



The World Bank

Water Saving and Low Carbon Paddy Rice Program for Results (P178796)

Program Information Documents (PID)

Appraisal Stage | Date Prepared/Updated: 29-Mar-2023 | Report No: PIDA278759

**BASIC INFORMATION****A. Basic Program Data**

Country China	Project ID P178796	Program Name Water Saving and Low Carbon Paddy Rice Program for Results	Parent Project ID (if any)	
Region EAST ASIA AND PACIFIC	Estimated Appraisal Date 03-Apr-2023	Estimated Board Date 30-May-2023	Practice Area (Lead) Water	
Financing Instrument Program-for-Results Financing	Borrower(s) The People's Republic of China	Implementing Agency Hunan Provincial Department of Agriculture and Rural Affairs		

Proposed Program Development Objective(s)

To strengthen low-carbon and climate resilient rice production in Hunan province

COST & FINANCING**SUMMARY (USD Millions)**

Government program Cost	1,238.00
Total Operation Cost	1,238.00
Total Program Cost	1,238.00
Total Financing	1,238.00
Financing Gap	0.00

FINANCING (USD Millions)

Total World Bank Group Financing	250.00
World Bank Lending	250.00
Total Government Contribution	988.00

Decision



The review did authorize the team to appraise and negotiate

B. Introduction and Context

Country Context

1. **The Government of China has embarked on a path of green agriculture development, characterized with low GHG emission and sustainable production.** China's agricultural sector is one of the largest in the world. In 2021, the country's agricultural gross domestic product (GDP) reached CNY 8.3 trillion (US\$ 1.22 trillion), accounting for 7.3 percent of the national GDP.¹ Following the country's decision on carbon peaking before 2030 and carbon neutrality before 2060, the Government formally launched the China Green Agriculture Development Strategy in 2021 to move toward greener, more climate resilient, and sustainable agricultural development. Consequently, China issued the Implementation Plan for Emission Reduction and Carbon Sequestration in the Agricultural Sector in May 2022, considering rice paddy methane emission reduction as top priority. These policies paved the path towards low carbon rice production in China. However, such high-level guidance has yet to be fully translated into specific measures and actions to promote water saving and low carbon rice production at scale.

2. **China is the largest rice producer and consumer in the world.** Rice is essential for global food security. Rice is one of the most important staple foods for more than half of the world's population, accounting for 21 percent of global caloric intake and 15 percent of protein. China contributes to around 30 percent of global rice production, with a total of 30 million ha. harvested area. Rice is the staple food for over 60 percent of the population in China. Once a net exporter of rice, China has been a net rice importer since 2011 and emerges as the largest rice importer in the world, which marked a major change in the global rice market. Raising yields on existing rice lands in China is critical for food security in China and globally.

3. **Among all crops, rice is the largest greenhouse gases (GHG) emitter and the most water intensive grain crop.** Rice contributes to 48 percent of total crop emissions and around 2.5 percent of global anthropogenic emissions. In particular, rice is one of the principal anthropogenic sources of methane. It was estimated that the methane emissions from rice were 31 Tg CH₄ yr⁻¹ from 2008 to 2017, accounting for about 9 percent of global anthropogenic methane emissions. Rice production has even higher methane sharing in China—China is the world's largest methane emitter,² while rice accounts for 40 percent of China's agricultural methane emissions and 16 percent of the country's total methane emissions.³ Rice is also a "thirsty crop", with the largest irrigated harvested area globally. Rice production in China heavily rely on irrigation. Over 90 percent of rice areas in China are irrigated, much higher than the global average of 60 percent. Rice production in China also relies on excessive and inefficient use of fertilizers, and pesticides, contributing to significant environmental and carbon footprints.

4. **Reducing rice GHG emissions in China, especially methane emissions, is important to climate change mitigation globally.** Methane accounts for about half of the net rise in global average temperature since the pre-industrial era. Methane is a much more powerful greenhouse gas than carbon dioxide, however, it is also short-lived. In the first 20 years after its release, methane is around 80 times more powerful than carbon dioxide in global warming potential (GWP).

