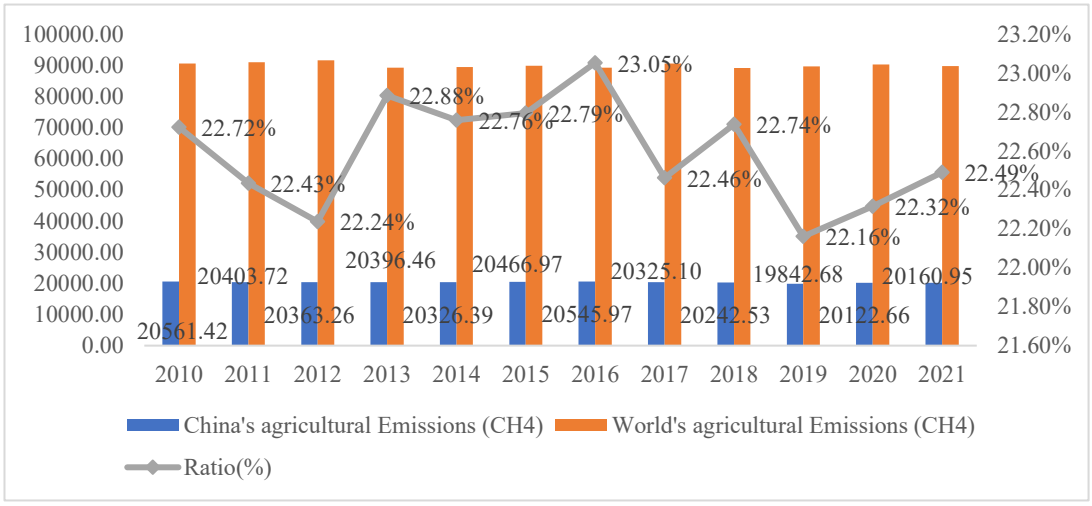

Figure 1. 9 CH4 Emissions in Agriculture of China and World (FAOSTAT database, 2010-2021)

Figure 1.10 shows the trends in N2O emissions from Chinese agriculture, which initially rose and then declined from 2010 to 2021. The peak occurred in 2015, with

emissions reaching 1,280.57 metric tons, making up 15.16% of global agricultural N2O emissions. This number declined continuously, reaching 1,090.69 metric tons in 2021, accounting for 12.55% of the global total.

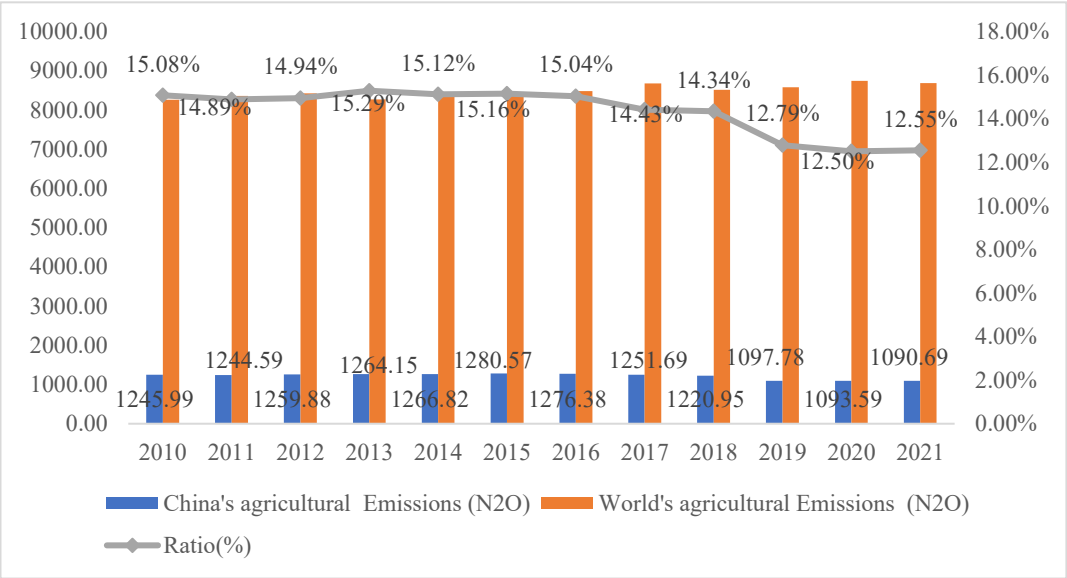

Figure 1. 10 N2O Emissions in Agriculture of China and World (FAOSTAT database, 2010-2021)

These trends highlight the significant contribution of Chinese agriculture to global GHG emissions and underscore the need for targeted strategies to mitigate these emissions in the context of sustainable agricultural practices.