¹ Statistical Bulletin of the People's Republic of China on National Economic and Social Development in 2021. ([link](#))

² Kirschke et al. (2013) Three decades of global methane sources and sinks, *Nature Geoscience.*, 6, 813–823. ([link](#))

³ The People's Republic of China, Second Biennial Update Report on Climate Change. ([link](#))



But it also breaks down much more quickly than carbon dioxide. This means that curbing methane emissions could rapidly reduce the rate of global warming, leading to near-term gains in battling climate change. Therefore, the COP26 Global Methane Pledge highlighted that rapidly reducing methane emissions is regarded as the single most effective strategy to keep the goal of limiting warming to additional 1.5°C within reach, while yielding co-benefits of improving agricultural productivity.⁴ The COP27 reiterated the importance of reducing methane emissions, including reducing methane from rice cultivation. China has announced at COP27 that it had drafted a methane reduction plan, including reducing methane emissions from agricultural sector. The efforts to reduce methane emissions and water use from paddy fields in China can provide important lessons to other rice production countries worldwide.

5. **Rice production in China is also vulnerable to climate change.** The major rice production regions in China are increasingly affected by floods and droughts. The Yangtze River Basin, the region with the largest rice areas in China, had experienced the record-breaking floods in 2020 and one of the most severe droughts in 2022. Projections for the Yangtze River Basin indicate a hotter future, with more variable rainfall and more frequent floods and droughts. Rice production is one of the agro-ecosystems most vulnerable to climate change. Climate change has negative impacts on rice, such as shortening the growth period, decreasing yields, uneven quality, and increasing production costs. The increase in temperature also accelerates the decomposition nutrients, such as chemical fertilizer and soil organic matters. Climate warming in winter can also accelerate rice pests. Enhancing climate resilience of rice production in China is considered as the key priority to ensure rice yields and enhance food security.

Sectoral and Institutional Context

6. **Win-win solutions are available to significantly reduce rice GHG emissions and water use.** Methane is emitted from rice paddy due to organic matter decomposition under anaerobic soil conditions when soil is submerged under water. Therefore, better water management can reduce submergence, leading to the reduction of methane and water use. Water-saving technologies, such as alternate wetting and drying (AWD), can reduce up to 50 percent of methane emissions and 30 percent of water use without reducing the rice yields.⁵ Better fertilizer management can reduce GHG emissions, especially the emissions of nitrous oxide. Returning straws to soil can improve soil fertility and increase soil carbon sink. However, the decomposition of fresh crop straws under anaerobic soil conditions can also increase methane emissions. Combining AWD with proper straw returning can allow the aerobic decomposition of straw residues, which will significantly lower methane emissions. Therefore, the co-management of water-straw-fertilizer is considered as the package solution for low-carbon and climate resilient rice production.

7. **The government faces challenges in creating the enabling environment for promoting low-carbon rice at scale.** There is a lack of specific policies and technical standards to promote and guide the implementation of mitigation measures for rice production. The government also faces information challenges to better measure, report and verify the GHG emissions. Thus, developing a measurement, reporting and verification (MRV) system is crucial to track GHG emission reduction from rice paddy and to support carbon trading. In addition, irrigation and drainage related infrastructure development and O&M are managed by agriculture and water sectors in China. Agriculture sector is responsible for the development and operation and maintenance (O&M) of on-farm irrigation and drainage systems and small water storages, while water sector is responsible for the development and O&M of main irrigation systems. Strong coordination between agriculture and water sectors is needed to ensure good performance of the entire irrigation and drainage system and sustainability of the irrigation and drainage services.

⁴ Global Methane Pledge ([link](#))

⁵ Jiang Y. et al., 2019. Water management to mitigate the global warming potential of rice systems: A global meta-analysis. Field Crops Research ([link](#)).



8. **Farmers also face various challenges in adopting the package of climate mitigation solutions, especially the water saving technologies.** Farmers are facing system constraints. Adopting water saving technologies, such as AWD, require good irrigation and drainage services with well-maintained infrastructure. The flexible and well performing irrigation and drainage system with reliable water sources is essential. Well-leveled farmlands are needed to avoid irregular drying and wetting. Proper O&M with a sustainable financing mechanism are also key to enable these critical irrigation and drainage services. Farmers also lack incentive to reduce GHG emissions and save water. Irrigation is almost free in many regions, or is charged based on farmland area rather than the volume of water used. In addition, farmers lack capacity to adopt these water-saving and low carbon practices. Without proper training and adequate extension support services, farmers tend to stick to the traditional flooding irrigation and fertilizer practices which they are very familiar with.