To strengthen AGD, the Chinese government has introduced the Comprehensive Rural Revitalization Plan (2024–2027) and the Plan for Accelerating the Building of a Strong Agricultural Country (2024–2035). The Comprehensive Rural Revitalization Plan sets modernization and all-round development of agriculture and rural areas as its overarching goals, with ecological revitalization and green industrial development as intrinsic requirements. Building a Strong Agricultural Country is identified as the core pathway, clearly indicating the development direction for China’s agriculture. A

robust agricultural sector must be resource-efficient, environmentally friendly, and sustainable. The traditional approach of sacrificing the environment to increase output is no longer viable, ecological sustainability forms the foundational basis of a strong agricultural country. AGP serves as a key instrument and concrete practice for achieving ecological revitalization and realizing the goal of a strong agricultural country.

1.4 Rural Financial Sector in China

Rural finance (RF) refers to the monetary financing of rural areas and the economic activities associated with monetary circulation and credit (Adams, 2021). It integrates credit, finance, and the rural economy by reallocating funds within rural areas and is essentially the outcome of agricultural credit system reforms (Bouman, 2019). RF plays a vital role in China's development (Fan et al., 2023). Broadly, it encompasses all financial and credit activities related to agriculture, rural areas, and farmers. Narrowly, it refers to the provision of formal and informal financial services (such as deposits, loans, insurance, and securities) to rural households with limited savings capacity and severe financing constraints (Chahal, 2017). Beyond institutional outlets and products, RF also involves cultivating financial awareness and enhancing financial literacy among farmers (Khanal & Omobitan, 2020).

1.4.1 Performance of Rural Finance

RF originated in Europe and the United States, but China's exploration of RF started late and has undergone many transformations and is still in an imperfect stage (Zhang & Loubere, 2015). At present, China's rural financial environment has been improved to a certain extent, and a diversified and multi-level rural financial system has been basically established (Tian et al., 2020). However, the problem of difficult loans in the rural financial market has not been fundamentally solved (Qi, 2021). Agricultural insurance, agricultural futures, large-scale agricultural machinery financial leasing, land trust, direct financing of agriculture-related enterprises and other aspects of penetration and integration is not high, and the problem of imperfect RF functions is becoming increasingly prominent (Liu et al., 2022).

1.4.1(a) Rural financial institutions and their distribution

Rural credit cooperatives are the primary providers of financial services in rural China (Wang et al., 2020). Additionally, the Agricultural Bank of China (Zhao, 2017), the Agricultural Development Bank of China (Yeung et al., 2017), and the Postal Savings Bank of China (He & Zhang, 2017) have established branches in rural areas, offering basic financial services such as savings and loans. Recently, some commercial banks have also begun expanding their operations into rural regions (Wang et al., 2023). This has led to the formation of a "three-in-one" rural financial supply model, comprising commercial finance, policy-oriented finance, and cooperative finance (Liu, 2023).

According to the latest data from the China Banking and Insurance Regulatory Commission, as of December 31, 2023, there were 4,490 banking financial legal entities in China. Among these were 1,636 village banks, 1,607 rural commercial banks, 23 rural cooperative banks, and 499 rural credit cooperatives. The total number of licensed banking financial institutions in China was 225,382, which included 6,825 village banks, 61,556 rural commercial banks, 678 rural cooperative banks, and 10,707 rural credit cooperatives, collectively accounting for 35.39% of all licensed banking institutions. By the end of 2023, the total assets of rural financial institutions in China were approximately 54.61 trillion yuan, which is lower than that of state-owned banks, joint-stock banks, and city commercial banks, representing 13.1% of the total assets of banking financial institutions. Despite the increase in the number of rural financial institution branches, many remote rural areas still suffer from inadequate financial service coverage, making it difficult for rural residents to access financial services.