9. **The Government's High-Standard Farmland Construction Plan (HSFCP, 2021-2030), lays a solid foundation for water-saving and low-carbon rice production.** The national HSFCP plan was issued in September 2021,⁶ which was followed by the provincial HSFCP for each province. The national HSFCP sets up ambitious goals to develop 1.075 billion mu (72 million ha.) high-standard farmlands by 2025, and 1.2 billion mu (80 million ha.) by 2030. In particular, the HSFCP highlighted the needs for international cooperation of utilizing international loans to support its ambitious HSFCP. Food security is the top priority of the HSFCP. The HSFCP has a strong focus on climate resilience. The high-standard farmlands are expected to maintain stable and high yields even under the impacts of floods and droughts. Therefore, developing well performing irrigation and drainage facilities is a key task of the HSFCP. This is well aligned with the system requirements of adopting water saving technologies, such as AWD. The HSFCP also emphasizes the improvement of soil fertility for yield enhancement through straw returning, organic fertilizer application and green manure use, which are also important parts of the rice production mitigation strategies.

10. **These recent policy reforms in China create good opportunities to generate incentives for water-saving and low-carbon rice production.** Promoting water saving and low carbon rice production can generate positive externalities of GHG emission reduction, water saving, and water pollution abatement. The country is now widely promoting eco-compensation mechanisms to reward positive (or to reduce negative) environmental externalities. Market-based eco-compensation mechanisms are also being piloted, such as carbon market, water right trading, and pollution emission trading, which can be leveraged to promote low-carbon rice transformation. In addition, China launched the Comprehensive Agricultural Water Pricing Reform program since 2016. This program was incorporated into the national HSFCP to enhance the sustainability of O&M. It lays the foundation to incentivize water saving through tariff reform, including establishing irrigation water right system, establishing volumetric water tariff regime, developing a water-saving reward system, promoting demand-driven irrigation water management, improving water flow measurement facilities, and empowering farmer water user associations (WUAs).

11. **Hunan Province, the province with the largest rice area in China, has a high potential to lead the way in water-saving and low-carbon rice production.** Hunan Province is selected as the Program Province. Hunan Province has 4.2 million ha. of rice harvested areas, which is nearly the same rice harvested area of the Philippines and around 60 percent of that area in Vietnam. Around 85 percent of the farmlands in Hunan are used to produce single- and double-cropping rice. Majority of the rice areas in Hunan are surface water irrigated. Hunan produces 13 percent of China's total rice production in a water intensive manner. Hunan started to promote rice water saving techniques in the 1990s. However, many farmers are still practicing continuous flood irrigation, especially on the farmlands where drainage facilities are

⁶ National High-Standard Farmland Construction Plan (HSFCP, 2021-2030) ([link](#))



lacking or deteriorated. Therefore, Hunan represents a global hotspot of rice methane emissions according to the space observation data from the Sentinel-5P satellite. Hunan Province committed itself in the provincial HSFCP (2021-2030) establishing high-standard farmlands in 85 percent of its farmlands by 2030. Embedding and scaling up water saving and low carbon rice practices through this ambitious provincial program are expected to reduce rice GHG emissions and save water.

12. Hunan Province is highly committed to climate adaptation and mitigation in the agricultural sector. Rice production in Hunan is highly vulnerable to climate change, with high exposure to floods and droughts. In 2020, Hunan had around 7 million people and over 95 percent of the counties suffered from another major flood after the devastating 1998 flood. In 2022, Hunan was heavily hit by the most severe drought since 1961. One third of the meteorological stations in Hunan did not observe any effective rainfalls for over 50 days and over 900 km of rivers were fully dried up. Frequent floods and droughts significantly impact rice production in Hunan. Therefore, enhancing climate resilience is a priority of Hunan HSFCP. Meanwhile, following China's carbon peaking commitment, Hunan Province issued the implementation plan for Hunan carbon peaking, including promoting agricultural mitigation measures, enhancing agricultural GHG accounting and monitoring, and exploring carbon trading. Hunan also issued the implementation plan for emission reduction and carbon sequestration in agricultural and rural sector in 2022, considering rice paddy methane emission reduction as the top priority.

PforR Program Scope

13. The Government program is outlined in ‘Hunan High-Standard Farmland Construction Plan’ (Hunan HSFCP, 2021-2030). Hunan issued its provincial HSFCP in June 2022, mainly for the farmlands of rice production. Hunan HSFCP has eight key tasks of ‘farmland-soil-water-road-forest-electricity-technique-management’, including connecting and leveling farmlands ('farmland'), enhancing soil quality and fertility by straw returning, applying organic fertilizer and green manure, deep tillage, protecting and improving plough layer, enhancing soil organic matters, lowering shallow groundwater table, improving sandy and clay soil types, and maintaining suitable soil pH ('soil'), improving irrigation and drainage systems by rehabilitating small water storages, constructing and rehabilitating irrigation and drainage facilities, and constructing efficient irrigation systems ('water'), improving farmland roads to meet the needs of agricultural machinery and transport ('road'), maintaining buffer zones with natural plants to prevent wind, water and soil erosions, and constructing ecological ditches to reduce pollution ('forest'), strengthening electrical networks to ensure agricultural electricity use ('electricity'), promoting good technologies and practices by enhancing agricultural machinery application, applying high quality seeds, promoting soil testing and formula fertilizer application, promoting integrated pest control, and enhancing training for farmers ('technique'), and improving O&M and monitoring ('management').

14. The PforR Program is anchored in the Hunan HSFCP to achieve win-win outcomes of reducing GHG emissions and enhancing resilience for rice production. The proposed PforR will be implemented at both the provincial and demonstration county levels. The PforR Program will leverage the opportunities in Hunan HSFCP to remove the system constraints for adopting mitigation measures and enhancing resilience, by building more reliable and flexible irrigation and drainage systems, leveling lands, enhancing soil quality and fertility, improving fertilizer and pesticide management, and improving associated high-standard farmland facilities. The Program will bridge the gaps to incorporate the mitigation concepts and measures into Hunan HSFCP, and scale up these measures with comprehensive training programs for farmers. Provincial policies, guidelines and standards will be developed and issued to guide the implementation of mitigation measures at the county level. The coordination mechanism between agriculture and water sector will be established. The Program will apply the provincial MRV system to track rice GHG emissions, including methane. Agricultural water pricing reform will be implemented to create incentives for saving water and to support sustainable



O&M. Carbon trading and water trading mechanisms will be explored and piloted to further financial incentives for farmers to invest and adhere to new water saving and low carbon rice production technologies.

15. The Program's Results Areas support a nested hierarchy of activities at provincial and county levels. The PforR Results Areas are the following:

(a) **Results Area 1: Strengthening government management system for sustainable development impacts at scale.** This Results Area will strengthen related policies, guidelines and standards, enhance the capacity of rice GHG measurement, reporting and verification, and establish coordination mechanisms between agriculture and water sectors at county level. Activities under Results Area 1 include:

- Developing and issuing a provincial incentive policy on water-saving and low-carbon rice production;
- Developing and issuing of the provincial strategy and implementation plan on water-saving and low-carbon rice production;
- Developing and issuing the provincial technical standards for water-saving and low-carbon rice production;
- Revising and issuing provincial water-saving irrigation quota for rice production;
- Issuing a provincial guiding document on water use right trading;
- Adopting a provincial MRV standard for carbon sequestration and GHG emission reduction from rice production, and applying the MRV tools in the selected counties to support carbon trading pilots;
- Establishing agriculture and water sector coordination mechanisms at the county level.

(b) **Results Area 2: Reducing GHG emissions from low-carbon development.** This Results Area will focus on the mitigation actions to reduce rice GHG emissions. Activities under Results Area 2 include:

- Constructing/upgrading high-standard farmlands, including the construction and rehabilitation of irrigation and drainage systems, the improvement of small water storages, land leveling, the improvement of soil quality and fertility, the development of on-farm access roads and windbreak shelter forests and grasses, and the development of associated facilities;
- Scaling up the key mitigation measures of water-straw-fertilizer co-management, along with some complimentary measures (including seed improvement and integrated pest management);
- Targeted training and capacity building to support farmers adopting mitigation measures, including actions to enhance the capacity of female farmers;
- Piloting carbon trading in the selected counties.

(c) **Results Area 3: Improving irrigation and drainage services for climate resilient rice production.** The activities under Results Area 3 include:

- Supporting comprehensive agricultural water tariff reform;
- Supporting sustainable irrigation and drainage services;
- Enhancing the capacity of farmer cooperative organizations and WUAs for O&M, including empowering women participation and leadership in O&M;
- Piloting water right trading or buy-back in the selected counties.