1.4.1(b) Agricultural loans balance continued to grow

In recent years, the construction of a rural payment system has made remarkable achievements (Wu et al., 2023), the sustainable development of rural financial institutions and the ability to provide services have been significantly improved (Wei et al., 2023), and the scale of rural financial institutions' agricultural loans has also been increasing, which has played a great role in promoting the development of agriculture and rural economic (Bai et al., 2022) and social development (Li et al., 2023). Figure1.11 shows the growth of agricultural loans from 2010-2023. The balance

of agricultural loans has been growing, but the growth rate has continued to decline from the highest (28.77%) in 2010 to the lowest (4.77%) in 2019 and has maintained a growing trend since then. By the end of 2023, the balance of agricultural loans was 56.6 trillion yuan, an increase of 14.34% over the beginning of the year.

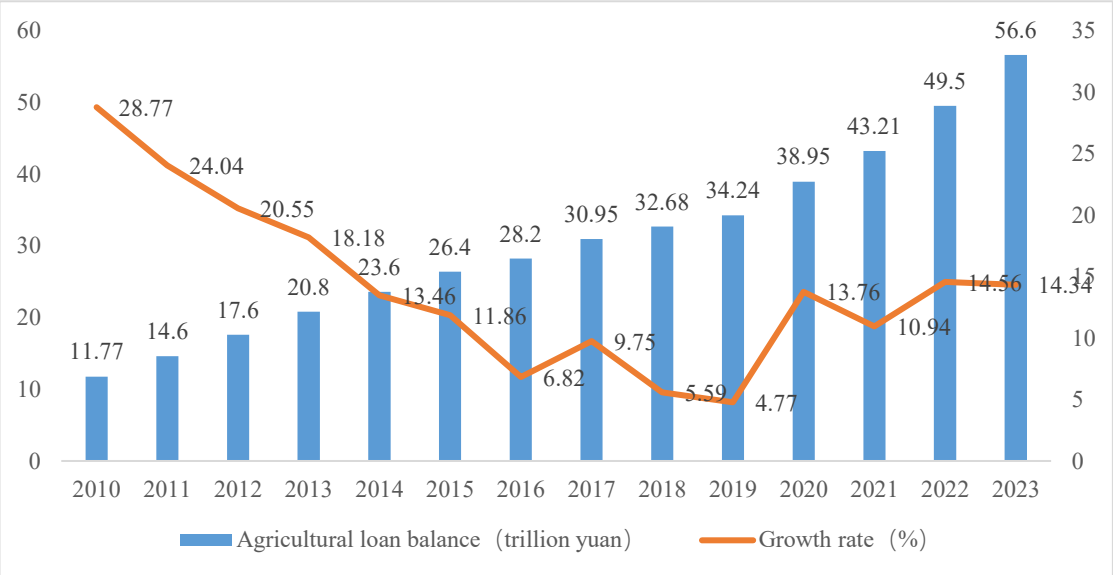

Figure 1. 11 Balance and growth rate of China's agricultural loans (People's Bank of China, 2010-2023)

The balance of agricultural loans in China has steadily increased in recent years, indicating a growing commitment from financial institutions to support agriculture, rural areas, and farmers. However, challenges such as high credit risk, elevated loan thresholds, and insufficient service coverage persist. To foster the sustainable and healthy development of agricultural loans, it is imperative to further refine the rural credit system, enhance the service capacity of financial institutions, and improve risk management practices.

1.4.2 Challenges of Rural Finance

This section discusses the key challenges confronting China's rural financial sector, including inadequate service provision, a narrow range of financial products, insufficient innovation, and weak risk assessment mechanisms, areas where DFI can play a transformative role.