C. Proposed Program Development Objective(s)

Program Development Objective(s)



16. **The PDO is 'To strengthen low-carbon and climate resilient rice production in Hunan province'.** The PDO-level results indicators include:

- **PDO#1: Strengthened enabling environment for water-saving and low-carbon rice production.** The development and issuance of the five key documents at the provincial level that will enable and mainstream the production of water-saving and low carbon rice production and incentivize farmers to utilize the new production technologies and practices;
- **PDO#2: Net GHG emission reduction in demonstration counties.** The net GHG emission reductions in the six demonstration counties, measured by tons of CO₂ equivalent. The net GHG emission reductions will be mainly the result of methane emission reduction through water management, nitrous oxide emission reduction through fertilizer management, and carbon sequestration through straw management and soil fertility improvement. The MRV system will be used to estimate the net GHG emission reductions in the demonstration counties; and
- **PDO#3: Beneficiaries reached with improved irrigation and drainage services in demonstration counties (of whom women).** The total number of beneficiaries with access to improved and reliable irrigation and drainage service as defined in the HSFCP designs in the six demonstration counties.

D. Environmental and Social Effects

17. **An Environmental and Social Systems Assessment (ESSA) was prepared to evaluate the soundness of applicable environmental and social systems.** The ESSA screened the program activities and critically reviewed the legal and regulatory framework for E&S management relevant to the Program activities, including the legal framework, management procedures, and institutional arrangements, performance, resources, and capacity. The ESSA recommends a set of time-bound actions to address the identified gaps to enhance E&S management performance, consistent with the World Bank's core principles and planning elements.

18. **The overall E&S risks/impacts associated with these PforR activities are rated Substantial.** Consistent with the Bank Guidance on PforR ESSA, a Program-specific E&S exclusion list was established and the activities with the potential to cause significant adverse impacts that are sensitive, diverse, or unprecedented on the environment and/or people were excluded. Typical E&S risks under the Program include temporary small-scale construction-related and site-specific risks/impacts, such as nuisance dust, noise, wastewater, solid waste, soil erosion, limited project land use, and occupational health and safety (OHS) issues. In addition, the impacts on the local environment, society, and ecosystems resulting from the operation/implementation of the PforR supported facilities/activities include the workers' health and safety risks, Community impact, impacts caused by farmland transfer, livelihood impact due to small-scale land use and the price reform of agricultural irrigation water, and impact of ethnic minorities, and potential downstream impacts of non-physical activities, among others. These adverse E&S impacts are neither significant nor irreversible and can be easily identified, avoided, minimized, and mitigated through known and demonstrated technologies and good management practices. Neither the Bank OP/BP 7.50 (International Waterways) nor OP/BP 7.60 (Disputed Areas) applies to the Program.

19. **The ESSA concludes that China has established comprehensive systems and capable institutions for managing the related E&S issues at the provincial and local levels.** The legal framework consists of laws, regulations, guidelines, and standards that are largely consistent with the World Bank's Program for Results Policy and Directive. The systems



have corresponding implementation mechanisms and institutional arrangements for enforcing the legal frameworks. A fully financed and well constituted and staffed institutional structure through various official levels exists and efficiently operates to generally well execute the existing legal framework and to guarantee the achievement of sound performance tracks on the ground. The track records show that the management capacity and performance is generally sufficient and that the systems can provide an acceptable basis for addressing the possible E&S issues related to the activities supported under the PforR.

E. Financing

20. **Program financing.** Total program financing over the fiscal year (FY) 2024 to 2028 is expected to be US\$1,238 million equivalent, of which an expected US\$988 million (80 percent) will be financed by the Government and US\$250 million (20 percent) by the IBRD Loan. The proposed PforR will exclude high risk activities with potentially adverse impacts on the environment and or affected people. In addition, it will exclude activities that involve the procurement of (a) works estimated to cost US\$75 million equivalent or more per contract; (b) goods estimated to cost US\$50 million equivalent or more per contract; and non-consulting services estimated to cost US\$50 million equivalent or more per contract; or (c) consulting services estimated to cost US\$20 million equivalent or more per contract.

Program Financing

Sources	Amount (USD Million)	% of Total
Counterpart Funding	988	80
Borrower/Recipient	988	80
International Bank for Reconstruction and Development (IBRD)	250	20
Total Program Financing	1,238	100

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