1.4.2(a) Inadequate financial services for agriculture in rural areas

Over the past few years, China's rural financial products and services have continuously evolved and diversified to cater to the varied financial needs of rural residents and agricultural enterprises (Long et al., 2022). Agricultural credit remains the backbone of rural finance, yet loan amounts are typically small, application processes are cumbersome, and approval times are lengthy (Lin & He, 2023). The proliferation of internet and mobile payment technologies has gradually enhanced payment services in rural areas (Liu et al., 2023), with platforms like Alipay and WeChat Pay becoming increasingly popular (Ye et al., 2023). Despite this progress, the adoption and use of electronic banking services among rural residents remain lower than in urban areas (Cai et al., 2024). DFI, with its capacity to expand service coverage and streamline financial procedures, can address these limitations.

1.4.2(b) Limited financial products and services

Agricultural production requires substantial and ongoing capital investment (Diamond et al., 2023). Due to the long production cycles and high risks associated with agriculture, farmers and agricultural enterprises often face significant funding

shortages when purchasing seeds, fertilizers, and machinery (Zhong et al., 2023). Concurrently, as living standards improve, rural residents increasingly need funds for housing, education, and healthcare (Li, 2023). The existing financial products are predominantly focused on traditional loans and savings, lacking specialized financial products designed to accommodate the unique cycles and characteristics of agricultural production (Hu, 2023). This narrow range of services fails to meet the broader financial needs of farmers, including non-agricultural purposes. DFI can facilitate the design and delivery of diverse, customized products to meet both agricultural and non-agricultural financing demands (Gregory et al., 2025).

1.4.2(c) Lack of innovation

Rural financial institutions remain constrained by traditional banking models, slow product development, and inefficient processes (Ru, 2023). When faced with loan demand, due to asymmetric information sources and large infrastructure gaps, the loan approval process is complicated and time-consuming, which seriously affects the timeliness and efficiency of loans, resulting in an imbalance between financial supply and demand (Peisen Liu et al., 2023), and making farmers resist loan approval and prefer small loan companies. By leveraging big data, mobile platforms, and fintech solutions, DFI can improve efficiency, reduce costs, and foster innovation in rural financial services.

1.4.2(d) Challenges in risk assessment

Agriculture is highly susceptible to natural environmental factors (Roy et al., 2023). Seasonal changes, adverse weather conditions, and pest infestations can significantly threaten the quality and quantity of agricultural products (Skendžić et al., 2021), making it difficult for farmers to control yields and resulting in higher default risks. Due to information asymmetry, financial institutions struggle to obtain comprehensive and accurate credit information about farmers and agricultural enterprises, which exacerbates credit risk (He & He, 2022). The rural credit system is underdeveloped, with incomplete credit records, impairing financial institutions' ability to assess risk and make informed lending decisions (Qian, 2024). DFI, through digital credit scoring, blockchain-based traceability, and data-driven insurance models, can enhance risk assessment and broaden access to risk-sharing mechanisms (Lin et al., 2024).

1.4.3 Agriculture and Rural Finance in China

Over the past few years, with the advancement of the rural revitalization strategy, all financial institutions have achieved certain results in the development of rural areas, but most of the business is still dominated by rural credit cooperatives (Wang et al., 2023). The substantial improvement in rural credit cooperatives' performance is partly attributed to their market monopoly position in rural areas (Feng et al., 2023). The monopoly of the financial market of a single institution hurts the overall welfare level of the local area (Anshelevich & Sekar, 2015), and with the improvement of the

competitiveness of the financial market of the county, it can promote the development of its welfare level (Feng et al., 2023). The main economic source of China's rural areas is still farming, but problems such as insufficient productivity (Qin et al., 2022), few financial services (Tang & Sun, 2022), and a single market make agriculture in a weak position (Hu et al., 2023). The local government cannot invest the corresponding funds, resulting in the low overall income and assets of farmers and the scale of financial institutions is difficult to expand (Bin et al., 2023).

Figure 1.12 illustrates two ratios, which reflect the level of support provided by financial institutions to crop farming, forestry, livestock, and fishery, as well as the overall economic development. From 2011 to 2022, financial institutions' support for crop farming, forestry, livestock, and fishery accounted for approximately 60%. Nevertheless, their support for overall economic development has increased from 112.3% in 2011 to 176.82%, indicating that, compared to the overall economic landscape, financial institutions' support for loans in crop farming, forestry, livestock, and fishery remains relatively small. This growing disparity between the two has resulted in a substantial funding gap and a pressing need for financial support in agricultural production.